Appendix A – Example connections to Wisconsin contexts and connections to Engineering, Technology, and Society

The vision for the new Wisconsin State Science Standards outlines the importance of providing opportunities for students to apply scientific thinking, skills, and understanding to local, real-world phenomena and problems. In order to achieve this goal, Appendix A lists real-world connections that are specific to Wisconsin, as well as connections to engineering and technology, for most science content standards (some boxes are blank where practical connections tend to work in any context, not just Wisconsin). These connections are listed as a grade band progression, but most could be used at any grade level. The connections note which learning element progression they connect to (such as LS1.A). They are only provided for the Life Science, Physical Science, and Earth and Space Science sections. Engineering, Technology, and Society (ETS) is not called out as a separate section here; instead, those connections are provided in the context of science disciplines, as the standards intend for science and engineering to be integrated, not for engineering to be taught as a stand-alone subject. These sections are shaded grey to emphasize that these examples are not a required part of the standards. Teachers are encouraged to connect to local phenomena and meaningful engineering problems that make sense in their instruction and their community for their students.

LIFE SCIENCE				
Standard SCI.LS1: Students use science and engineering practices, crosscutting concepts, and an understanding of **structures and processes** (on a scale from molecules to organisms) to make sense of phenomena and solve problems.				
	K-2	**3-5**	**6-8**	**9-12**
SCI.LS1: CONNECTIONS				
Example Wisconsin Connections	Wisconsin plants (e.g., burdock, maple trees, and black walnut trees) have structures for seed dispersal (LS1.A). Badgers' claws are long and sharp and allow them to dig quickly (LS1.A). Seagulls and geese have webbed feet that allow them to walk on land and paddle in water (LS1.A). Plants often grow anywhere there is soil, even in cracks in pavement. They grow better in places with more sunlight, rather than in	Explore concepts in this standard using native Wisconsin animals such as the grey wolf, badger, beaver, and red fox (LS1.A, B). Wood turtles respond to changing weather conditions by burrowing under the mud on the bank of a river and emerging again when conditions are favorable (LS1.A). Many species of Wisconsin bats hibernate during the winter (LS1.A). Injured Wisconsin wildlife often can no longer use their senses, memories, and body structures to find food or reproduce (LS1.B).	Climate change has an effect on Wisconsin plants such as wild rice and on the migratory patterns of animals (LS1.B). Crops grown in Wisconsin can be converted to Biofuels (LS1.C). Genetically modifying crops can influence their growth (LS1.C). An animal's chance of survival may increase due to certain behaviors. Examples include: --Winter "yarding" behavior among deer; --The seasonal migration of geese and cranes;	Wisconsin Fast Plants allow students to investigate and model energy dynamics in living systems (LS1.C). By-products of fermentation industries are used to provide energy for the fermentation processes (LS1.C). Coppice cutting is a system of woodland management in Wisconsin that involves harvesting trees and allowing the stumps to produce new growth (LS1.B).

	shadows from buildings or other plants (LS1.A)		--The hibernation of bears and bats --Finding alternate food sources, such as in garbage cans (LS1.B, D).	Wisconsin's Exact Sciences company uses molecular markers and proteins to detect cancer (LS1.C).
Engineering, Technology & Society Connections	Engineers use inspiration from nature in designs (biomimicry). Examples include Velcro and burr structures, and lotus leaf and waterproofing methods. Engineers design limbs for amputees.	Engineers design prosthetics and other artificial devices such as hearing aids and cochlear implants.	Engineers develop fuels from biological raw materials (biofuels). Engineers can alter biological organisms through genetic engineering.	One of the National Academy of Engineering Grand Challenges includes reverse engineering the brain to figure out how the brain works. Wisconsin biological engineers design antibody and molecular tests to determine if someone is infected with a virus, such as COVID-19.

Standard SCI.LS2--Ecosystems: Students use science and engineering practices, crosscutting concepts, and an understanding of the ***interactions, energy, and dynamics within ecosystems*** to make sense of phenomena and solve problems.

