PROPOSED GREEN/SUSTAINABILITY KNOWLEDGE AND SKILL STATEMENTS

All Career Clusters™

Agriculture, Food, & Natural Resources

Architecture & Construction

Information Technology

Manufacturing

Science, Technology, Engineering & Mathematics

Transportation, Distribution & Logistics

PROJECT OVERVIEW

The goal of this U.S. Department of Education funded project is to incorporate green- and sustainability-related knowledge and skills standards into existing career clusters. These standards follow the format currently used by the National Career Clusters™ Framework and represent an addendum to that collection. Find the current collection at http://www.careertech.org/resources/clusters/knowledge-skills.html.

States may, but are not required to, develop and implement career and technical education programs of study in one or more of the states' 16 Career Clusters™ identified by the National Association of State Directors of Career Technical Education Consortium that are recognized by the Office of Vocational and Adult Education. The 16 career clusters are occupational categories with industry-validated knowledge and skills statements that define what students need to know and be able to do in order to realize success in a chosen field. Within each of the career clusters, career pathways have been developed, which outline sequences of academic, career, and technical courses and training that begin as early as ninth grade and lead to progressively higher levels of education and higher-skilled positions in specific industries or occupations. Most, if not all, states are using one or more of the career clusters as the basis for implementing their career pathways.

These standards have been identified to help states and local programs to prepare individuals for green occupations by incorporating green knowledge and skills standards into existing career clusters and, in turn, career pathways beginning with the six career cluster areas that are likely to experience the greatest need for green workers: Agriculture, Food & Natural Resources; Architecture & Construction; Information Technology; Manufacturing; Science, Technology, Engineering & Mathematics; and Transportation, Distribution & Logistics.

There is a collection of green- and sustainability-related knowledge and skill standards that apply to all 16 Career Clusters™. This collection also includes definitions of many of the commonly used terms found in the each of the six cluster-specific collections. It will be published at the same online location as the six collections of green and sustainability Career Cluster™ standards. That location will be determined in the spring of 2012.

ALL CAREER CLUSTERS™

GREEN/SUSTAINABILITY STANDARDS

ALL CAREER CLUSTERS™

	KNOWLEDGE AND SKILLS STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Define the following key terms and explain their relationship to one another: • Green • Green job • Sustainability • Sustainable development	1. State the definitions of each term: Green: The term "green" has been loosely applied to any effort, product or initiative that proposes to benefit the environment. The term is not scientific and there is little consensus about what activities can qualify as "green" and which cannot. Green job: Jobs that help to protect ecosystems and biodiversity; reduce energy, materials, carbon and water consumption through high efficiency strategies; and minimize or altogether avoid generation of all forms of waste and pollution. Sustainability: The long-term, responsible management of environmental, societal and business resource use. Sustainable Development: An approach to development that meets the needs of the present in such a way that future generations can also meet their own needs. 2. Explain key elements of the relationships between green, green jobs, sustainability and sustainable development. • Green activities typically, but not always, employ the use of sustainability and/or sustainable development. • Green typically refers to environmental impact while sustainability refers to impact on the environment, people, and the economy. • Occasionally, activities labeled as "green" may benefit one aspect of the environment while being a detriment to another. Sustainability is perceived as a	1a. When presented with a term, provide the correct definition. 1b. Share the definition of sustainability and sustainable development in a presentation. 2a. Identify distinctions between the four key terms. 2b. Write a company memo explaining the company approach to sustainability. 3a. Identify examples of sustainability initiatives by organizations within a career pathway of interest. 3b. Prepare a report that describes the sustainability efforts of a given company in a career pathway of interest.

KNOWLEDGE AND SKILLS STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
	more comprehensive, systematic and scientific approach. • Green jobs may include occupations that directly benefit the environment, but they may also refer to occupations grounded in sustainability thinking and practice. Sustainable development includes the understanding that economic activities continue and evolve to meet the needs of individuals and communities within the limits of natural resources and ecosystems. 3. Identify applications of sustainability in careers, industries, and organizations of interest.	

GREEN/SUSTAINABILITY STANDARDS

ALL CAREER CLUSTERS™

	KNOWLEDGE AND SKILLS STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
2	Define the following core concepts of sustainability and green efforts/initiatives and explain how these concepts can contribute to the ability to solve societal, environmental and business problems while creating a more sustainable future. • Triple Bottom Line for business • Cradle-to-cradle resource use • Materials life-cycle analysis	1. Define each of the identified concepts. Triple Bottom Line for business: An approach that considers three primary outcomes: 1) higher quality of life for humans (people), 2) healthier ecosystems (planet), and 3) robust and equitable economies (prosperity) Cradle-to-Cradle resource use: An approach to the design of systems and materials that strives for resource use that is not just efficient, but waste free and not only mitigates harm to people and the environment but enriches and improves quality of life and ecosystem health. Life-cycle analysis: An inventory or assessment of the impacts of relevant energy and material inputs and environmental outputs at all stages of a product's life cycle. Is used to make more informed decisions about design, consumption, reuse, recycling, and disposal of product materials to promote the Triple Bottom Line. 2. Identify real-world examples of a business employing these concepts. 3. Evaluate an example of real-world implementation of these concepts in terms of the outcomes, costs and benefits.	1a. Match definitions and examples with each concept. 1b. Explain how each concept can be used to support or inform a green/sustainability initiative. 2a. Identify examples of how concepts have been applied by organizations in a real-world situation. 2b. Given an environmental issue and/or societal issue (e.g., access to clean water or air for all), describe how the concepts apply to organizations that may have a role in preventing or helping solve the issue. (e.g., role of transportation infrastructure) 3a. Describe projections of the impact of green/sustainability on career options within a given career cluster/pathway. 3b. When provided with a given career, explain how the use of green/sustainability concepts can help a person's career have positive impacts for society and the environment.

GREEN/SUSTAINABILITY STANDARDS

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	KNOWLEDGE AND SKILLS STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
3	Define and use the following enabling concepts of sustainability and green efforts/initiatives. • Precautionary principle • Ecosystem services • Ecological footprint • Tragedy of the Commons • Systems thinking • Unintended Consequences • Quality of life indicators	1. Define each of the identified concepts. Precautionary principle: If an action has a suspected risk of causing harm to people or to the environment the burden of proof that it is not harmful falls on those taking the action and the action is not taken until shown to be safe Ecosystem services: Benefits to humankind from the collective resources and processes of ecosystems (e.g., products like clean drinking water and air and processes like decomposition of wastes) Ecological footprint: A standardized measure of human demand on the Earth's ecosystems. Tragedy of the Commons: A dilemma arising from the situation in which multiple individuals, acting independently and rationally in their own self-interest, will ultimately deplete or destroy a shared limited resource, even when it is clear that it is not in the group's interest for this to happen. Systems thinking: The process of understanding how relationships, interconnections, and interdependencies within a whole and applying that understanding. Unintended Consequences: Outcomes that are not the ones intended by a purposeful action. Quality of life indicators: Standard indicators of the quality of life include not only wealth and employment, but also the built environment, physical and mental health, education, recreation and leisure time, and social belonging. 2. Identify real-world examples of these concepts used in context.	1a. Match definitions and examples with each concept. 1b. Explain how each concept can be used to support or inform a green/sustainability initiative. 2a. Identify examples of how concepts have been applied by organizations in a real world situation.

GREEN/SUSTAINABILITY STANDARDS

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	KNOWLEDGE AND SKILLS STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
4	Utilize problem-solving skills to address a real world opportunity to help create healthier ecosystems and communities while protecting or increasing organizational health.	1. Apply a problem-solving approach to a challenge or opportunity faced by a business or non-profit organization to improve sustainability efforts while maintaining or increasing profits or organizational health. 2. Explain how these problem-solving skills can be employed, at some level, by nearly all employees in an organization.	1a.Given a company scenario about a sustainability issue (e.g. spiking energy prices, mercury pollution from coal-fired power plants, material shortages, economic slowdown and increased unemployment), what actions can be taken at the corporate and individual level to help create healthier ecosystems, social systems, and bottom line performance. 2a. Research and explain examples of how problem-solving skills can be used by employees in a variety of roles and situations in an organization to promote sustainability.

AGRICULTURE, FOOD & NATURAL RESOURCES

AGRICULTURE, FOOD & NATURAL RESOURCES CAREER CLUSTER™

	KNOWLEDGE AND SKILLS STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Apply understanding of ecosystems and systems thinking to the management of natural resources to maximize the health and productivity of the environment, agriculture, communities, and society.	1. Identify how environment, economy, and social equity impacts are or are not integrated in AFNR organizational systems. 2. Explain restorative and sustainable (i.e., greening of the) terrestrial and aquatic management opportunities and fields. 3. Evaluate the synergistic opportunities within and between AFNR fields that utilize whole systems critical thinking and actions for a more green and sustainable future.	1a. Research geographical and demographic data to recognize the relationships between environment, economy, and social equity in various geographic areas. 2a. Evaluate the impacts on physical and biological ecosystem health, human health, and quality of life from a variety of AFNR management systems. 3a. Evaluate the resiliency and potential of a variety of AFNR management systems to create beneficial impacts on both the human quality of life and the surrounding landscape or waterscape mosaic. 3b. Explain the dependence of a variety of AFNR management systems on the surrounding mix of landscapes, waterscapes, and ecosystems.
2	Analyze community practice or policy development related to sustainability in AFNR.	1. Analyze impacts on sustainability of food policies and/or natural resources policies at the federal, state, and local levels in AFNR systems. 2. Evaluate the role of corporations, governmental agencies, non-profit organizations, and individuals in determining community practice and policy related to sustainability in AFNR systems. 3. Design and implement community education forums/programs related to sustainability in AFNR systems that elicit direct input from community members about project implementation and community well being.	1a. Describe key federal policies and programs, and level of federal funding, supporting farms and other food ventures, including size and scale, products (commodities, specialty crops, dairy, meats), and their content and potential if revised for sustainability. 1b. Explain where each proportion of the food dollar goes and why. 1c. Investigate policies and programs that support green/local food systems such as food policy councils, sustainable agriculture groups, and laws allowing small- and medium-scale sustainable food production and processing. 1d. Describe key federal policies and programs, and level of federal funding, supporting natural resources utilization, including size and scale, products (energy, materials, products), and their content and potential if revised for environmental and social sustainability. 2a. Identify the advantages and disadvantages of green/sustainability efforts led by each: corporations, government agencies, non-profit organizations, and

	KNOWLEDGE AND SKILLS STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
			individuals. 2b. Compare to the advantages and disadvantages of green/sustainability efforts led by coalitions. 2c. List examples of corporations, government agencies, non-profit organizations, and individuals taking roles in changing practice and/or policies and analyze those efforts in relation to green and sustainability goals. 3a. Conduct a forum on water conservation and water quality in your local community. 3b. Present an educational forum on green technologies in food production or landscaping to area producers and/or consumers.
3	Communicate the impact of "green" and sustainability principles on agriculture, food and natural resource systems.	1. Explain key concepts (listed below) central to understanding sustainability as it relates to agriculture, food, and natural resources. • Precautionary Principle and Risk Paradigm, exponential growth • population carrying capacity • ecological footprint • Tragedy of the Commons • systems thinking • laws of thermodynamics • principles of ecosystem function • Greenhouse Effect • law of unintended consequences • impacts of scale • effective change strategies 2. Develop a food system model that illustrates sustainability principles and can be adapted from a global to a local level. 3. Communicate the environmental and community costs and benefits of food that is grown using sustainable agricultural practices and is both	1a. Prepare a community presentation that describes the impact of green and sustainability principles on agriculture, food, and natural resource systems. 2a. Explain community-based marketing methods including direct marketing, CSAs (community supported agriculture), cooperatives, and wholesale distribution to institutions and larger buyers. 2b. Describe emerging agricultural practices including urban farming and community agricultural practices. 2c. List existing policies and programs that link farmers to institutions and consumers to support people knowing and appreciating local farmers, farming practices, and food heritage. 2d. Create a model that incorporates marketing, agricultural practices, and consumer education programs for the food system in a local community. 3a. List the potential environmental benefits from sustainable farming practices. 3b. Describe the potential economic benefits to communities from the economic multiplier effect:

	KNOWLEDGE AND SKILLS STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
		distributed and consumed in the region.	improved farmer viability, percentage of the food dollar, and customer loyalty. 3c. Describe the potential social/community value and public health benefits of sustainable agricultural practices that increase food security, local heritage, taste, skill preservation, and improved eating habits, and create less exposure to crop chemicals. 3d. List the potential costs of sustainable practices in food systems and explore financial and regulatory mechanisms to build workable business models. 3e. Develop presentations, articles, or digital media that communicate the costs and benefits of sustainability principles on food systems.
4	Recognize the social, health, environmental, and economic costs and benefits of renewable energy production (e.g., solar, wind, and biofuels) in comparison to non-renewable energies (e.g., coal, oil, and natural gas).	1. Perform a cost-benefit analysis on the various forms of renewable energy production and compare to a similar analysis for non-renewable energies. 2. Plan the use of energy conservation and renewable energies when designing a sustainable lifestyle or community.	1a. Compare the costs and benefits of renewable energies (e.g., solar, wind) and non-renewable energies (e.g., coal, natural gas), including often excluded factors such as impact on human and ecosystem health, volatile energy prices, and regulatory disparities regarding subsidies, financing and education of consumers. 1b. Conduct a cost-benefit analysis of growing biofuel crops versus other high market value crops. 1c. Compare biofuel production and use to other forms of renewable energy (e.g., solar, wind) and non-renewable energies (e.g., coal, natural gas, oil- based gasoline and diesel). 2a. Explain how renewable energies can be combined with conservation and green materials to create sustainable consumption and production. 2b. Identify federal and state policies that affect energy conservation and the production and use of renewable energies. 2c. Compare the support for and examples of community

	KNOWLEDGE AND SKILLS STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
			wind or community solar in Germany to the United States.
5	Analyze energy usage, renewable energy options, and renewable materials options to promote sustainable practices across AFNR.	1. Compare options for energy usage in an AFNR organization. 2. Compare options for renewable materials usage in an AFNR organization.	1a. Perform an energy audit of an agricultural or food facility and make recommendations for energy conservation and renewable energy retrofitting. 2a. Develop a renewable materials use plan for a natural resource extraction process.
6	Use green technologies and sustainability practices to maintain safe and healthful working environments that sustain the natural environment and promote well being in the AFNR workplaces.	1. Explain rules and laws designed to protect the natural environment and promote safe working conditions. 2. Evaluate the impact of green technologies on improving working conditions and sustaining the natural environment.	1a. List federal and state policies that use sustainability principles to protect the natural environment and promote safe working conditions. 1b. Locate working rules and procedures in AFNR organizations that are designed to protect the natural environment and promote safe working conditions. 2a. Explain the impact of new, green technologies on working conditions in horticultural applications. 2b. Discuss how new, green technologies impact the natural environment in mining operations.
7	Demonstrate an understanding of green and sustainability trends that are impacting processes and markets in AFNR.	1. Discuss the processes of change that are moving AFNR economics and practices in the direction of environmental sustainability and improved quality of life for communities. 2. Discuss the relationship between the advancement of green and sustainability practices and the need for continuing education/professional development.	1a. Identify the possible components of a green economy in AFNR systems. 1b. Create an action plan that would move an AFNR organization in the direction of green careers and sustainability. 2a. Identify the career opportunities that are emerging related to green and sustainability practices in AFNR. 2b. List continuing education/professional development opportunities for acquiring skills related to green and sustainability practices in AFNR.

GREEN/SUSTAINABILITY STANDARDS			
AGRICULTURE, FOOD & NATURAL RESOURCES CAREER CLUSTER™			
	KNOWLEDGE AND SKILLS STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
8	Apply adaptive ecosystem management to a common pool resource (e.g., an irrigation system or fishing grounds) problem which addresses ecological (data, models, concepts, understanding, and scientific responsibilities), socioeconomic (values, interests, information, assets, private sector responsibilities), and institutional (law, policies, authority, assets, public sector responsibilities) contexts.	1. Describe adaptive ecosystem management (i.e., joint employment of trial and error and scientific experimentation methodologies to determine a best management practice) and how it is an important sustainability tool.	1a. Discuss the use of adaptive systems management in natural resource management (e.g., Northwest Forest Plan or the Oregon Plan for Salmon and Watersheds).

GREEN/SUSTAINABILITY STANDARDS

AGRICULTURE, FOOD & NATURAL RESOURCES CAREER CLUSTER™—AGRIBUSINESS SYSTEMS PATHWAY

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Understand and apply knowledge of economic market models and international agreements to promote sustainability in agribusiness systems.	1. Describe social, economic, and environmental trade-offs between global free-trade and direct fair-trade models and commodity markets.	1a. Discuss the social, economic, and environmental impacts of NAFTA or other international trade agreements. 1b. Compare and contrast producer-to-consumer unsustainable supply chain scenarios to shared and sustainable value chain scenarios for a given product of international, national, and bioregional origin.
2	Use understanding of natural resources and conservation to develop policies and practices for agribusiness that promotes ecological and human health.	1. Develop an agribusiness plan that reflects the business' effect on the local economy, job market, and community health. 2. Identify connections between green and sustainable business practices/policies and a community's social, financial, and environmental health.	1a. Explain how water, air, and soil quality as well as climate stabilization and local ecosystem quality can be improved through a sustainable agribusiness plan. 1b. Create a plan for a local agribusiness that promotes ecological and human health while also improving the local economy, job market, and community health. 2a. Relate the impacts of the features of the federal farm bill to the viability of sustainable food businesses nationally and internationally. 2b. Predict the impacts on a community's social, financial, and environmental health with a change in a local business' sustainability policies.
3	Accomplish green and sustainable business goals (e.g., "triple bottom line") by employing leadership skills.	1. Use planning and leadership skills to achieve the "triple bottom line" – social well being, improved environment, and profit – for an agribusiness. 2. Communicate the benefit of the "triple bottom line" to employees, customers, and community stakeholders.	1a. Develop a business plan that addresses the goals of the "triple bottom line." 1b. Identify business strategies that promote a combination of social well being, improved environment, and profit. 2a. Develop key messages about the "triple bottom line" to use in speeches and articles. 2b. Employ change strategies to persuade others of the benefit of striving for "triple bottom line".

GREEN/SUSTAINABILITY STANDARDS **AGRICULTURE, FOOD & NATURAL RESOURCES CAREER CLUSTER™—AGRIBUSINESS SYSTEMS PATHWAY**			
	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
4	Analyze the added value of products or services in the marketplace when green and sustainability-based practices are featured.	1. List the green and sustainability-based features consumers seek in agricultural products. 2. Utilize tools, resources, and promising practices to help start a sustainable agricultural or food business.	1a. Identify the disadvantages and benefits of organic, Genetically Modified Organism (GMO)-free, hormone-free, pastured, free-range, natural, raw, biodynamic and/or other farming practices. 1b. List practices that legally allow for labeling of one of the green third-party certifications. 1c. List successful business models based on consumer demand for green and sustainable food products and the potentially successful models with changes in laws. 2a. Identify tools, resources, and promising practices for sustainable agricultural and food businesses. 2b. Locate examples of start-up and ongoing agricultural or food businesses focusing on green and sustainability-based products, practices, or services.

GREEN/SUSTAINABILITY STANDARDS

AGRICULTURE, FOOD, & NATURAL RESOURCES CAREER CLUSTER™—ANIMAL SYSTEMS PATHWAY

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Apply green and sustainability principles to animal (e.g., livestock, poultry, aquatic) production practices that prevent and/or mitigate negative impacts to the environment, animals, and humans.	1. Create and explain a systems map displaying the relationships between environment, economy, and social equity in a managed animal system. 2. Identify potential and actual negative environmental impacts of a managed animal system and be able to apply strategies to prevent and/or mitigate them.	1a. Identify the economic, environmental, and social/human components of a managed animal system. 2a. Describe potential negative environmental impacts of a managed animal system (e.g., waste runoff from a livestock feeding facility). 2b. List applications of green and sustainability practices to managed animal systems.
2	Design animal (e.g., livestock, poultry, aquatic) management and/or production systems that incorporate conservation of air, water, soil, and energy.	1. Develop a plan for an animal management or production system that incorporates strategies for conservation of air, water, soil, and energy. 2. Define carrying capacity in terms of the difference between extensive and intensive grazing systems and explain their subsequent effect on soil and fodder quality.	1a. Create animal-based ecological designs for conservation that include air (e.g., add efficient micro-organism (EM) technology amendment to corrals to reduce odor), water (e.g., live fencing/live trees as fence posts along waterways or pond and swale construction to capture gravity-fed water), soil (e.g., rotational grazing to eliminate overgrazing and soil erosion as well as soil compaction), and energy (e.g., chicken coops inside greenhouses to increase ambient temperature and extend growing season, biodigesters). 2a. Design rotational paddock systems and management plans that reflect the needs and behaviors of both large and small farm animals, improve site quality, and utilize solid waste.
3	Manage wildlife populations to achieve optimal ecological health.	1. Develop a wildlife management plan for a terrestrial and aquatic ecosystem, with emphasis on the connections between the two. 2. Compare current wildlife management plans to assess their sustainability and ecological effects.	1a. Identify the components of a wildlife management plan. 1b. Describe characteristics of optimal ecological health in a given ecosystem. 1c. Prepare a management plan for a local wildlife area. 2a. Explain the characteristics of a wildlife management plan that addresses sustainability. 2b. Assess a wildlife management plan for its effects on ecological and wildlife health.

GREEN/SUSTAINABILITY STANDARDS

AGRICULTURE, FOOD, & NATURAL RESOURCES CAREER CLUSTER™—ENVIRONMENTAL SERVICE SYSTEMS PATHWAY

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Apply sustainability principles, policies, and practices to environmental service systems to facilitate development of solutions for environmental and related human welfare issues, problems, and applications.	1. Explain why more comprehensive environmental testing services might be required in a society structured for sustainable development (i.e., meeting the needs of the present in ways which enable future generations to meet their own needs). 2. Define the environmental and human welfare impacts of different industrial practices and patterns and the benefits of industrial ecology solutions to mitigating environmental damage.	1a. Evaluate present environmental services testing in light of the precautionary principle of sustainability. 1b. Identify agricultural and development practices and testing services that cause or reduce soil erosion or help to restore soil fertility. 2a. Explain how to interact with water sources, including extraction, use, and restoration practices, to maximize sustainable yields. 2b. Explain how fisheries practices, regulations and technologies, and appropriate testing/measurement affect the capacity to replenish a sustainable population of fish. 2c. Describe causes of air pollution and the ability of ecosystems to absorb this pollution without causing environmental disruption (e.g., global warming) or human health issues and the implications for environmental testing. 2d. Describe how a composting facility collects food waste and distributes the resource back into the same bio-region.
2	Explain the costs and benefits of water reclamation in the context of ecosystem management.	1. Evaluate the processes of water reclamation in terms of beneficial and negative impacts on the environment, human welfare, and economies (i.e., household, community, and national economies). 2. Explain how water consumption can require energy consumption and what energy consumption applications are most beneficial to the environment. 3. Describe design elements of a water system (including waste treatment facility) that apply sustainability principles and increase "triple bottom line" benefits.	1a. Define the processes of water reclamation. 1b. List the benefits of various processes of water reclamation for the environment, human welfare, and the economy. 2a. Describe the relationship between water consumption and energy consumption. 3a. List how sustainability principles affect the design elements of water systems. 3b. Discuss the integration of economy, environment, and social equity in the financing and management of a water and/or wastewater treatment facility.

GREEN/SUSTAINABILITY STANDARDS **AGRICULTURE, FOOD, & NATURAL RESOURCES CAREER CLUSTER™—ENVIRONMENTAL SERVICE SYSTEMS PATHWAY**			
	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
3	Apply green technologies and sustainability principles in managing resource recycling programs.	1. Develop a management plan for a resource recycling program.	1a. Analyze the marketability and sustainability of recyclable goods. 1b. Develop strategies for reducing the flow of recoverable material into the waste stream. 1c. Identify ways to "close the loop" with a recycling or resource recovery program. 1d. Identify approaches for analysis and testing processes that can identify conservation, recycling, and resource recovery opportunities in a given context.
4	Apply green technologies and sustainability principles in developing waste management systems.	1. Develop a plan for a community or institutional waste management system which utilizes green technologies.	1a. List green technologies that could impact waste management. 1b. Describe the impact of sustainability principles on waste management. 1c. Design a waste management system for a greenhouse that utilizes green technologies.
5	Understand the role of environmental health and safety in creating a sustainable society.	1. Describe the components of an environmental health and safety program or department in a green/sustainable business. 2. Explain the role of environmental chemical testing in promoting health and safety. 3. Demonstrate procedures in environmental chemical testing.	1a. List the components of an environmental health and safety program. 1b. Identify measures to include in an environmental health and safety program that promote environmental and human health. 2a. Describe the need for environmental chemical testing. 2b. List environmental chemicals that are commonly found and pose a risk to human and environmental health. 2c. Explain the differences between naturally occurring chemicals and human introduced chemicals in the environment. 2d. Explain the role of human activity in causing changes in occurrence of naturally occurring chemicals. 3a. Conduct environmental chemical testing for surface

KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
		water and ground water. 3b. Conduct air emissions testing. 3c. Conduct environmental chemical testing for soil.

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Design and implement procedures and plans that demonstrate application of sustainability principles and policies to increase efficiency and reduce environmental impact of the food production and processing industry.	1. Use metrics to define the environmental impact of food products based on production, processing, and transportation techniques. 2. Develop plans to reduce the environmental impact of food products by applying green technologies and sustainability practices to production, processing, and transportation activities.	1a. Analyze the lifecycle of a food product. 1b. Calculate the "carbon footprint" of a food product. 2a. Create a plan to reduce the "carbon footprint" of a food product. 2b. List green technologies and sustainability practices that impact food processing and transportation.
2	Analyze the impact of various food production and processing practices and policies on ecological and public health.	1. Differentiate between conventional and organic food production practices in the context of public and occupational health impacts.	1a. Describe differences between conventional and organic food production practices. 1b. List the possible public and occupational health hazards of conventional and organic food production systems. 1c. Assess health risk and environmental justice concerns based upon case studies, socioeconomic mapping, and data collected via the employment of rapid assessment methodologies.
3	Demonstrate viable methods for local entrepreneurs and food processing businesses to process and distribute food products produced with green technologies and/or sustainable practices.	1. Plan services associated with the aggregation, preservation, storage, and packaging of sustainable food and food products to prepare products for distribution to various markets 2. Compare demand for specific sustainable food products and assess the potential of any given community to supply that product.	1a. List examples of successful sustainable food product development and marketing to various wholesale buyers, retailers, food service institutions, and households. 1b. Describe the processing, distribution, and regulatory infrastructure needed to support small-to-medium scale and specialty food processing and programs that support agricultural entrepreneurship. 1c. Describe the sustainable food entrepreneurship knowledge, technical assistance, and physical infrastructure available. 2a. Interview farmers about current crop surpluses, growing space, and plans for growth of sustainable practices. 2b. Compile demand statistics for sustainable food products in the form of graphs, charts, and articles and

KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
		compare demand with local versus regional, national, or international supply. 2c. Determine which messages are most effective at increasing the demand for green and/or sustainable food products. 2d. Identify alternatives to processed foods (e.g., raw foods, foraging [non-timber forest products], fresh, locally harvested).

GREEN/SUSTAINABILITY STANDARDS

AGRICULTURE, FOOD & NATURAL RESOURCES CAREER CLUSTER™—NATURAL RESOURCES SYSTEMS PATHWAY

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Apply green technologies and sustainability principles when planning and conducting natural resource management activities to determine the need, feasibility, and application of logical, reasoned solutions to natural resource system problems and issues.	1. Examine natural resource topics using systems analysis with attention to the relationships between environment, economy, and social equity. 2. Define the environmental impact of population, technology, and consumption habits on sustainability. 3. Summarize the inherent value of natural capital, such as soils, minerals, water, air, flora, fauna, and insects to managed ecosystems.	1a. Identify how ecological concepts and principles impact effective resource management. 1b. Create an analogy for how ecological concepts and principles function in a natural system. 1c. Analyze the issue of scarce water resources in the Mountain West in terms of relationships between the environment, local and regional economies, and status of people living in communities. 1d. Create a set of "greening" recommendations for a given natural resources dependent business to help them make profits while optimizing the positive impacts on the environment, economy, and community. 2a. Calculate the ecological footprint of the average person in different countries and explain the variance. 2b. Describe how population changes have affected sustainability. 2c. Explain how technology innovations have helped and/or hindered sustainability. 3a. Describe the value of soils, minerals, water, air, flora, and fauna to managed ecosystems. 3b. Examine the physical and chemical properties, and microbiological abundance of soil in healthy and degraded, natural and agricultural, ecosystems in relation to plant growth.
2	Develop strategies to influence natural resource management and utilization policies and practices through application of sustainability principles.	1. Identify how national and state policies affect the ability to perform preservation and enhancement activities. 2. Identify promising and proven institutional policies and practices that protect and restore the natural resource and environmental "commons" (public land, air, water bodies, fisheries, forests).	1a. Explain current national and state policies that impact natural resource preservation and conversation activities. 2a. Describe examples of natural resource "commons" restoration. 2b. List institutional practices that contribute to protection and restoration of large, public bodies of water.