	K-2	3-5	6-8	9-12
SCI.LS2: CONNECTIONS				
Example Wisconsin Connections	As with LS1, native Wisconsin organisms could be emphasized (LS2.A).	Red-winged blackbirds alert the others of a hawk overhead. Garter snakes hibernate in hibernacula in groups to retain temperature (LS2.D). Phosphorous flows into the streams and lakes and impacts algae growth (LS2.B). Matter cycles, such as when organisms live and die, look different in a built-up or urban environment and more open green spaces (LS2.B).	The population of lake trout is declining in Lake Michigan (LS2.A). Predator and prey populations impact each other from year to year. Wisconsin examples of predators include wolves, coyotes, and bears, which limit the population of deer (LS2.A). Weather and climate variations are limiting factors on Wisconsin populations of deer, turkey, and eagles (LS2.A).	Relate the concept of carrying capacity to whitetail deer management (LS2.A). Investigate the interrelationship of the Isle Royale wolf and moose populations, or urban coyote and rodent (or human or domestic animal) populations (LS2.A). Invasive earthworm disturbances in Wisconsin hardwood forests negatively affects native species (LS2.C). Evaluate and compare the diversity of WI habitats (LS2.A, D).

			Changes in deer populations affect biodiversity in forest ecosystems (LS2.C).	Ecosystems of urban green spaces have different energy dynamics than surrounding areas (LS2.B).
Engineering, Technology & Society Connections	Engineers design buildings to be more sustainable such as green roofs, using energy and water more efficiently. Engineers design systems to help food scarcity such as growing food in areas with little soil and water (hydroponics).	Engineered solutions to human problems (e.g. dams, bridges, water runoff systems, roads, bright lights at night, and mega farms) impact the environment.	Engineers create artificial living environments such as biodomes that could help sustain life on other planets. Engineers design solutions to create positive impacts from waste products: manure digesters, methane capture for energy at landfills, and abandoned coal mines.	Biological engineers design systems to use microbes to break down waste. Engineers design solutions to physical disturbances (e.g. erosion) caused by stormwater runoff from impervious surfaces and work to prevent polluted runoff.

Standard SCI.LS3--Heredity: Students use science and engineering practices, crosscutting concepts, and an understanding of ***heredity*** to make sense of phenomena and solve problems.				
	K-2	**3-5**	**6-8**	**9-12**
SCI.LS3: CONNECTIONS				
Example Wisconsin Connections	When growing Wisconsin Fast Plants, the seeds harvested from the plants grow into the same kind of plant (LS3.A, B). The same types of plants and animals found near a school (e.g. maple trees, squirrels) look similar but have some differences (LS3.B).	WI Fast Plants have genetic variation in pigment in the stems (LS3.A, B). The same type of animals in a green space versus more urban environment eat different things and can have different behaviors (e.g. squirrels, raccoons, coyotes, seagulls) (LS3.A).	Genetic engineering of bioluminescence is caused by genetic information being altered (LS3.A). People use knowledge of genetics and sexual reproduction to select for specific traits in animals, such as cows and pet dogs, and plants, such as agricultural crops (LS3.B). Air pollution, which can be more abundant in urban environments, can cause heritable mutations in animals (LS3.B).	Genetic engineering of bioluminescence is caused by genetic information being altered. (LS3.A). People use knowledge of genetics and sexual reproduction to breed cows and dogs (LS3.B). Wisconsin Fast Plants can be used to test the effect of genetic and environmental factors (LS2.A, B). Genetic Analysis Using Online Bioinformatics Tools can be used to explore genetic and environmental factors (LS3.B).

				Sickle cell anemia and lactose intolerance vary in prevalence by different demographics (LS3.B).
Engineering, Technology & Society Connections			Biological engineers can change how proteins are regulated by altering genes with tools such as CRISPR-Cas9.	Engineers alter gene expression through advanced biotechnology techniques to genetically modify organisms for increased production of human desired products. Better medicines can be engineered using knowledge of genetics.