GREEN/SUSTAINABILITY STANDARDS **AGRICULTURE, FOOD & NATURAL RESOURCES CAREER CLUSTER™—NATURAL RESOURCES SYSTEMS PATHWAY**			
	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
3	Understand principle factors that drive landscape ecological patterns and processes and explain their significance with respect to conservation planning and sustainable land use productivity.	1. Identify the factors driving ecological patterns and processes in a local ecosystem.	1a. Describe an example of a factor that drives ecological patterns (e.g., increased annual rainfall). 1b. Predict the impact on conversation and land use when ecological patterns change (e.g., change in types of crops that can be grown with increased moisture available). 1c. Hypothesize pollinator meta-population dynamics given varying numbers and sizes of natural habitat sites and the subsequent impact upon adjacent fruit and nut crop performance.
4	Understand different forms and costs and benefits of renewable biological energy (biofuels) options and their relative impacts upon soil, water, and air systems.	1. Evaluate the costs and benefits to soil, water, and air systems of the available forms of renewable biofuels.	1a. Discuss the available and potentially available forms of biofuels. 1b. Calculate air carbon mitigation/emissions between biofuel production in different ecosystems (primary forest, secondary forest, grasslands, and degraded lands).
5	Employ water conservation practices at AFNR enterprises and public works.	1. Develop a plan of water conservation practices for operations in AFNR including public water facilities.	1a. Create a plan for water conservation practices at a local agricultural operation. 1b. Develop an educational program on water conservation practices in horticultural applications for your community. 1c. Create a plan for the application of water conservation practices at a local public works facility.
6	Employ green technologies and sustainability practices that prevent and/or mitigate negative environmental impacts in materials (e.g., coal, sand, natural gas) extraction.	1. Assess material extraction practices for environmental impacts.	1a. List green technologies and sustainability practices that can help prevent and/or mitigate potential negative impacts of material extraction. 1b. From raw material extraction to finished product, trace the environmental and social impact of one consumer product and make recommendations for improvement.

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Understand how environment, economy, and social equity are integrated in plant systems.	1. Create and explain a systems map displaying the relationships between environment, economy, and social equity in a managed plant system. 2. Develop plant diversification practices for increasing the biological diversity on the land while maintaining ecosystem health and enterprise profitability.	1a. Identify the economic, environmental, and social/human components of a managed plant system. 1b. Describe potential negative environmental impacts of a managed plant system (e.g., soil runoff from a field). 1c. List applications of green and sustainability practices to managed plant systems. 2a. List examples of plant diversification practices. 2b. Evaluate the impact on ecosystem health and enterprise profitability when employing plant diversification practices. 2c. Describe the use of plant systems for bio-char applications.
2	Employ green technologies and sustainability practices that prevent and/or mitigate negative environmental impacts in horticultural production systems and landscaping.	1. Develop a landscaping plan that incorporates green technologies and sustainability practices (e.g., permaculture that is low energy, low maintenance, and edible; native plants; water conservation and onsite water recycling). 2. Create a plan for a horticulture production system which uses sustainable materials and green technologies.	1a. Identify the components of a landscaping plan that can be impacted by green technologies and sustainability practices. 1b. Prepare a landscaping plan that utilizes green technologies and sustainability practices for a local green space. 2a. Identify the sustainable materials and green technologies available in horticulture production. 2b. Demonstrate ability to apply sustainability practices in nursery production. 2c. Explain permaculture and native landscaping and their benefits and uses from a sustainability perspective.
3	Employ green technologies and sustainability practices that prevent and/or mitigate negative environmental impacts in crop production applications.	1. Create a plan for crop production which incorporates sustainable materials and green technologies. 2. Apply soil conservation practices in crop production.	1a. Identify the components of a crop production plan that can be impacted by green technologies and sustainability practices. 1b. Prepare a crop production plan that utilizes green technologies and sustainability practices for a local crop producer.

GREEN/SUSTAINABILITY STANDARDS **AGRICULTURE, FOOD & NATURAL RESOURCES CAREER CLUSTER™—PLANT SYSTEMS PATHWAY**			
	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
			1c. Design a closed-loop system for waste and resources on the farm to enhance plant growth. 1b. Develop an onsite composting system for both plant and animal wastes. 2a. Explain soil conversation practices in crop production (e.g., minimum tillage). 2b. Determine appropriate soil conservation practices in given crop production scenario.
4	Enhance plant production in natural environments through application of green technologies and sustainability principles.	1. Develop a plant production plan for a natural environment which utilizes green technologies and sustainability principles.	1a. Recognize multi-purpose tree (MPT) and shrub species for their combined environmental protection and food production attributes. 1b. Appraise native and introduced tree and shrub species for their value as multi-purpose components of integrated land management systems.

GREEN/SUSTAINABILITY STANDARDS

AGRICULTURE, FOOD & NATURAL RESOURCES CAREER CLUSTER™—POWER, STRUCTURAL, AND TECHNICAL SYSTEMS PATHWAY

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Apply green technologies and sustainability principles to engineering applications with mechanical equipment, biological systems, land treatment, power utilization, and technology to facilitate work in the power, structural, and technical systems.	1. Develop a plan for the use of an engineering application for a power system or technology system and make recommendations to make the application green and sustainable. 2. Assess the value of equipment and systems maintenance as a means to extend life cycle.	1a. Evaluate an engineering application in AFNR technology systems for its contribution to green and sustainability efforts. 1b. List emerging technology in agricultural machinery and equipment that contributes to green and sustainability principles. 2a. Explain how maintenance of systems and equipment can contribute to a healthy environment (e.g., less material in the waste stream, less demand for raw materials).
2	Plan, implement, manage, and provide green design and construction support services to facilitate the development of agricultural buildings and structures that promote sustainability.	1. Design AFNR buildings and facilities using green building principles and practices. 2. Evaluate farm site designs based on green and sustainability principles given constraints of relative location, multi-functionality, and efficient energy planning.	1a. Discuss applications of LEED certification elements to the design and construction of AFNR buildings and facilities. 1b. Identify technologies and practices that improve the energy efficiency of a greenhouse. 2a. Identify elements of farm site designs that contribute to green and sustainability principles. 2b. Discuss urban and rural farm development through the lens of built and natural environment integration and appropriate technologies adoption.

ARCHITECTURE AND CONSTRUCTION

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Understand the overarching significance of the building industry—design, construction and operation/ maintenance—in humankind's global "footprint" on the environment (e.g., impact on air, food, water, biodiversity, medicine, energy and other ecosystem services).	1. Compare statistics for consumption of energy, water, and materials and contributions to environmental degradation (pollution, greenhouse effect, etc.) attributable to the building industry in comparison to other sectors, such as transportation, industry, etc. 2. Compare simple pie-charts showing percentages of domestic energy use by type, water use, green-house gas production, etc., by building sector. Complement with charts showing consumption/contributions of other countries of the world on a "total" and "per capita" basis. 3. Explain human illnesses that are due to poor design or construction. 4. Explain displacement of wildlife and ecosystem degradation that is due to poor design choices or construction. 5. Explain loss of groundwater and ecosystem degradation that is due to poor design choices or construction.	1a. Calculate the ecological footprint of a given building being used in a certain way by its inhabitants. 2a. Calculate and compare the pollution caused by two buildings, one without, and one with, sustainable design/construction. 3a. List the human illnesses thought to be caused by pollution from fossil fuel combustion/utilization. 4a. Analyze a given building for its potential impacts on wildlife habitat and ecosystem degradation. 5a. Analyze a given building for its potential impacts on groundwater contamination.
2	Use integrated design process to accomplish green and sustainable outcomes in architecture and construction applications.	1. Identify team roles and where they are integrated from onset to finish of the building process. 2. Explain full life cycle costing, including the accounting for social and environmental impacts.	1a. Explain the role of each in the building process: the building user, architect, mechanical engineers, general contractor, craftsperson, and laborers. 1b. Describe how an integrated team approach can contribute to meeting green and sustainability goals. 2a. Explain the components of a given life cycle analysis of a building and identify what parts of the analysis are still incomplete.
3	Examine the impacts on environmental and societal conditions over the life cycle of a building including frequently overlooked externalities (e.g., pollution, health impacts on humans involved in material procurement, humans using the building,	1. Identify the environmental impacts in the design phase of a building (e.g., production of components, harvest of raw materials). 2. Identify the environmental impacts in the	1a. Describe a choice in the design phase of a building that has environmental impact, such as source of wood (e.g., recycled, rare). 2a. Describe efforts that can be made in the construction

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
	and environmental degradation).	construction phase of a building. 3. Identify the environmental impacts in the operation/maintenance phase of a building. 4. Identify the environmental impacts in the deconstruction/demolition/disposal phase of a building.	phase of the building to reduce environmental impact, such as minimizing ecosystem destruction, reducing waste from the jobsite and reducing the amount of transportation required for delivery of materials. 3a. Describe efforts that can be made in the maintenance phase of a building to reduce environmental impact, such as reduction of energy and materials use and reduction of operation/maintenance waste. 4a. Describe efforts that can be made in the deconstruction/demolition/disposal phase of a building to reduce environmental impact, such as site redevelopment/demolition waste, and recovery of useful products/disposal of waste products.
4	Evaluate the benefits and costs of green and sustainable applications in design, construction, and maintenance of the built environment.	1. Identify what makes a design or construction application greener and more sustainable. 2. Identify the health concerns of chemical, physical, and biological pollutants in the design, construction, and maintenance process.	1a. Review and explain the benefits of natural sunlight as it relates to worker productivity and pollution reduction. 2a. Explain the potential health impacts of high volatile organic compounds (VOC), content compared to the health benefits with low/no VOC options. 2b. Explain the positive effects of natural sunlight in a learning or working environment, such as Vitamin-D enrichment, counteraction to Seasonal Affective Disorder (SAD) syndrome, stress reduction, and better productivity, in comparison to the negative effects of not using natural sunlight in built environments such as dependence on fossil fuels.
5	Employ materials and components that are required to make the built environment more sustainable.	1. Identify methods, materials, and techniques that are consistent with green building and sustainable design. 2. Recognize what makes a material or product green/sustainable. 3. Gauge range of impacts on the environment to determine which green products and processes to	1a. Analyze a materials list for a building and create a list of substitute materials that are greener, i.e., more beneficial for both humans and the environment. 2a. Explain the cradle-to-cradle concept in comparison to the cradle-to-grave concept and give three examples. 3a. Identify metrics to compare products and processes based on their environmental impact.

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
		use.	3b. Identify more sustainable substitutes for typically unsustainable building practices and products.
6	Understand options to reduce energy loads and use "green" energy sources for building applications.	1. Determine how to quantify and qualify both design energy loads and material resource loads of a building and provide a comparative analysis with alternative, more sustainable solutions. 2. Describe how to assess, support and utilize incentive programs to enhance the attractiveness of sustainable design, construction, and operation/maintenance for the building owner. 3. Explain the inextricable linkage between water use and energy use, including the importance of understanding building science principles and humidity issues to prevent water damage and mold problems in a house and to optimize energy performance and healthy indoor air quality.	1a. Create an energy efficiency and renewable energy package for a given building, and calculate the dollar and pollution savings in energy generated by renewable fuels. 2a. Explain renewable portfolio standards, feed-in tariffs, community wind models from Germany, and present financing of renewable energies for a homeowner or business owner in the U.S., and explain how this compares to how coal-fired power plants are currently regulated, incentivized, and financed in the U.S. 3a. Consider water conservation and use of on-site water sources (rainwater harvesting, graywater use) as important strategies for energy conservation. 3b. Given a description of a building with moisture problems from poor construction or design, explain what is inappropriate about the building design and how to fix the problem.
7	Appreciate the regional aspects of green and sustainable building design and construction.	1. Consider how regional climate as well as resource availability will impact strategies of sustainable design and construction. 2. Explain regional natural/renewable resource availability (quantity and quality) and full cost economics of harvesting, such as sunlight for PV/solar electricity and solar domestic hot water, water for hydropower, wind for electrical power, and wood and/or biofuels for heat and co-generation. 3. Explain how to compare the full cost-benefit features with other non-renewable sources, including health costs and ecosystem services costs that may not be in the direct bills received by the building owner but are shared by society as a	1a. For a given building, discuss design adjustments for four different climate zones. 2a. Conduct a cost and savings analysis for a solar home design in a cloudy northern climate compared to a mild southern climate to show the cost effectiveness of the home for the colder climate. 3a. Review and explain the full cost analysis of coal-fired versus solar or wind-produced electrical power for a given building or community. 4a. Analyze the community level loss of economic dollars when buildings are inefficient and have unnecessarily high utility bills. 4b. Demonstrate the economic benefits to a community with a robust energy efficient building or weatherization

GREEN/SUSTAINABILITY STANDARDS

ARCHITECTURE & CONSTRUCTION CAREER CLUSTER™

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
		whole. 4. Understand the relationship between affordable green housing and community economic health.	program.
8	Communicate the value of green and sustainable practices in architecture and construction to co-workers and clients.	1. Evaluate and use green terms to communicate sustainability value where applicable to co-workers and customers. 2. Communicate sustainability practices to customers for operating and maintaining green built structures. 3. Define "green washing" and develop objective skills to provide balanced and informative green options/choices.	1a. Write an article that communicates the value of green and sustainable design in the built environment. 2a. Write and role play a sales presentation explaining the benefits of green and sustainable design. 3a. Identify examples of products that promote "green" without having significant positive impact on environment or human health.
9	Understand the standards, regulations, and codes intended to create a more green and sustainable built environment.	1. Identify regulations and standards specific to green building (e.g., (National Association of Home Builders (NAHB) Green Standard, Leadership in Energy and Environmental Design (LEED), Living Building, Passive House Institute US (PHIUS), Collaborative for High Performance Schools (CHPS), and International and Regional Construction Codes). 2. Describe green/sustainable standards and principles that go beyond the norm to maintain healthier buildings, ecosystems, and communities.	1a. Identify key and distinguishing attributes of various green building standards. 2a. Explain the differences between LEED, net zero building, and the living building challenge.

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1	Use integrated design teams to ensure the green and sustainability goals (i.e., equity and profitability, limited environmental impact, and the health, wellness, and quality of life of workers and building users) are achieved when designing new construction or remodeling existing construction.	1. Recognize the role of designers, engineers, consultants, stakeholders, and client when assembling an advisory team for green planning and development. 2. Explain the essential integrated design process that is used to optimize green and sustainable design principles. 3. Predict the impact of design and construction activities on environmental and human conditions. 4. Consult expert sources in the design of green and sustainable building. 5. Communicate to the client during the design and pre-construction phase the benefits of sustainable/green design and construction so that the design can be optimized for sustainability as much as possible.	1a. Describe the roles within the integrated design process. 2a. Explain the mistakes that occur and their environmental and human negative impacts when an integrated design process is not used. 2b. Describe how to conduct and facilitate a design charette to ascertain more optimal design ideas and build a community of learning. 3a. Predict the impact during the design/pre-construction phase on the physical site and work to maintain in the design the same or better ecosystem services (e.g., cleaning/providing water; providing food for wildlife) that were available in the original site. 3b. Predict the impact of the design/pre-construction on the health, wellness, and quality of life of building occupants. 3c. Predict the impacts of the design and construction process on the health, wellness, and quality of life of humans that provide the materials or energy or labor for the design and construction. 3d. Predict the impacts of the design and construction process on the health and wellness of the ecosystems that are changed to provide the materials or energy for the design and construction. 4a. Consult sustainable design and construction standards to maintain in the design and construction the same as or better ecosystem services than what were available in the original site (e.g., cleaning/providing water; providing food or shelter for wildlife, providing essential ecosystem services for the food chain). 4b. Consult sustainable design and construction standards to create in the design and construction the optimized use of energy efficiency, renewable energies, and green building materials to reduce pollution and other negative impacts from the building.