Standard SCI.LS4--Evolution: Students use science and engineering practices, crosscutting concepts, and an understanding of ***biological evolution*** to make sense of phenomena and solve problems.				
	K-2	**3-5**	**6-8**	**9-12**
SCI.LS4: CONNECTIONS				
Example Wisconsin Connections	Wisconsin and other Midwestern states have very different native species than states such as Florida or Arizona (LS4.A). A variety of living things live in all parts of Wisconsin (LS4.D).	Fossils, such as trilobite fossils in Wisconsin, provide evidence of environmental changes (LS4.A). Bird sizes can vary due to differences in food and habitat. For example, Cooper's Hawks in Wisconsin are larger than Cooper's Hawks west of the Mississippi (LS4.B).	The discovery of ancient mammoths and mastodon remains documents the existence, diversity, extinction, and change of life forms in Wisconsin (LS4.A). The Wisconsin and Mississippi Rivers offer a barrier for gene flow for deer (LS4.C). Beaver populations influence trout fishing and affect biodiversity in other ways, including the impact of building activities on habitat (LS4.D). The loss of wetlands, and the alteration of prairies to agricultural use and then back to prairies, has	Data on fish limits and sizes in licensing over time can be analyzed to study the resulting effects on fish populations (LS4.C, D). Diatoms provide data for study of population dynamics (LS4.C, D). Whooping cranes provide an example of sustaining biodiversity (LS4.D). The biodiversity index of local schoolyards or nearby natural areas could be measured before and after conservation efforts (LS4.D).

			resulted in changes in biodiversity (LS4.D). Loss of old growth forest is due to human influences (LS4.D).	
Engineering, Technology & Society Connections		Engineer better habitats for zoo animals.	Engineers use genetic engineering to attain specific traits in livestock and crops.	Adaptations for bird flight relates to aeronautical engineering. Vaccines need to change to compete with evolving bacteria and viruses. Crop diseases, pesticide resistance in plants and insects are examples of natural selection.

PHYSICAL SCIENCE				
Standard SCI.PS1: Students use science and engineering practices, crosscutting concepts, and an understanding of ***matter and its interactions*** to make sense of phenomena and solve problems.				
	K-2	**3-5**	**6-8**	**9-12**
SCI.PS1: CONNECTIONS				
Example Wisconsin Connections	Lakes freeze in the winter and thaw again in the spring (PS1.B). The heat from an oven causes a change to cookie dough that is irreversible (PS1.B). Different materials used for surfaces on playgrounds (sand, grass, asphalt, rubber,	Studying the chemistry of soil helps a farmer plan for how to support crop growth (PS1.A, B). Ore mining methods are dependent on the properties of the materials (PS1.A). White residue observed on roads after winter is evidence of conservation	Changes in chemical composition of bodies of water can be observed over time and analyzed to understand relationships in chemical processes. (PS1.A, B) Salt is used to lower the melting point of ice found on roads so that the ice will melt even when temperatures are lower than 32 degrees F or 0 degrees C (PS1.A).	The La Crosse, Point Beach, and Kewaunee Nuclear Plants provide (or provided) electrical power to communities across Wisconsin (PS1.C). A chemical process can be used to convert cellulosic biomass to ethanol so that it can be used as a fuel source (PS1.A). Evidence of oxidation on metal surfaces differs based on the type of metal, and explains why different metals are used for different products (e.g. fences, bridges, sports equipment, medical devices, tools, and plumbing fixtures) (PS1.B).

	etc.) can be compared based on observable properties (PS1.A).	of matter – also showing matter exists in water as particles that are too small to see (PS1.B).	Chemical reactions are an important part of Wisconsin's dairy industry, as is pasteurization (PS1.B).	Wisconsin researchers study nuclear fusion and fission as energy resources (PS1.C).
Example Engineering, Technology & Society Connections	Engineers and materials scientists evaluate properties of materials to identify possible uses (such as making a shelter for Wisconsin weather conditions).	Engineers evaluate different materials for bridge design and repair.	Different metals are used based on the range of temperatures that will be encountered (e.g. how much they expand and contract varies). Hot and cold packs use chemical reactions.	Engineers design and optimize polymers for certain applications. Engineers explore and improve designs for water softeners, noting why we need them in Wisconsin. Engineers create biofuels and/or compare combustion of different fuel types.