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			4c. Consult with both the designers (e.g., architects) and engineers throughout the design/pre-construction process to optimize the design for minimal resource use. 4d. Understand the existing certifications and innovations within the building industry to try to design the building to the highest standards possible for sustainability. 5a. Make a presentation to a theoretical or real community client that explains the benefits of green and sustainable design and the integrated design process.
2	Understand and use patterns, systems, and flows of land, materials, energy, and natural resources in the design of green and sustainable building projects.	1. Explain the significance of land use patterns — urban, suburban and rural—on the sustainability/unsustainability of the built environment. 2. Describe the growing significance of "embodied" energy (and water) in the total environmental impact of the building industry. (Embodied energy is the amount of energy required to extract, process, manufacture, transport, and erect the materials of a building. It also takes into account the pollution generated by that energy use.) 3. Explain the importance of the ecosystem services (e.g., cleaning the water) in an undeveloped site and the requirement in green design to maintain or even enhance those ecosystem services. 4. Evaluate site conditions and natural flows such as sun paths, water flows, nutrient flows, mineral flows, wind patterns, etc.	1a. Consider the competing advantages and disadvantages of differing development patterns and subsidies, especially urban versus suburban "sprawl," on transportation needs, water resources, wastewater disposal, agriculture, etc. 1b. Consider the rehabilitation and re-use of existing buildings and infrastructure rather than of new construction. 2a. Consider ways to reduce the expenditure of embodied, polluting energy in building practices. 2b. Consider ways to reduce water use in the building. 3a. Define "ecosystem services" and provide examples of how we are all reliant on them (e.g., clean water, timber, pollination, etc.). 3b. Describe how ecosystem services are being compromised by humankind. 3c. Identify ways in which we can protect or even enhance ecosystem services during the design process. 4a. Take advantage of natural flows of the site in design alternatives to utilize water, light, heat, air, and nutrients effectively and efficiently with positive environmental impacts.

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3	Understand how the selection of, and design for, the facility site and landscape can improve the impact of the built environment on the green environment.	1. Define how the site's selection can mitigate greenhouse gas emissions by governing necessary travel to and from the facility. 2. Explain how redeveloping a brownfield site can represent a positive step for the community. 3. Define how choosing sites in already developed areas can save time and money and reduce negative impacts on the site. 4. Explain why it is important not to build sites in areas with potential future problems (such as areas with steep slopes or high water tables). 5. Describe how a building's relationship to the sun has a large impact on energy use, and how window placement, appropriate use of mass storage, superinsulation, building orientation, and landscaping can dramatically reduce the need for heating and cooling a building. 6. Use sustainable design principles in the landscaping of the built environment.	1a. Create a comparative analysis between two sites for their potential transportation impacts on the emissions of greenhouse gases. 2a. Create an educational presentation about a local existing or potential brownfield redevelopment (that can perhaps be used at the building site or posted for the public). 3a. Given two sites and assumptions about where the building occupants live and times for commutes, calculate the productivity improvements (time and money) for building occupants in a potentially redeveloped site in comparison to a new site located outside of the existing infrastructure. 4a. Discuss and estimate reductions in quality of life and community/taxpayer costs incurred when buildings are on sites that risk potential damage from predictable extreme weather events. 5a. Review buildings that have received national awards for their super-insulated and solar designs, including their savings in utility costs and their reduced pollution. Identify what features made these buildings more effective. 6a. Describe why it is best to select native plants for low-impact landscaping (well adapted to climate, require little or no irrigation). 6b. Describe why it is best to select plants with similar needs (i.e., "zoning"). 6c. Describe how the practice of xeriscaping, particularly in the Southwest, can reduce irrigation needs and oil-based pesticide use. 6d. Explain how designing bioswales and rain gardens can absorb and treat stormwater runoff from paved areas. 6e. Describe advantages of installing permeable pavement, particularly in areas where vehicles drive or park.

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			6f. Describe how pavement that is light colored (high albedo) can reduce overall temperatures and lower air conditioning requirements of surrounding buildings. 6g. Describe how you could encourage the use of alternative transportation in your design of the "hardscape" surrounding the building. 6h. Describe the use of permaculture to produce low energy, low maintenance, and edible landscaping that has beneficial environmental, social, and economic impacts.
4	Understand the impact of material and energy sourcing in design of green and sustainable buildings.	1. Describe options for local (on-site) sourcing of electrical and thermal energy production. 2. Describe how the construction materials chosen can impact the quality of the indoor environment.	1a. Use a solar pathfinder to measure solar access for a site. 1b. Use quality web-based modeling software to run production options for differing array sizes and equipment efficiencies for solar electricity and similar web-based modeling for solar thermal, local wind, and local geothermal collection and use. 2a. Identify products that have chemical constituents that offgas into the indoor environment and how they can be replaced by greener and more sustainable materials or managed to mitigate overexposure for the building occupants and surrounding community. 2b. Identify products that are absorptive (i.e. soak up or attract other substances from the environment around them) and how to properly maintain them during operations to avoid causing IAQ problems. 2c. Identify products that affect acoustic, thermal, or visual properties of a space that ultimately influence an occupant's experience of a building. 2d. Identify those materials that are more or less polluting in their extraction, production, use, and disposal or reuse.
5	Understand the impact of design decisions for lighting, heating, and cooling on the sustainability of buildings.	1. Explain architectural day lighting, applications and design options, analysis, and implementation. 2. Explain the use of glass and glazing systems for	1a. Conduct day lighting analysis and integrated energy efficient artificial lighting analysis and controls. 1b. Understand the heating/cooling load implications of

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	light and view harvesting and thermal envelope control. 3. Distinguish between basic and green versions of HVAC system options, both residential and commercial, for integrated design strategies and systems coordination, including how design choices regarding air infiltration reduction, superinsulation, moisture control, energy recovery ventilation systems, and other design choices can reduce or eliminate the need for nonrenewable energy systems.	various day lighting strategies. 1c. Explain basic principles and effective applications of overhead sky lighting (roof monitors) and sidewall lighting. 1d. Explain the effects of reflectivity and absorptivity of materials. 1e. Explain the effects of color, texture, and finish on daylight quality and quantity. 1f. Know how to use simulation software to model and analyze daylight harvesting design choices. 1g. Understand the principles and techniques of daylight harvesting controls and integration with artificial lighting systems. 1h. Understand use and design of light shelves for both exterior and interior applications. 2a. Explain and describe the importance of SHGC (solar heat gain coefficients), VT (visible light transmission), coatings, laminations, gases, thermal break systems and techniques, multi-glazing, seals, and air-spaces. 2b. Demonstrate how to calculate performance (u-values as reciprocals of insulation values, conduction heat loss and air infiltration loss) of system components. 2c. Explain the importance of appropriate window selection and installation procedures as part of the design. 2d. Understand that high R values, a vapor barrier and sealing on at least three sides, are the components of quality thermal shutters or drapes. 3a. Understand occupancy types and HVAC load implications. 3b. Know basic mechanical HVAC systems and delivery methods. Understand radiant and convective heat transfer

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			systems. 3c. Understand passive conditioning strategies. 3d. Understand ventilation/make-up air systems and the value of reduced air infiltration and energy recovery systems. 3e. Understand occupancy sensors and their application as energy efficient controls and indoor air quality. 3f. Understand healthy oxygen levels, the ill-effects of high CO2 levels and other indoor air pollutants, and the possible control systems and other design strategies to create healthier indoor air. 3g. Understand the relative energy content of fuels, the differences between energy content of fuels and converted energy value of fuels, and the pollution caused by each of the fuels. 3h. Understand basic sources/forms of renewable energy and their possible applications in green and sustainable design.
6	Use modeling and analyzing tools and strategies to improve green and sustainable design decisions for a building.	1. Employ energy modeling to determine the impact of design decisions and differentiate between design alternatives. 2. Explain how building modeling, analysis, simulation, and other software can be utilized. 3. Use the analysis of calculated building heating and cooling thermal loads, both seasonally and at design conditions, to minimize pollution from the building's operation.	1a. Identify typical inputs and outputs for energy modeling. 1b. Utilize energy model software to determine energy consumption of a proposed design. 1c. Develop design alternatives that minimize energy use while appropriately meeting client needs. 1d. Identify limitations of energy modeling. 1e. Explain the concept of sensitivity analysis in regard to energy modeling. 2a. Use computer software to produce greener design and construction documents. 2b. Use architectural and engineering software in conjunction with integrated (Building Information Modeling (BIM) search engine software (or newer versions

KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
		as they become available) for building product specification based on environmental performance criteria. 3a. For a given building, explain how to optimize the design for reduced heating and cooling loads and pollution minimization. 3b. Explain differences between internal thermal loads and external thermal loads. 3c. Explain differences between latent and sensible loads. 3d. Explain how weather conditions are some of the driving forces for building thermal loads. 3e. Explain a psychometric chart, the moisture content of air and its relationship to energy use. 3f. Explain the value and techniques to design for superinsulation, reduced air infiltration, and the utilization of energy recovery ventilation systems.

GREEN/SUSTAINABILITY STANDARDS

ARCHITECTURE & CONSTRUCTION CAREER CLUSTER™—CONSTRUCTION PATHWAY

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Describe how each role and tradesperson on the building site can contribute to the greening of the building's construction.	1. Identify how various trades can impact each other's work, especially with regard to air sealing, insulation detail, and moisture management. 2. Identify specification language that is unique to green building projects. 3. Identify best practices that are unique to green building projects. 4. Describe typical submittals and requirements of subcontractors on a green building project pursuing third-party certification. 5. Speak with and listen to individuals performing specific trade functions related to the built environment.	1a. Complete a document that describes how each trade can contribute to greener, more sustainable construction. 2a. Fill in a given set of specifications with green construction language. 3a. When given a list of practices, identify which are best practices for green construction. 3b. Demonstrate best practice skills for green construction. 4a. Fill out appropriate documents for third-party certifications of a green building 5a. Create a summary report of key information from interviews with/presentations from specific green building experts.
2	Explain how properly constructed high performance building envelopes can eliminate unnecessary uses of energy for heating and cooling.	1. Describe the relative value of wall insulation, window u-factor, and framing factor in wall assembly performance. 2. Identify the importance of insulation installation in overall wall performance. 3. Define how sealing cracks and ensuring the continuity of air barriers can reduce infiltration. 4. Identify building science details that have climate-specific design responses.	1a. Present the benefits of superinsulation in terms of occupant comfort and life cycle economic benefits. 2a. Describe common mistakes in inappropriate insulation installation. 3a. Demonstrate and describe best practices for reduced air infiltration. 4a. Present the basics of building science that are essential to build healthier and greener buildings.
3	Understand how site considerations can mitigate and minimize the negative environmental impacts of construction projects.	1. Describe the conditions that cause demolition and construction industries to be the single largest contributor to the solid waste stream. 2. Describe ways in which the amount of environmental damage caused to a project site during construction can be reduced.	1a. Identify ways to reduce the solid waste generated by the construction industry, and describe the pollution reduction and economic benefits of systemizing these strategies within a company. 2a. Identify ways to prevent loss of soil due to stormwater runoff and wind erosion (e.g., use of silt fences). 2b. Describe ways of protecting topsoil for reuse. 2c. Identify ways to prevent pollution of water and

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			sedimentation of storm sewers or receiving streams. 2d. Identify ways to mitigate air pollution from dust and particulates.
4	Explain how the selection of materials and assemblies can contribute to green construction of a building.	1. Describe options for on-site sourcing of construction materials. 2. Distinguish air barriers from vapor retarders and vapor barriers, and describe proper design and installation for optimal building performance. 3. Explain the use of water-resistive barriers and their proper design and installation to protect against accumulation of water in walls and optimize the performance of the building envelopes.	1a. Identify material types (e.g., clay, stone, straw bale, and wood). 1b. Determine harvestable quantities of materials. 1c. Evaluate alternative harvest methods. 1d. Determine impacts on project budgeting and the environment of material selection. 2a. Apply working knowledge of IR (infra-red) cameras for diagnostics. 2b. Demonstrate ability to conduct or oversee first-instance testing. 2c. Demonstrate ability to conduct or oversee whole building blower door testing. 2d. Identify which materials are vapor retarders, vapor barriers, or air infiltration barriers and describe the appropriate use of each. 3a. Explain drainage plane principles, capillary breaks, and effective system design strategies and techniques. 3b. Describe flashing principles and techniques. 3c. For a given building and climate, select appropriate vapor barrier materials, and demonstrate effective installation.
5	Understand how indoor air quality considerations can mitigate and minimize the negative environmental and human impacts of construction projects.	1. Explain techniques for mold prevention, how to recognize early warning signs, and conditions to improve indoor air quality. 2. Explain the negative impacts of VOC and other potentially harmful construction material	1a. Identify causes of mold on and in buildings. 1b. Describe types of testing and remediation services available. 2a. Verify low/no VOC through product specification literature and Material Safety Data Sheets (MSDS) and

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
		exposures and the importance of reduction in exposure for construction installers and post-construction occupants.	Product Safety Data Sheet (PSDS). 2b. Understand the various testing techniques and indoor air quality (IAQ) monitoring equipment types. 2c. Explain construction techniques (e.g., flushing the building) that minimize worker exposure to untested or harmful chemicals during the construction process.
6	Explain how the selection of tools and techniques can contribute to green construction of a building.	1. Use building practices associated with green and sustainable construction that are a departure from traditional practices. 2. Explain the uses, appropriate application, performance characteristics, and compatibility with other products of building sub-components used to control air and water movement (e.g., sealants, caulks, adhesives, tapes, and gaskets) to maximize the performance of the building envelope for energy efficiency, reduce negative environmental impacts, and maximize use of green materials. 3. Explain the uses, appropriate application, performance characteristics, and compatibility with other products of building sub-components used to transition between materials (e.g., fasteners and flashings) to reduce premature system failure and maximize the performance of the building envelope for energy efficiency, reduce of negative environmental impacts, and maximize use of green materials. 4. Describe product installation requirements and pre-installation job site conditions such as moisture control.	1a. Communicate green practices, materials and systems to the building team and client. 1b. Use correct sequence and orientation for installation processes utilizing green team methods. 1c. Identify building techniques and materials affiliated with green practices. 1d. Identify what may be required beyond the traditional building codes to consider construction practices "green." 2a. Understand the appropriate use of sealants and caulks to withstand adverse weather conditions. 2b. Understand the appropriate use of sealants and caulks for thermal, acoustical, and fire safety performance. 2c. Understand proper installation of caulks/sealants and premature fatigue prevention techniques. 2d. Understand the use of tapes and gaskets for thermal performance and as barriers to adverse weather conditions, as well as uses for joint geometry. 3a. Understand galvanic action and material compatibility and incompatibility against corrosion by reading a galvanic chart. Understand chemical reactions on fasteners (e.g., alkaline copper quaternary (ACQ) pressure treated wood, aluminum fasteners, etc.). 3b. Understand chemical reactions to optimize materials selection and installation (e.g., PVC and ethylene propylene diene Monomer (EPDM) roofing materials are

KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
		incompatible long term with asphalt products used in drainage plane flashing such as bituthene and building felt). 3c. Understand greener alternatives to fasteners and flashings. 4a. Understand the use of a moisture meter for reading moisture content of wood fiber prior to encapsulation and/or painting. 4b. Understand the need for testing moisture content of concrete slabs prior to application of adhesives and finishes.

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Understand how preventative maintenance methods can increase energy efficiency and reduce pollution from a building and its site.	1. Describe how continuous commissioning can identify ways to improve energy efficiency with existing equipment. 2. Identify ways in which a lighting retrofit could reduce energy pollution and waste. 3. Identify how water conservation choices in equipment and settings can save energy and reduce pollution. 4. Identify how high-performance HVAC systems can save energy and reduce pollution. 5. Identify how appropriate landscaping can save energy and reduce pollution. 6. Identify how green cleaning products can reduce pollution in a building and throughout the product supply chain (e.g., the production, use, and disposal or recycling of the green cleaners). 7. Describe how improving the performance and sustainability of one component in a building system can positively impact the performance and sustainability of related components (e.g., retrofitting lighting systems to be energy efficient and reducing waste heat from the lights which, in turn, increases the heating demand beyond the capacity of the existing heating system but also lowers the size needed for a replacement air conditioning system). 8. Describe the value of recommissioning a building (i.e., redesign the use of an existing building structure) to optimize performance. 9. Describe how to analyze and implement replacement of fossil fuel-based equipment with renewable energies-based equipment when planning building updates.	1a. Demonstrate controls calibration. 1b. Develop and present a preventative maintenance plan to optimize building performance for a given building. 1c. Develop and present a system for staying updated on new green/energy efficiency/renewable energies and materials use, including how this can be institutionalized into job descriptions and common practices for the building. 2a. Calculate the savings from lighting retrofits, including using a light meter to assess opportunities for delamping, cleaning of reflectors, relamping and more efficient bulbs/tubes, occupancy and daylighting sensors, and increasing daylighting. 3a. For a given building, design a water conservation operations and maintenance plan that includes water use both inside and outside of the building, including an explanation of the basic math used to calculate savings. 4a. Create a comprehensive list of possible actions that can improve the efficiency and reduce the pollution of existing HVAC systems, including an understanding of potential savings from each option. 4b. Explain the calculations that show the return on investment from replacing HVAC equipment, including the savings in reduced maintenance costs. Compare this to a full life-cycle analysis example that accounts for health impact costs and other negative environmental impact costs. 5a. For a given building, create a list of recommendations for landscaping that can save energy and reduce pollution in operations and maintenance. 6a. Create a presentation to present to a purchasing agent in a local business or government agency about how green cleaning products can reduce pollution in a building and throughout the product supply chain (e.g., the production,

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
			use, and disposal or recycling of the green cleaners). 7a. For a given building, describe how retrofitting lighting systems to be energy efficient and reducing waste heat from the lights increases the heating demand, perhaps beyond the capacity of the existing heating system but also lowers the size needed for a replacement air conditioning system as well as the air conditioning costs. 8a. Conduct an energy audit and use the information to create a redesign of a given building to optimize energy performance via changes in how the building is used and in operations and maintenance. 9a. Describe how to analyze and implement replacement of fossil fuel-based equipment with renewable energies-based equipment when planning building updates.
2	Demonstrate the economic benefits of employing green and sustainable practices in the operations and maintenance of building systems.	1. Calculate the near-term and long-term cost savings of employing energy efficiency and conservation practices in building systems. 2. Communicate the results of a cost-benefit analysis of employing green and sustainable practices in the operations and maintenance of building systems.	1a. Explain the calculations that show the return on investment from updating or replacing equipment and changing operations and maintenance practices to optimize energy efficiency and reduce negative environmental impacts. 1b. Compare the results of simple return on investment and full life-cycle costing analyses for a variety of energy retrofit and operations/maintenance recommendations. 1c. Calculate the demand charge savings, the kwh cost savings, and the pollution reductions from a given lighting retrofit. 1d. Explain how comprehensive replacement of lighting equipment is more cost effective than replacement upon burnout when doing a lighting retrofit. 1e. Calculate the savings from a complete list of energy conservation recommendations generated by an energy audit. 1f. Calculate the savings from a better match of the operating schedule (e.g., setbacks, turning on and off

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
			equipment, fresh air intakes, and exhaust) to the occupancy schedule. 1g. Explain the impacts of demand charge on a given building's utility bill and how to cost effectively reduce it. 2a. Present to a building owner the results of an energy audit on their building, including the cost-benefit analysis of changes in operations and maintenance. 2b. Address the building owners' potential concerns with informed responses that facilitate action and implementation.
3	Recognize the potential impacts of operations and maintenance on the ecosystem services being provided by the site and know ways to maintain or enhance ecosystem services, such as the cleaning of the water and air and the provision of food to humans and other species in the food chain (i.e., apply energy-efficient and more sustainable techniques, processes, and materials for retrofitting and sustaining ecosystem services and human health in the existing built environment).	1. Identify energy-efficient and more sustainable techniques, processes, and green materials. 2. Recognize and act upon need for retrofitting structures. (For example, with water, conduct an audit on water use, prioritize possible actions, and take actions to conserve water use and maintain water quality wherever possible.) 3. Recognize the negative impacts of choosing maintenance upgrades that damage ecosystem services (i.e. extending a non-permeable parking lot to an area that reduces access to water for nearby trees). 4. Recognize the positive impacts of choosing maintenance upgrades that enhance ecosystem services and reduce pollution (i.e. replacing existing landscaping with permaculture and native plants to reduce building heating/cooling costs, reduce the need for fossil fuels to fertilize and cut the growth, reduce the need for water and accompanying storm water system, and provide a green space that also produces food).	1a. From a list of processes and materials use, identify which ones are beneficial to protecting ecosystem services at a typical site. 2a. Conduct and implement a water conservation audit for a local organization. 3a. For a given list of maintenance and operations upgrades, list the threats produced to ecosystem services and possible alternatives. 4a. For a given list of green and more sustainable maintenance and operations upgrades, list the benefits to the preservation of ecosystem health.

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
4	Understand life cycles of building products and preparation of a maintenance and replacement schedules.	1. Research and specify more durable and more sustainable products, taking into account warranty periods. 2. Design preventive maintenance schedules to optimize product performance, reduce pollution, and improve cost-effectiveness. 3. Explain the usefulness of replacement or repair cycles to optimize sustainability and negative environmental impacts. 4. Demonstrate testing for product fatigue or observe premature failure. 5. Design operation and maintenance procedures to reduce waste and enhance reuse of materials.	1a. For a given building, research and recommend more durable and more sustainable products, including a rationale for the selections. 2a. Show, for a given building, how preventive maintenance schedules need to change over the life cycle of the building to optimize performance and energy efficiency. 3a. Calculate and compare the savings when a building uses appropriate replacement and repair versus when it does not. 4a. Create a checklist for a typical building type (e.g., restaurant, school) for checking for product fatigue and premature failure. 5a. Research regulations, options, community programs, incentives, technologies, and other components of effective waste management and present, for a given commercial building, a plan to reduce excess material use and optimize recycling of remaining materials.
5	Describe how a previously developed site can be restored to serve as habitat for native species, improve ecosystem services, and reduce irrigation and pest management needs.	1. Describe how installing vegetated roofs can be included as part of restoring a previously developed site. 2. Describe how removing existing paved areas and improving infiltration can help to meet this goal. 3. Compare the operation and maintenance cost as well as the environmental impacts of landscaping when it is or is not a sustainable design for a building. 4. Describe how replacing or retrofitting an irrigation system can reduce operation and maintenance costs and reduce negative environmental impacts.	1a. Conduct a feasibility study for a green roof on a local community building and present to the owners. 2a. Create a plan for an existing building to improve on-site water drainage, and explain its benefits over alternatives (e.g., storm sewer systems). 3a. Describe how tree protection fencing helps to preserve existing vegetation. 3b. Describe how removing exotic or invasive species can reduce operation and maintenance costs and improve habitat and ecosystem services. 4a. Describe an irrigation system that is optimized for water conservation and reduced energy use and how the selection of certain plantings can further optimize energy and water conservation.

INFORMATION TECHNOLOGY

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Assess, explain, and measure how IT can be used to advance and/or enable green and sustainability measures.	1. Describe the use of IT in measuring and predicting the impact of changes to business practices on sustainability. 2. Explain how IT services can reduce the environmental impact of an organization's activities.	1a. Explain how data held in Information Systems can be used to improve sustainability. 1b. Explain the impact of making energy use visible through IT systems on sustainability practices. 2a. Describe how IT services can be used to reduce CO_2 emissions due to reduction in travel needs (e.g., online meetings). 2b. Explain how IT services can be used to reduce paper usage in an organization (e.g., electronic storage of records). 2c. Explain how using IT services to support telecommuting conserves energy (e.g., reduced travel, less energy to heat and cool office space).
2	Consider impact on human health and the environment related to IT manufacturing and disposal.	1. Identify the human cost of IT manufacturing in countries where environmental laws are weak or non-existent. 2. Analyze the perceived short-term economic benefits of manufacturing in "distant" locations versus the long-term costs. 3. Explain existing disposal practices that are harmful to human health and what needs to change to solve this.	1a. Determine the cost of cleanup and health issues related to IT manufacturing in countries with poor environmental laws. 2a. Run a cost-benefit analysis of outsourcing IT manufacturing in another country. 3a. Identify good end-of-life practices (responsible recycling), compare these with bad practices (shipping overseas, putting in landfills), and create a project where students can help catalyze solutions (e.g., suggest policies to lawmakers).
3	Consider the entire life cycle of computing components and their impact on the environment.	1. Explain how Energy Star, Climate Savers Computing, and EPEAT impact the life cycle of computing components. 2. Explain energy use in each of the phases of computing component lifecycle: manufacturing, use, and disposal. 3. Explain the aspects of delivering IT services that have recycling potential. 4. Explain the role of recycled products in	1a. Explain how rating systems like Energy Star and Electronic Product Environmental Assessment Tool (EPEAT) influence manufacturers of computing components. 1b. Describe how the Climate Savers Computing Initiative encourages more sustainable practices in computer manufacturing. 2a. Contrast maximizing efficiencies during the use phase by buying new components with maximizing utility of

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
		delivering IT services. 5. Describe the role of reusing or re-purposing computing components in a sustainable IT strategy.	resources used during the use phase by using existing components as long as possible. 2b. Complete a Total Lifecycle Analysis of computing components. 3a. Describe how the EPEAT rating system uses recycling as criteria. 4a. Describe places in the IT use cycle where recycled materials can be leveraged (e.g., manufacturing, printing). 5a. Compare buying new versus upgrading computing equipment.
4	Employ behavioral change models to change the culture of the organization to integrate sustainability with IT.	1. Apply the Community-Based Social Marketing (CBSM) model of fostering sustainable behaviors. 2. Explain IT-related environmental impacts in language relevant to the organization.	1a. Explain why it is important to consider behavior when implementing IT-related green and sustainability projects. 1b. Describe the strategies used in CBSM and describe why these are effective in IT sustainability initiatives. 2a. Describe the impact of IT-related green and sustainability efforts relative to the overall mission, goals, and strategies of the organization.
5	Evaluate data center energy use, and use power usage effectiveness (PUE) and other measurements that define the environmental impacts of a data center.	1. Explain how PUE quantifies direct and indirect impacts of computing on energy consumption. 2. Consider the indirect impacts of computing in IT applications (e.g., computer cooling, electricity loss from components). 3. Identify energy losses and strategies to prevent or mitigate energy losses.	1a. Define the components of a data center PUE. 1b. Review a data center PUE and identify how energy consumption is reported. 1c. Describe the benefits and pitfalls of using data center PUE. 2a. List the indirect sources of energy loss and consumption of computing. 2b. Identify ways to minimize energy loss in data centers. 3a. Match energy losses with appropriate strategies to prevent or mitigate such losses. 3b. Examine the impact of under-utilization of server resources by applications that are no longer used or lightly

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
			used. 3c. Evaluate different data center cooling strategies (e.g., room, row, and rack), and describe the appropriate uses of each.
6	Evaluate energy sourcing (including renewable and nonrenewable sources) required for IT infrastructure.	1. Identify viable energy sources by region (e.g., solar, wind, nuclear, and fossil fuels). 2. Analyze economic and environmental impacts of using services in various energy centers.	1a. Collect information about available energy sources in a given region. 2a. Compare the financial and environmental costs of the use of an energy source for a given region.
7	Explain and measure the impact IT decisions have on the environment, social conditions, and financial viability of an organization.	1. Understand the different elements that contribute to the environmental impact of selection between IT service models (e.g., onsite, private cloud, and public cloud). 2. Compare the energy consumption of providing the same IT service via each service model. 3. Identify areas where simple conservation measures in IT systems result in significant financial and environmental savings.	1a. Describe the differences in energy use points for each model: powering servers, powering A/C, server efficiency, and delivery to consumer via the network. 1b. Explain the factors that must be considered when deciding on an IT service model to meet a specific need. 2a. Calculate the energy consumption of each of the three service models for an organization's given need/use. 3a. List commonly used conservation IT measures in organizations.
8	Explain green and sustainable IT policies and standards that relate to reducing permanently damaging environmental, social, and financial/economic impacts.	1. Describe various workforce practices that reduce negative environmental impacts. 2. Explain how IT services can reduce negative workforce environmental impacts on non-IT functions. 3. Explain how to develop and implement a Return on Investment (ROI) analysis for a Sustainable IT Initiative. 4. Identify the aspects of delivering IT services to be examined in a Sustainable IT initiative.	1a. Identify various ways that employees can work remotely and securely. 1b. Identify various alternative travel options to individuals' work sites 1c. Identify various ways to improve the office work space environment. 2a. Compare the environmental and social costs of working from home with those of travelling to, and working in, an office. 2b. Identify IT services that are needed to create an effective work-at-home environment. 3a. Identify objectives and goals for implementing a Green

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
			IT Initiative. 3b. Identify needs and cost effectiveness of power redundancy on systems that don't require 24/7 use. 3c. Calculate and understand the carbon footprint of an organization. 4a. Outline a process to identify and eliminate unused or underused services that continue to be provided. 4b. Enumerate aspects of both desktop computing and delivering computing services to be considered in a Sustainable IT initiative.
9	Understand and employ strategies to reduce the negative impacts of IT infrastructure on an organization's energy use.	1. Explain how each element of an IT infrastructure (laptops, mobile devices, research servers, printers, copiers, multifunction devices, etc.) impacts the total energy use of an organization. 2. Calculate the proportion of energy use from IT infrastructure in an organization. 3. Identify effective strategies to reduce the required energy use for an organization's IT infrastructure. 4. Explain "vampire power." 5. Describe ways to reduce power consumed through "phantom load." 6. Explain the impact of desktop computers on power usage. 7. Describe ways to minimize the power consumption of desktop computing. 8. Explain how printing contributes to the desktop computing power footprint.	1a. Compare desktop to laptop computer lifecycles (manufacturing, use, disposal) with regard to their total environmental footprint. 1b. Develop recommendations on appropriate technology choices for specific usage scenarios. 2a. Describe methods to measure energy use by IT services in an organization. 3a. Evaluate ways to make the energy use by IT in an organization visible to the organization's members. 3b. Develop implementation strategies to reduce energy use by IT. 4a. Describe what is meant by "vampire power," and list computing components that contribute to it. 5a. Describe different methods used to reduce "vampire power" in electronics. 5b. Brainstorm new ways to combat "vampire power" in ways that provide additional end-user benefits. 6a. Compare power efficiency of desktop versus laptop computers. 6b. Describe the power usage profile of desktop

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
			computing equipment that is always on. 7a. Describe power management settings, and recommend optimal settings for power savings without impacting user productivity. 7b. Describe strategies for managing cases where power management interferes with users' productivity. 8a. Compare power efficiency of using shared laser printers versus personal inkjet printers. 8b. Describe ways to reduce paper use in printing. 8c. Describe alternatives to creating printed copies.
10	Understand the impacts of an organization's storage needs (e.g., virtual, archived, offline, online, de-duplication, physical, and many copies of the same data) on green/sustainability efforts.	1. Explore ways to reduce multiple copies of data. 2. Describe storage approaches and technologies that reduce the environmental impacts of storing data. 3. Explain the differing power requirements of various storage options.	1a. Describe how use of collaboration services can reduce the need for storing many copies of documents. 1b. Explain how some business processes encourage multiple paper and electronic copies of documents, and propose technologies that can address this problem. 2a. Explain de-duplication, and describe how it reduces storage needs. 2b. Explain how archival or offline storage technologies can be used to reduce negative environmental impacts. 3a. Compare different storage technologies with regard to their power requirements.