Standard SCI.PS2: Students use science and engineering practices, crosscutting concepts, and an understanding of ***forces, interactions, motion and stability*** to make sense of phenomena and solve problems.				
	K-2	**3-5**	**6-8**	**9-12**
SCI.PS2: CONNECTIONS				
Example Wisconsin Connections	The strength of the hit to a hockey puck influences how far it will travel (PS2.A). Equipment on a school playground can be used to illustrate pushes and pulls (PS2.A).	Local summer fairs, carnivals, and amusement park rides illustrate unbalanced forces and the gravitational force (PS2.A, B). Collisions during a Green Bay Packers game illustrate unbalanced forces (PS2.A).	Increased static electricity in Wisconsin's dry winters can exemplify forces acting at a distance (PS2.B).	Sailboats on Wisconsin lakes, and equipment used by Wisconsin sports teams, can exemplify quantitative changes in motion and Newton's Laws (PS2.A). The Northern lights visible in Northern Wisconsin are caused by Earth's magnetic fields (PS2.B).
Example Engineering, Technology & Society Connections	Engineers design games or model playground equipment that incorporate pushes or pulls.	Engineers design toys, transportation methods, or simple machines that use gravitational, magnetic, or other forces.	Engineers develop solutions related to collision safety (e.g. car safety design or sports helmets). Local construction projects illustrate multiple aspects of forces, motion, and interactions.	Engineers design devices that use magnetic levitation to solve a problem (e.g. faster trains). Engineers design electrostatic devices to serve as recycling sorters or electromagnetic devices to generate electricity or pick up objects.

Standard SCI.PS3: Students use science and engineering practices, crosscutting concepts, and an understanding of ***energy*** to make sense of phenomena and solve problems.				
	K-2	**3-5**	**6-8**	**9-12**
SCI.PS3: CONNECTIONS				
Example Wisconsin Connections	During different seasons or weather, observe patterns in how much sunlight warms objects in the schoolyard (PS3.C). Solutions to reduce the heating effect of the sun include ginseng producers putting up shades for their plants; creating shade in a park or at the community garden; shade cloth at garden centers to create shade for plants that require partial to full shade (PS3.D).	Wind and solar power can be compared between locations and climates (PS3.A). Electrical energy is generated in many ways. Research what sources and processes your nearest power plant uses to transform and transfer energy (PS3.C).	Maple syrup production incorporates several energy topics including how temperatures above 0°C cause a positive pressure inside of a tree, which can result in the flow of sap. The heat used to boil off excess water and create the syrup (PS3.A). Biofuels provide an example related to energy conversions and energy of a system (PS3.D).	As uranium in Wisconsin soil shifts to more stable states, it changes into the radioactive gas radon, which can be a risk in Wisconsin homes (PS3.A). Milwaukee's streetcars have a bank of batteries that recharge when connected to overhead wires and allow continued transport without those wires (PS3.B). Historical geographical data can be used to evaluate changes over time of the amount of energy transformation through photosynthesis in different regions of the state, and how conversation of energy from the sun thus looks different over time (PS3.D).
Example Engineering, Technology & Society Connections	Engineers design solar ovens to heat food and shading devices to reduce heat from the sun.	Engineers design turbine blades for wind and water power. Engineers solve problems through effective design of electrical circuits.	Engineers design insulated containers for food or other perishable items (e.g. vaccines in areas with hot climates and limited refrigeration).	Engineers investigate possibilities for systems that make solar power and wind power more efficient in energy transfer, or chemical systems that could make artificial photosynthesis energy efficient.

Standard SCI.PS4: Students use science and engineering practices, crosscutting concepts, and an understanding of ***waves and their applications in technologies for information transfer*** to make sense of phenomena and solve problems.