GREEN/SUSTAINABILITY STANDARDS **INFORMATION TECHNOLOGY CAREER CLUSTER™—INFORMATION SUPPORT AND SERVICE PATHWAY**			
	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Analyze the need to replace systems and system components from a green/sustainability perspective.	1. Explain the process and benefits of increasing the longevity of equipment. 2. Demonstrate how adding RAM, upgrading components, etc., can help reduce the environmental impacts of IT systems. 3. Explain how using modular components can be environmentally beneficial. 4. Identify options for reducing consumption of materials, recycling, and re-using, and explain how to take responsibility for tracking the end result of each option (e.g., ensuring computers donated to a school don't end up in a landfill at the end of useful life).	1a. Explain what to look for when purchasing equipment to ensure its longevity and reduce its unsustainable consumption of materials. 1b. Identify strategies for increasing equipment longevity once it has been purchased. 2a. List components of IT equipment, and describe how to evaluate the specifications to "right size" the equipment for its use. 2b. Evaluate components of IT equipment for their contribution to the power footprint, and describe ways to minimize their impact. 3a. Identify modular components. 3b. Describe the potential energy conservation benefits of using modular components in an IT system. 4a. Explain the benefits of recycling electronics and the risks of not recycling. 4b. Describe how to evaluate recycling or reuse opportunities for their ultimate environmental impacts. 4c. Develop best practices for handling the end-of-life of computer equipment.
2	Employ green/sustainable practices in maintenance of data centers.	1. Explain the Lawrence Berkeley National Laboratory Technical Best Practices of Data Center Energy Management. 2. Explain how proper selection and maintenance of heating and cooling systems in data centers contributes to energy conservation.	1a. Describe the mechanical aspects of optimizing energy efficiency and facility performance. 1b. Evaluate the LBNL Best Practices, and determine which measures are applicable to different size server rooms and data centers. 2a. Describe why it is important to identify data center hot spots and how to minimize their impact in existing data centers.

GREEN/SUSTAINABILITY STANDARDS

INFORMATION TECHNOLOGY CAREER CLUSTER™—INFORMATION SUPPORT AND SERVICE PATHWAY

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
3	Explain the purpose and application of simulation technology as it relates to green/sustainability principles.	1. Describe applications of simulation that can contribute to green/sustainability goals.	1a. List examples of how organizations use simulation technology to reduce negative environmental and social impacts (e.g., simulation software in building design applications to improve energy conservation).
4	Explain the purpose and application of virtualization technology as it relates to sustainability principles.	1. List the pros and cons of virtualization technology. 2. Explain the capital impacts (e.g., less buildings) of virtualization.	1a. Identify how power use is impacted by virtualization. 1b. Identify the implications of license costs relative to the use of virtualization. 1c. Identify the impact of virtualization on resource conservation. 1d. Identify the impact on network traffic within a single node under virtualization. 2a. Describe the reduction in space footprint realized by using virtualization. 2b. Describe how virtualization changes data center power density requirements.
5	Identify and implement environmentally sound techniques to preserve power.	1. Model the use of environmentally sound strategies and techniques for preserving power when using computer equipment.	1a. Identify various ways to preserve power through Basic Input/Output System (BIOS) settings. 1b. Identify various ways to preserve power through OS settings. 1c. Identify various ways to preserve power through IT policy and procedures.
6	Implement environmentally sound techniques to reuse and dispose of hazardous materials.	1. Model the use of environmentally sound strategies and techniques for reusing and disposing of environmentally hazardous substances found in computing equipment.	1a. Identify various ways to recycle computers for reuse or parts. 1b. Demonstrate knowledge of dealing with materials that meet RoHS guidelines. 1c. Demonstrate knowledge of how to use third-party vendors for shredding, incinerating, and hard drive wiping.

GREEN/SUSTAINABILITY STANDARDS **INFORMATION TECHNOLOGY CAREER CLUSTER™—NETWORK SYSTEMS PATHWAY**			
	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Demonstrate how to utilize the network to manage the endpoints on the network.	1. Demonstrate ability to turn off components through a network.	1a. Identify network products that offer the ability to manage IP endpoints. 1b. Identify the gaps in availability of network products that allow endpoint management.
2	Understand how to design networks that are energy efficient.	1. Propose design changes that increase the energy efficiency of a network.	1a. List common strategies to increase energy efficiency of a network. 1b. Evaluate an existing network for instances of energy inefficiency.
3	Understand how to measure and monitor energy use of the network components.	1. Apply methods to measure and monitor energy use of network components.	1a. Find idle, peak, and average power use for network components. 1b. Calculate sum of energy use and cost for all components on a network at various times (e.g., idle, peak, and average).

GREEN/SUSTAINABILITY STANDARDS **INFORMATION TECHNOLOGY CAREER CLUSTER™—PROGRAMMING AND SOFTWARE DEVELOPMENT PATHWAY**			
	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Describe the economic and environmental implications of using efficient software development practices.	1. Describe the business and environmental advantages of software re-use. 2. Explain how using the Agile approach to software development influences the product development cycle and the environment. 3. Explain how efficient coding creates environmental benefits (i.e., computers work less hard to get same work done).	1a. Give examples of software re-use. 1b. Calculate the labor and energy savings of reusing software code. 2a. Relate the principles of Agile software development to principles of sustainability. 3a. Compare the perceived energy use of two or more sets of coding that accomplish the same task(s).

GREEN/SUSTAINABILITY STANDARDS **INFORMATION TECHNOLOGY CAREER CLUSTER™—WEB AND DIGITAL COMMUNICATIONS PATHWAY**			
	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Design electronic materials that do not encourage printing on paper for use by end user (e.g., use of typography, writing style, layout).	1. Describe the impact of typography on the environment. 2. Explain how web design impacts the need or desire to print web pages.	1a. Evaluate different fonts for their online-readability and printed toner use. 1b. Describe the characteristics of fonts that makes them easier to read on screen, therefore decreasing printing. 2a. Describe best practices for web design to encourage on-line viewing. 2b. Describe best practices for web writing styles that discourage printing of web pages.
2	Understand dematerialization (taking something physical and turning it into digital form) and how to quantify or evaluate impacts of green/sustainability efforts.	1. Explain the positive environmental impacts of dematerialization (reduce paper use, shipping materials, transportation needs, need for retail space, and waste).	1a. Describe the journey of a physical product from manufacture to use, and compare that with the lifecycle of its electronic equivalent.

MANUFACTURING

MANUFACTURING CAREER CLUSTER™

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Communicate the benefits of applying green and sustainability principles to manufacturing.	1. Explain how green manufacturing can be an extension of existing "lean manufacturing" (i.e., doing more with less) efforts. 2. Use oral and written communication skills in creating, expressing, and interpreting information and ideas related to green practices and sustainability efforts in manufacturing.	1a. Identify efficiencies that result from implementing sustainability (e.g., waste reduction, energy savings, fewer lost-time accidents, improved human health). 2a. Express sustainability in terms of key performance indicators such as Carbon Footprint, Environmental Impact Factor (E-Factor), and Reaction Mass Efficiency (RME).
2	Understand the state of green and sustainability efforts in U.S. manufacturing as compared with those in other countries.	1. Compare U.S. manufacturing practices to practices of other countries regarding green and sustainability efforts.	1a. Identify the requirements for manufacturers in each country. 1b. Locate the life-cycle requirements for products. 1c. Describe how some countries have little or no restrictions on how products are made, while other countries' governments require that products sold within those countries be manufactured according to certain minimal environmental impact requirements.
3	Demonstrate how to make the business case for green and sustainability decisions throughout manufacturing.	1. Use common metrics for sustainability to assess manufacturing facility performance. 2. Quantify and explain the internal and external costs (e.g., economic, social, and human health) and benefits of sustainability projects in manufacturing for decision-making purposes. 3. Explain or develop a business case analysis that compares life-cycle costs of sustainable materials, products and processes (e.g., energy choices, material selection, and chemical surface treatment vs. sandblast treatment).	1a. Identify key performance indicators, such as Carbon Footprint, Environmental Impact Factor (E-Factor), and Energy Intensity (Btu/product), used to make sustainable manufacturing choices and documentation of progress. 2a. Identify how external costs are ultimately internalized over time. 3a. Identify all of the costs and benefits in a given situation (e.g., permits, training, and remediation). 3b. Identify installation costs, operating costs (including energy, maintenance, etc.), risk costs (e.g., insurance, chance of downtime), and end-of-life costs (e.g., disposal, recycling).
4	Demonstrate problem solving using sustainability skills.	1. Apply sustainability principles when solving manufacturing problems or making improvements. 2. Use green and sustainability principles when	1a. Explain examples of problem-solving tools that can be taught: 5 Whys, Fish-Bone Diagram, Project Charter Cards, and other LEAN tools used in continual improvement.

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
		making decisions in manufacturing scenarios. 3. Explain models of collaborations among participants in the supply chain (e.g., suppliers, clients, and end users) to optimize sustainable manufacturing outcomes.	2a. Use the application of the Triple Bottom Line and 4 Rs (Refuse, Reduce, Reuse, and Recycle) in a manufacturing scenario. 3a. Diagram inputs and outputs by each member of a supply chain including wastes.
5	Understand and demonstrate how environmental, economic, and social sustainability are interrelated with regard to manufacturing.	1. Use a Value Stream Map (VSM) or other process flow diagram to demonstrate material inputs and waste outputs from a manufacturing process and a supply chain. 2. State knowledge of major environmental regulations impacting manufacturing. 3. Describe how an initiative can affect the sustainability of the company and its impact on the environment and society. 4. Explain the basics of life-cycle analysis of a product and the effects of that product at every stage of its life cycle. 5. Describe application of environmental management systems, including social responsibility principles.	1a. Explain the primary sustainability impacts of manufacturing including issues relating to waste, energy, water, pollution, and green chemistry. 1b. Explain the operation of manufacturing facilities with the triple bottom line in mind. 1c. Diagram inputs and outputs in a supply chain inclusive of waste streams and environmental impacts. 1d. Describe the short- and long-term impacts and risks for people and the planet for each waste stream in a manufacturing process. 2a. Describe the responsibilities of different regulatory agencies and significant legislation related to a particular manufacturing process. 3a. Express project benefits in dollars, waste reduction, and other benefits. 4a. Demonstrate life-cycle cost analyses of two or more investment options, each with different initial and operating costs. 5a. Provide an overview of environmental management systems and social responsibility planning, implementation, and reporting. 5b. Analyze an example of environmental management systems and social responsibility planning, implementation, and reporting.

GREEN/SUSTAINABILITY STANDARDS

MANUFACTURING CAREER CLUSTER™

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
6	Understand and explain existing and emerging standards, metrics, and best practices for green and sustainable manufacturing.	1. Describe existing and emerging standards, metrics, and best practices for green and sustainable manufacturing.	1a. Explain three or more of the following: SA8000, UL Sustainable Manufacturing Standard, Lowell Center for Sustainable Production Guidelines, Rocky Mountain Sustainable Production, ISO Energy Management Standards, Energy Star for Plant Managers, U.S. Dept. of Commerce Sustainability 101 Training Module, GRI, OECD Sustainable Manufacturing Metrics, EU Reach laws and Takeback laws, Restrictions of Hazardous Substances Act, Waste Electronic Equipment and other takeback directives, WRI Greenhouse Gas Protocols.

GREEN/SUSTAINABILITY STANDARDS **MANUFACTURING CAREER CLUSTER™—HEALTH, SAFETY AND ENVIRONMENTAL ASSURANCE PATHWAY**			
	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Explain and apply the necessity and benefits of moving beyond compliance using green and sustainability principles in manufacturing settings (i.e., efforts to account for global ecosystem and human impacts beyond minimal requirements of the Occupational Safety and Health Administration [OSHA] and the Environmental Protection Agency [EPA]).	1. Calculate the reduction in costs by implementing efficiency projects in manufacturing settings that also reduce environmental impacts. 2. Incorporate sustainability concepts into worker safety practices. 3. Identify reporting requirements related to green and sustainability measures in manufacturing settings.	1a. Explain an example of a manufacturer that reduced costs and increased performance by implementing waste reduction projects. 1b. Describe how a manufacturer can experience increase in profitability by reducing environmental impacts. 2a. Identify examples of incorporating sustainability concepts into worker safety practices. 3a. List reporting requirements in a manufacturing setting and identify those related to green practices and sustainability. 3b. Explain the reputational benefits and reputational risk reduction that accrue from sustainable manufacturing documentation, including potential integration into product marketing.
2	Incorporate green and sustainability principles and design for the environment (DfE) concepts into environmental initiatives to reduce waste streams and reduce or eliminate toxics in waste streams.	1. Develop standard operating procedures that reduce worker risk exposure by incorporating material substitution and waste reduction, and elimination practices.	1a. Explain how to reduce worker risk of injury due to cleaning chemical exposure by substituting less toxic reagents. 1b. Explain how to reduce risk of worker injury with better, more reliable, and more efficient lighting. 1c. Describe the safety benefits of replacing solvent-based coatings with water-based coatings.
3	Use understanding of environmental requirements (e.g., Clean Air Act, Clean Water Act) in manufacturing settings.	1. Read and comprehend a Material Safety & Data Sheet (MSDS). 2. Provide an overview of common regulatory agencies and the issues they regulate.	1a. Explain risks associated with a given chemical by interpreting data on a MSDS. 2a. Explain requirements associated with common EPA regulations (e.g., Title V air permit, National Pollutant Discharge Elimination System water permit).

GREEN/SUSTAINABILITY STANDARDS

MANUFACTURING CAREER CLUSTER™—LOGISTICS AND INVENTORY CONTROL PATHWAY

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Demonstrate ability to apply green and sustainability principles to logistics and inventory controls.	1. Explain how manufacturers minimize inventories to save space and energy. 2. Explain the environmental impacts of shipping options and the need to ensure full containers when shipping.	1a. Explain the relationship among inventory, space, and energy use. 2a. Explain the relationships among the size and types of packaging, shipping quantities, energy use, and the cost to customers.
2	Incorporate understanding of all environmental impacts when making logistics choices.	1. Determine transportation costs and environmental impacts in a logistics decision.	1a. Compare carbon footprints of different transportation options. 1b. Explain the impacts that just-in-time (JIT) delivery can have on the use of transportation fuels. 1c. Explain the value of sourcing locally. 1d. Explain the value of transportation choices with smaller environmental impacts.
3	Propose reducing waste streams resulting from packaging materials.	1. Design packaging materials that are reusable and/or of minimal volume and weight.	1a. Describe methods of packaging for incoming shipments that can be returned, reused, or recycled. 1b. Describe methods of packaging materials for outgoing shipments that can be returned, reused, or recycled by the customer. 1c. Explain how packaging materials from vendors can be reused for a different purpose within the plant.

GREEN/SUSTAINABILITY STANDARDS

MANUFACTURING CAREER CLUSTER™—MANUFACTURING PRODUCT PROCESS DEVELOPMENT PATHWAY

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Apply green and sustainability principles to process design.	1. Calculate the Carbon Footprint, Environmental Impact Factor (E-Factor), or Reaction Mass Efficiency (RME) for an improvement to a given process.	1a. Design manufacturing processes with energy efficiency and pollution prevention in mind. 1b. Design processes to minimize materials, water and energy use, waste, and environmental releases. 1c. Identify options to reduce or eliminate the use of toxic materials when evaluating new manufacturing processes. 1d. Create standard operating procedures (SOPs) that include the production worker for new process(es) that incorporate green and sustainability principles.
2	Understand the environmental, social, and human health impacts that manufacturing process decisions have through the entire supply chain and through the product's life cycle.	1. Explain the environmental, social, and human health impacts of material and process selection on the worker making the product, the end user of the product, and the community in which the product is made and used. 2. Explain a life cycle analysis of a manufacturing process that takes into account the triple bottom line perspective.	1a. Explain how quality working conditions and livable wages are beneficial to the worker, the manufacturer, and society as a whole. 1b. Explain ways of reducing waste or consumables throughout the product's life cycle. 1c. Explain ways of recapturing material and energy inputs into products. 1d. Explain ways of recapturing materials at the end of a product's useful life. 2. Compare the economic, social, and environmental value of one manufacturing process to another and name the triple bottom line benefits and problems with each example.
3	Use green and sustainability principles in designing products.	1. Design products to optimize materials and energy use, minimize or mitigate negative environmental impacts, and design for reuse and ease of disassembly. 2. Choose products that improve the quality of life for end users and society as a whole.	1a. Use "design for the environment" methods that include common metrics for determining environmental impact such as Carbon Footprint, Environmental Impact Factor (E-Factor), and Reaction Mass Efficiency (RME). 2a. Explain characteristics of products that contribute to or detract from quality of life.

GREEN/SUSTAINABILITY STANDARDS **MANUFACTURING CAREER CLUSTER™—MAINTENANCE, INSTALLATION AND REPAIR PATHWAY**			
	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Develop a plan for maintenance that prevents or mitigates negative environmental and human impact.	1. Describe the relationship between preventive and predictive maintenance and reduced downtime and associated costs. 2. Describe the relationship between implementing best practices and reducing operating costs.	1a. Complete a life-cycle cost analysis of investing in preventive maintenance and predictive maintenance (i.e., determining the condition of in-service equipment in order to predict when maintenance should be performed). 2a. Complete a life-cycle cost analysis of properly investing in maintaining and optimally operating equipment.
2	Provide input and explain rationale regarding equipment selection so that the chosen equipment is easily repaired and recycled.	1. Identify and describe the benefits of products used in maintenance, installation, and repair that are designed to be easily repaired or recycled.	1a. Identify products that can be repaired by the end user with little or no training. 1b. Provide examples of products designed for easy disassembly. 1c. Identify examples where materials in a product are recyclable. 1d. Identify products where recycled materials are used in production.
3	Understand how to maintain equipment and systems for peak efficiency, eliminating wasted energy and materials and preventing spills and pollution.	1. Explain the relationship between proper maintenance and reduced waste generation due to reduction of downtime, errors, excessive resource use, and system failures.	1a. Calculate the life-cycle costs of properly maintaining a system versus the risk and costs associated with system failures, resource waste, and downtime.
4	Understand the principles of preventive and predictive maintenance and demonstrate their use in a manufacturing setting.	1. Describe common preventive maintenance procedures. 2. Describe common predictive maintenance procedures.	1a. Describe the benefits of preventive maintenance. 2a. Describe the benefits of predictive maintenance.

GREEN/SUSTAINABILITY STANDARDS **MANUFACTURING CAREER CLUSTER™—PRODUCTION PATHWAY**			
	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Apply green and sustainability principles to the manufacturing process.	1. Suggest possible improvements to the manufacturing process that would mitigate environmental impacts.	1a. Given a production scenario, identify methods to reduce environmental impact.
2	Provide feedback to managers and designers for a process of continuous improvement regarding sustainability.	1. Describe a system within a company to communicate recommendations to improve the design of a product to mitigate environmental impacts such as: • minimizing the generation of all types of wastes during manufacturing, shipping, and use; • using the least amount of raw material needed; • having the product be recyclable after use; and • using chemicals with the least possible toxicity to humans or the environment.	1a. Identify opportunities for continuous improvement in product design. 1b. Use verbal and written skills to communicate recommendations.
3	Understand the environmental impacts of the production process.	1. Describe the production process's effect on energy, water, and materials use; pollution and greenhouse gas emissions; waste production; and other ecosystem impacts. 2. Explain toxic use reduction methodology in the production process (e.g., Massachusetts regulation training).	1a. Use oral and written skills to describe costs and benefits from implementing sustainable manufacturing practices. 2a. List examples of toxic use reduction.

GREEN/SUSTAINABILITY STANDARDS **MANUFACTURING CAREER CLUSTER™—QUALITY ASSURANCE PATHWAY**			
	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Incorporate metrics related to green practices and sustainability into quality assurance measures.	1. Identify metrics related to green practices and sustainability that can be used for quality assurance measures in manufacturing settings. 2. Calculate commonly used green- and sustainability-related metrics for quality assurance.	1a. Describe the use of U.S. Department of Energy, Energy Information Agency (DOE EIA) energy intensity data in creating metrics related to sustainability. 2a. Calculate energy use and energy intensity (e.g., MMBtu/unit of production, greenhouse gas emissions/unit of production). 2b. Calculate waste generated per unit of production (lb./each).

SCIENCE, TECHNOLOGY, ENGINEERING & MATHEMATICS (STEM)

GREEN/SUSTAINABILITY STANDARDS

SCIENCE, TECHNOLOGY, ENGINEERING & MATHEMATICS (STEM) CAREER CLUSTER™

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Understand and explain the concept of sustainability as it applies to STEM career fields.	1. Give examples of how STEM knowledge and skills are used to analyze and improve the sustainability of natural and/or human-built systems. 2. Describe how sustainability principles are incorporated in developing improved human-built systems, products, and processes. 3. Explain how key concepts (listed below) are central to understanding sustainability as it relates to STEM and the use of STEM to solve societal problems and create a more sustainable future. • Precautionary Principle and Risk Paradigm, exponential growth • population carrying capacity • ecological footprint • Tragedy of the Commons • systems thinking • laws of thermodynamics • principles of ecosystem function • Greenhouse Effect • law of unintended consequences • impacts of scale • effective change strategies 4. Explain threats to the ecosystem services we depend on for life (e.g., clean air, water, and food) and how STEM concepts can deepen our understanding of these threats and the role each of us can play to help create solutions.	1a. List ways that STEM can help create a more sustainable future. 2a. Give examples of STEM careers where an understanding of the principles of sustainability is likely to be critical to creating healthier ecosystems, communities, and economies and explain why you think so. 3a. Explain the following concepts: the Precautionary Principle and Risk Paradigm, exponential growth, population carrying capacity, ecological footprint, Tragedy of the Commons, systems thinking, laws of thermodynamics, principles of ecosystem function, the Greenhouse Effect, and the law of unintended consequences and how they can be used in STEM careers. 4a. List examples of green STEM careers that can deepen our understanding of threats to ecosystem services and how to help create solutions.

SCIENCE, TECHNOLOGY, ENGINEERING & MATHEMATICS (STEM) CAREER CLUSTER™

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
2	Apply STEM concepts to determine both detrimental and beneficial ("green" and sustainable) behaviors, and identify/create solutions to environmental threats (e.g., chemical toxicity in the environment, water and air quality degradation, climate change, and carbon emissions) and human welfare issues (e.g., poverty reduction, access to clean water and air and healthy food, quality of life indicators).	1. Analyze existing systems and behaviors to identify elements that are beneficial and harmful to environmental and human health. 2. Identify means to decrease the negative impacts of the human environmental footprint in everyday life and industry. 3. Propose means to decrease human suffering by our choices in everyday life and industry. 4. Investigate new and green innovations and policies using STEM knowledge to decrease pollution emissions, ecosystem degradation, and unsustainable resource use. 5. Describe causes and possible impacts of global climate change, and practice techniques in your personal, social, and professional life to minimize your contribution to climate change.	1a. Explain how individuals can use STEM concepts to be more effective agents of change in a wide variety of STEM related careers and daily behaviors (e.g., using STEM in informal education, technological innovation, and policy making). 2a. Create a presentation to educate peers about green and sustainable behaviors that can decrease the negative impacts of humans' environmental footprint and test for effectiveness. 3a. Develop campaign to educate peers about green and sustainable behaviors that can decrease human suffering and test for effectiveness. 4a. Discuss policy changes that could mitigate negative human impacts and how utilizing STEM knowledge in a variety of careers can help inform civic engagement efforts to educate and persuade elected representatives to take actions for a sustainable future. 5a. Use STEM knowledge to perform a cost-benefit analysis of an innovation or policy to reduce the negative impacts of climate change, including company and community benefits.
3	Apply communication strategies that incorporate principles of sustainability, as they relate to STEM, in oral, written, or visual formats to impact community practice and/or policy development.	1. Use systems representations, including the integration of the environment, the economy, and social equity, to communicate concepts of STEM within the context of creating a more sustainable future. 2. Identify and utilize communication strategies that result in sustainable behaviors by individuals and institutions. 3. Effectively communicate the pros, cons, and challenges to a governmental or organizational change plan for a more sustainable society (e.g., healthier ecosystems, social systems and	1a Organize data using charts, graphs, and tables in studying human impacts on the planet. 1b. Debate topics relating to STEM and sustainability and evaluate the quality of the arguments and data used. 1c. Identify essential actions that will lead to less human suffering and a greener, healthier economy. 2a. Write a letter to a government official, business, and other community leader to support or refute policies relating to sustainability and STEM activities. 3a. Develop part of a community action plan for advancing a sustainability based "green" region and present the plan using oral, written, and visual formats to community

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
		economies).	stakeholders.
4	Practice thoughtful consideration of green and sustainability issues related to STEM.	1. Reflect on the impacts of the use of science in making decisions that impact both ecological health and human health and well-being. 2. Compare research, policy, and technology efforts related to greening the economy, sustainability and STEM in the United States to those in other countries. 3. Use interdisciplinary thinking and collaboration as a necessary approach to solving sustainability challenges.	1a. Keep a log of daily activities that document how science is used in daily life and how it could be impacting ecological health and human well-being (e.g., consideration of the raw material workers, the production workers as well as the consumers and those impacted by the waste of the products). 2a. Create charts showing the different approaches to sustainability by country. 3a. Use concepts and skills learning in science, math, English, and history to explain the sustainability challenge in a STEM-related field. 3b. Work together to identify ideas to mitigate negative impacts on the environment and human well-being.
5	Apply principles of green/sustainability to professional activities.	1. Implement appropriate "green" and sustainable practices when developing plans, projects, and/or processes, or solving complex problems to ensure a sustainable school or workplace. 2. Explain the effects on the biosphere of human activities such as agriculture, fisheries, manufacturing, transportation, building, and recreation. 3. Evaluate environmental and social consequences of professional activities. 4. Consider the implications of professional decisions on people, the environment, the economy, and future generations. 5. Practice techniques that promote sustainable development, prevent and reduce the generation of pollution and waste, and preserve biological diversity. 6. Conserve resources such as energy, water, and	1a. Create, present, and help implement a green and sustainability plan for the school or a local organization. 2a. Use data and STEM knowledge to create a paper or presentation, or participate in a discussion or debate, about the effects on the biosphere of human activities such as agriculture, fisheries, manufacturing, transportation, building, and recreation. 3a. Interview local individuals or organizations (e.g., from government, businesses and nonprofits, including formal or informal educational organizations) about their green and sustainability policies and practices. 3b. Use data from secondary and primary sources to create an analysis with recommendations regarding green and sustainability policies and practices within an organization. 4a. Explain the environmental, social, and economic ramifications of a proposed plan for present and future generations. 5a. Create a personal action plan to promote a green

KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
	other materials during professional activities. 7. Identify statements from professional STEM associations about the importance of sustainable development within their respective fields.	economy and sustainable development that produces healthier ecosystems, social systems, and economies. 6a. Create a list of what any STEM professional can do to conserve resources such as energy, water, and other materials. 7a. Identify and present about the availability of, and meaning of, materials from professional associations about the importance of sustainable development practices in the fields of science, technology, engineering and math, and the contributions each area can make to a more sustainable future.

GREEN/SUSTAINABILITY STANDARDS

SCIENCE, TECHNOLOGY, ENGINEERING & MATHEMATICS (STEM) CAREER CLUSTER™—ENGINEERING AND TECHNOLOGY PATHWAY

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Apply principles of sustainability (e.g., creating healthier environments, economies, and social equities; integration of systems thinking and effective change skills) to attempt to solve engineering and technology problems.	1. Use systems thinking, with consideration of the relationships between economy, social equity, and environment, to plan and design projects. 2. Explain how a "green" workforce and community require the application of sustainable design principles. 3. Discuss statements from professional engineering and technology associations about the importance of sustainable development within their respective fields.	1a. Design an energy efficiency and renewable energies plan for the school which demonstrates understanding and consideration of the interrelated economic, environmental, and social impacts. 2a. Create a mural of a green and sustainable community and then list the components of sustainability that are included. 3a. Identify and present about the availability of, and meaning of, materials from professional associations regarding the importance of sustainable development practices in the fields of technology and engineering, and the contributions each area can make to a more sustainable future.
2	Understand and be able to improve the sustainability of design, manufacturing, and other technology and applied engineering processes.	1. Create designs and applications that incorporate "green" principles and practices. 2. Propose design and process changes that improve green and sustainability performance.	1a. Analyze an existing technology production and distribution system (e.g., production, use and disposal of a cell phone or clothing) and identify areas that could be greener and more sustainable. 1b. Compare and contrast two theoretical or real organizations for their use of green/sustainability principles and practices. 2a. Develop community and/or organizational education programs to minimize negative human impacts from energy and material use (e.g., IT systems – double-sided printing, shutting down, computer settings, etc.; Transportation – buses, ride sharing, etc.). 2b. Interact with community stakeholders (i.e., potential future employers) to create visions, plans, policies, and applications for sustainable communities and organizations.

GREEN/SUSTAINABILITY STANDARDS SCIENCE, TECHNOLOGY, ENGINEERING & MATHEMATICS (STEM) CAREER CLUSTER™—ENGINEERING AND TECHNOLOGY PATHWAY			
	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
3	Apply technology, including communication technology, to collaborate on sustainability-related projects.	1. Use appropriate technology and tools, including social media, to collaborate on environmental research and organizational or community-based action projects and compare data with people in other locations.	1a. Use technology and social media to produce multi-region research and environmental service projects (e.g., teleconferences, use of Wikispaces, blogs, Google Docs, Twitter, Facebook, etc.). 1b. Use technology (e.g., online carbon calculators) to monitor carbon and greenhouse gas emissions and perform a greenhouse gas inventory. 1c. Use technology and social media to discuss with others outside of the classroom how engineering and technology can help create healthier ecosystems, social systems, and economies.

GREEN/SUSTAINABILITY STANDARDS

SCIENCE, TECHNOLOGY, ENGINEERING & MATHEMATICS (STEM) CAREER CLUSTER™—SCIENCE AND MATHEMATICS PATHWAY

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Explain processes of environmental degradation (e.g., ozone depletion) that impact ecological and/or human health using science and math concepts.	1. Use science and math knowledge and skills to communicate how human activity is impacting the environment. 2. Explain how math and science is needed for essential cost-benefit analyses, with attention to both short- and long-term environmental and human (i.e., social and economic) impacts, in planning, implementation, and operations within an organization or community.	1a. Use graphs, charts, and tables to show how the world's population is changing and affecting the planet. 1b. Use visual aids to model the greenhouse effect and how it relates to renewable and non-renewable resources 1c. Explain the types, benefits, and drawbacks of using renewable energy technologies in comparison to nonrenewable resources. 1d. Discuss global water concerns and potential solutions. 1e. Perform a water cycle simulation including point and nonpoint source pollution. 1f. Present proper techniques of recycling and explain how it can aid in decreasing human effects on the planet. 2a. Utilize mathematical analysis to show the impacts of different subsidies, incentives, and financing on the utilization of renewable versus nonrenewable energies. 2b. Analyze the supply chain of a product or system for ways to improve its green and sustainability practices/impacts. 2c. Explain what a trade-off is and provide examples.
2	Demonstrate the ability to define and solve real-world problems by applying mathematics to principles of sustainability.	1. Recognize how numeracy is central to applying principles of sustainability. 2. Use mathematical concepts and formulas to quantify environmental issues and issues about human well-being, for example, population growth/density and per capita resource use, poverty rates, and quality of life indicators. 3. Manipulate basic units, measures, and rates used in sustainability, including kilowatt hours, megawatt hours, gigawatt hours, British Thermal Units, barrels, percent, parts per thousand (ppt), parts per million (ppm), parts per billion (ppb), parts per trillion, tonnes, miles per gallon, hectares,	1a. Work with rate of flow calculations to propose the best site for a micro-hydro power installation among several alternatives. 1b. Work with solar insolation values to calculate how much of a home's energy can come from the sun in a given application. 1c. Calculate the savings and pollution reduction available from usage of a variety of energy conserving technologies and behaviors (e.g., energy efficient lighting, low-flow showerheads, less idling, or properly inflated tires on cars). 2a. Review and explain the components of the Human Progress Indicator.

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
		acres, acre-feet, decibels, etc. 4. Apply mathematical concepts and demonstrate numeracy to address real-world problems, case studies, and hypothetical situations related to issues of sustainability.	3a. Calculate the energy available from renewable energies in the United States and the portion being utilized presently. 3b. Convert energy utilized in a typical home from CCF, gallons, and KWHs to an energy utilization index of Btu consumption per square foot to compare relative building efficiencies. 4a. Calculate how much money, energy and pollution could be saved or reduced if a local organization (business or community organization) or the students' homes utilized a variety of available energy conservation and/or renewable energy technologies.
3	Use scientific and mathematical problem-solving skills to develop solutions that create a more sustainable society.	1. Assess the impact that science and mathematics have on the environment and humans when used to develop projects or products. 2. Demonstrate skills that foster effective problem-solving techniques and processes resulting in sustainable solutions.	1a. Discuss historical innovations that have advanced conservation initiatives. 1b. Debate futuristic solutions to green/sustainability issues and discuss associated challenges and ethical dilemmas regarding the use of science and technology. 2a. Work cooperatively to make your classroom (or an alternate environment such a potential employer's business) as sustainable as possible.
4	Assess the impact that science and mathematics have on "greening" the economy.	1. Investigate how science and mathematics influence the development of "green" professions and occupations. 2. Explain statements from professional science and math associations about the importance of sustainable development within their respective fields.	1a. Utilize mathematics to discuss how the use of effective financial structures for a "green economy" (e.g., long-term financing, tax credits for pollution reduction) can impact the job opportunities in the United States. Include an analysis of how we compare to other industrialized nations in the fostering of a green economy (i.e., effects of a variety of incentives and restructuring such as feed-in tariffs and subsidies to renewable vs. nonrenewable energies that change the cost structure, profitability, and demand for products). 1b. Use mathematics to analyze the trend in "green" occupations as they relate to incentives and subsidies that impact the cost effectiveness and attractiveness of green

KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
		products or processes. 2a. Identify and present about the availability of, and meaning of, materials from professional associations regarding the importance of sustainable development practices in the fields of science and math, and the contributions each area can make to a more sustainable future.

TRANSPORTATION, DISTRIBUTION &LOGISTICS

TRANSPORTATION, DISTRIBUTION & LOGISTICS CAREER CLUSTER™

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Understand the role of human behavior in planning and managing green and sustainability efforts in U.S. transportation, distribution, and logistics.	1. Explain how change or lack of change in human behavior impacts the demands on transportation, distribution, and logistics infrastructure and systems.	1a. Show how driving habits can increase and decrease the needs for road infrastructure. 1b. Explain how consumer purchasing decisions impact the design of freight movement and storage. 1c. Predict the obstacles to needed changes in consumer behavior that are required to speed the adoption of new concepts (e.g., ride share, use of high-speed rail, or electric engine power).
2	Explain the economic costs and benefits for green and sustainability initiatives in transportation, distribution, and logistics.	1. Explain the internal and external costs (e.g., economic, social, and human health) and benefits of green and sustainability projects in transportation, distribution, and logistics for decision-making purposes.	1a. List the internal and external costs and benefits of changing all the engines of a fleet to an alternative energy source. 1b. Identify installation costs, operating costs (e.g., energy or maintenance), risk costs (e.g., insurance or chance of downtime), and end-of-life costs (e.g., disposal or recycling) for a green or sustainability initiative.
3	Understand the role of technology in advancements that promote sustainability in transportation, distribution, and logistics.	1. Distinguish advancements in transportation infrastructure and planning from advancements in transportation operations and distribution. 2. Explain how key technologies driving change in transportation, distribution, and logistics (e.g., alternative energy sources, alternative materials, Radio Frequency Identification [RFID], or social collaboration) are employed.	1a. List advancements in transportation infrastructure and planning that promote sustainability. 1b. List advancements in transportation operations and distribution that promote sustainability. 2a. Compare a component of today's transportation, distribution, and logistics with one from 20 years ago (e.g., warehousing today versus warehousing then) and describe the social and environmental impacts of these changes.
4	Understand the social and environmental impacts of business model choices in transportation, distribution, and logistics.	1. Compare the types of businesses operating in the transportation, distribution, and logistics sectors (e.g., multinational corporations, public entities, and "mom and pop" operations). Discuss the workforce types and sizes and the environmental and other social impacts of different business models.	1a. Compare the impact of an environmental decision of a multinational company in transportation, distribution, and logistics (e.g., FedEx) with a small company (e.g., a trucking company with five trucks). 1b. Compare the advantages and disadvantages of introducing technology in transportation, distribution, and logistics that has impacts on green and sustainability initiatives, and how this technology affects the number of

KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
		workforce and career opportunities and the skill level needed by individuals.

GREEN/SUSTAINABILITY STANDARDS **TRANSPORTATION, DISTRIBUTION & LOGISTICS CAREER CLUSTER™—FACILITY AND MOBILE EQUIPMENT MAINTENANCE PATHWAY**			
	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Understand the environmental impact in making decisions about repair or replacement of transportation equipment.	1. Conduct life-cycle cost analysis in making decisions to repair or replace transportation equipment.	1a. Calculate the economic and environmental cost of sourcing, installing, maintaining, repairing, and disposing of new and existing transportation equipment.
2	Understand the maintenance requirements of alternative engine energy sources in transportation operations.	1. Explain the differences in engines based on the energy source. 2. Contrast the maintenance requirements of engines powered by conventional fossil fuels with alternative energy sources (e.g., biofuels, electricity, or compressed natural gas)	1a. List the types of engine energy sources. 2a. Identify the maintenance requirements of engines powered by alternative energy sources. 2b. Describe the need for understanding electrical theory and systems in engine maintenance.
3	Understand the environmental, human, and economic impacts of using alternative fuels and lubricants in transportation equipment.	1. Explain the environmental, economic, and human health costs and benefits of using conventional and alternative fuels and lubricants in transportation maintenance. 2. Identify changes in engine systems and maintenance techniques when using alternative fuels and lubricants.	1a. State the environmental trade-offs of using alternative fuels and lubricants. 1b. Identify the toxicity levels of various types of fuels and lubricants. 2a. Describe the differences in engine systems and components required when using alternative fuels and lubricants.
4	Employ green and sustainable practices in the reuse, recycling, and disposal of maintenance products.	1. Select maintenance products that are more easily reused and recycled, or disposed of with minimal impact on the environment and human health.	1a. Read product technical sheets to understand the proper use, recycling, and toxicity information and its correct application.

GREEN/SUSTAINABILITY STANDARDS **TRANSPORTATION, DISTRIBUTION & LOGISTICS CAREER CLUSTER™—HEALTH, SAFETY, AND ENVIRONMENTAL MANAGEMENT PATHWAY**			
	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Explain the benefits of moving beyond compliance using green and sustainability principles in transportation, distribution, and logistics operations.	1. Describe how an operation in transportation, distribution, and logistics can increase profitability, meet compliance standards, or have a positive community impact by reducing negative environmental impacts.	1a. Discuss the near-term and long-term costs, savings, and environmental benefits of implementing a green initiative that reduces or mitigates negative environmental impact(s) (e.g., impact on the ability to attract new businesses to a region because of existing air or water pollution levels and the ability of businesses to meet existing environmental quality standards).
2	Understand the human health benefits of incorporating green and sustainability concepts into worker safety practices of a transportation, distribution, and logistics operation.	1. Incorporate green and sustainability concepts into worker safety practices.	1a. Identify examples of incorporating sustainability concepts into worker safety practices.

GREEN/SUSTAINABILITY STANDARDS			
TRANSPORTATION, DISTRIBUTION & LOGISTICS CAREER CLUSTER™—LOGISTICS PLANNING AND MANAGEMENT PATHWAY			
	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Understand the role of data analysis and modeling on logistics planning for green and sustainability efforts.	1. Calculate the estimated costs and savings of modifying the logistical operations of a transportation, distribution, and logistics enterprise.	1a. Show how changes in logistical operations will likely have an impact on economic and environmental outcomes.
2	Understand the relationship between space and energy use in a warehousing operation.	1. Explain the environmental and economic benefits of maximizing the available space in a warehouse. 2. Explain the emerging strategies and tools used to maximize space in a warehouse.	1a. Figure the cost per cubic foot of material for heating and cooling a warehouse where space is used very efficiently versus a warehouse where it is not. 2a. List strategies and tools currently in use to maximize space (e.g., narrow and very narrow aisles, or automated inventory pickers).
3	Understand the key concepts of route planning and the analysis used to promote environmental efforts.	1. Explain how route planning for transportation systems can have an impact on safety, speed, and the environment.	1a. List examples of route planning strategies (e.g., prohibitions on left turns by delivery fleets, minimum car requirements for railroads, or coordination of transportation services by public agencies in a community).

GREEN/SUSTAINABILITY STANDARDS

TRANSPORTATION, DISTRIBUTION & LOGISTICS CAREER CLUSTER™—SALES AND SERVICE PATHWAY

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Communicate the value of green and sustainability efforts to transportation, distribution, and logistics clients and customers.	1. Use oral, written, and visual presentation techniques to explain the economic, environmental, and human health benefits of green and sustainable practices to customers and potential customers of a transportation, distribution, and logistics operation.	1a. Prepare a presentation for a trucking firm customer that explains the benefits of the firm's green and sustainability efforts. 1b. Write a letter to the editor of a local news organization explaining the benefits of using new public transit strategies.

GREEN/SUSTAINABILITY STANDARDS **TRANSPORTATION, DISTRIBUTION & LOGISTICS CAREER CLUSTER™—TRANSPORTATION OPERATIONS PATHWAY**			
	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Understand and employ strategies for a transportation operation that affect energy conservation and human health benefits.	1. Operate equipment in a manner that improves environmental and human health.	1a. Reduce or eliminate idling when unnecessary. 1b. Employ driving techniques that extend fuel mileage.

GREEN/SUSTAINABILITY STANDARDS

TRANSPORTATION, DISTRIBUTION & LOGISTICS CAREER CLUSTER™—TRANSPORTATION SYSTEMS/INFRASTRUCTURE PLANNING, MANAGEMENT, AND REGULATION PATHWAY

	KNOWLEDGE AND SKILL STATEMENT	PERFORMANCE ELEMENT	SAMPLE INDICATORS
1	Understand the relationship among systems, equipment, and human behaviors related to environmental and human health.	1. Use systems thinking to address a problem or issue with transportation systems and infrastructure. 2. Identify effective strategies to influence human behavior in ways that lead to greater transportation efficiency.	1a. Explain the relationship of people, systems, goods, vehicles, and the environment in a given situation. 1b. Find examples of changes to transportation systems and infrastructure where there is evidence of systems thinking. 2a. List human behaviors that impact transportation systems and infrastructure. 2b. Describe strategies that have influenced behavior and led to greater transportation efficiency.
2	Incorporate strategies to make transportation systems and infrastructure more efficient and have less environmental and societal impact.	1. Use the concept of "optimizing systems" in the design and planning of transportation systems and infrastructure.	1a. Explain how building more is not always the best long-term solution to transportation needs. 1b. Show how incorporating public transit and individual transportation elements (e.g., bike lanes) to existing systems can optimize use.
3	Understand the role of alternative energy and materials in planning and managing transportation systems and infrastructure.	1. Explain how to use a life-cycle analysis in determining the value of alternative fuels and materials in transportation systems.	1a. Predict the long-term costs and benefits of using alternative fuels and materials in the planning and management of transportation systems.
4	Understand the role of international and federal regulations on transportation systems and infrastructure.	1. Explain the impact of the major international regulations (e.g., Kyoto treaty) and federal regulations (e.g., Clean Air Act) on the planning and design of transportation systems and infrastructure.	1a. State the primary purposes and components of major federal regulations that impact transportation systems and infrastructure.