	K-2	3-5	6-8	9-12
SCI.PS4: CONNECTIONS				
Example Wisconsin Connections	Odd noises occur in Clintonville due to the earth moving (PS4.A). Sounds are produced in a variety of ways during different seasons--birds, ice cracking, mosquitoes, etc. (PS4.A).	Waves and their impacts can be observed at local bodies of water (PS4.A). Students can research how we use patterns to send information (e.g. AM vs FM radio signals) (PS4.A).	Students can explore how sounds of insects above and below water can be related to predation (PS4.A). The Wisconsin Emergency Broadcast System uses waves to communicate. Students can consider ways to improve this system (PS4.C).	The placement of cell towers and strength of signals influence service quality across Wisconsin (PS4.C). Wave speed and other phenomena can be used to detect Earth or ice quakes (PS4.A). 5G cellular networks, now in place or being built in areas of Wisconsin, result in faster transfers of information using extremely high frequencies (PS4.A, C).
Engineering, Technology & Society Connections	Engineers design better methods to transmit sound, such as a "better" cup and string phone. Engineers use light and sound to communicate a message over a distance.	Engineers design strategies to aid color blind people in distinguishing between colors. Engineers design better speakers or headphones, building on knowledge of how they generate sound.	Ultrasound machines, fish finders, and ocean sonar equipment use waves to measure distance. Remote controls use radio waves or infrared radiation to communicate and transmit digital information. Engineers design earthquake resistant structures.	Using observations at different electromagnetic wavelengths helps astronomers explore the universe. Amplitude modulation and frequency modulation transmit information using radio waves; each may be used for different reasons. DVDs, flash drives, servers, and other electronic storage devices work differently and are appropriate for different applications.

Content Area: EARTH AND SPACE SCIENCE

Standard SCI.ESS1: Students use science and engineering practices, crosscutting concepts, and an understanding of ***Earth's place in the universe*** to make sense of phenomena and solve problems.

	K-2	3-5	6-8	9-12
SCI.ESS1: CONNECTIONS				

Example Wisconsin Connections	In Wisconsin there are patterns related to seasons, solar intensity, length of daylight, and location of the sun in the sky at different times of the year (ESS1.A, B).	Across Wisconsin, various landforms give evidence of ancient plate tectonics, erosional forces, and more recently - glacial activity (ESS1.C).	Yerkes Observatory in Williams Bay, WI was built in 1897 and is still the world's largest refractor telescope; it continues to be used for astronomical research (ESS1.A). Wisconsin rock strata show evidence of Precambrian Penokee mountain range (once as high as the Rockies) that were later eroded down and gave way to Paleozoic shallow seas to form sedimentary rock layers during Cambrian to Devonian Periods (ESS1.C).	Unique geographical provinces exist across Wisconsin (ESS1.C). Wisconsin has experienced numerous tectonic events throughout earth's history. These events were instrumental in forming many of our present landforms such as the Baraboo hills and Penokee Mountains (ESS1.C). Landforms such as moraines, drumlins, eskers, kames, kettles, buried forests, erratic boulders, outwash plains, and glacial lakes are evidence of glacial advances and retreats (ESS1.C). The geology and terrain of Wisconsin can provide evidence of our glacial history. The movements of past ice sheets brought about changes in the landscape seen today. The National Scenic Ice Age Trail provides examples and information (ESS1.C).
Engineering, Technology & Society Connections	Weather data in Wisconsin is collected by citizen scientists throughout the state.	Geological features of a community influence where a bridge, landfill, hydroelectric dam, etc. should be placed.	Reverse engineer a telescope to see how it is constructed and how it is designed for a purpose. There are applications of 3D printing in space technology.	NASA Engineers work on advances to air and space systems to support "highways in the sky," "smart aircraft," human missions, and other space endeavors. Development of new high-tech industries enable humans to forecast and assess the health of the Earth system.

Standard SCI.ESS2: Students use science and engineering practices, crosscutting concepts, and an understanding of ***Earth's systems*** to make sense of phenomena and solve problems.				
	K-2	**3-5**	**6-8**	**9-12**
SCI.ESS2: CONNECTIONS				
Example Wisconsin Connections	Beavers change their environment to meet their needs (ESS2.E). Wisconsin has several different growing zones	Wisconsin is home to about 15,000 inland freshwater lakes (most are glacially formed). Our state borders two of the five Great Lakes,	Earthquakes are very rare across Wisconsin, as seen in USGS Data (ESS2.B). Recent and historical weather and climate data for Wisconsin is	Weather and climate in Wisconsin is complex and varied, depending on topography, elevations, water body proximity, and human interactions. These natural and anthropogenic interactions occur both locally and globally. For example, Lake Michigan and Lake Superior

	which determine plantings (ESS2.D).	which are the largest collection of freshwater lakes in the world by total area, and contain 21% of Earth's surface fresh water by volume (ESS2.C). Wisconsin has different climate patterns than other parts of the U.S. and world (ESS2.D).	maintained by the State Climatology Office and NOAA (ESS2.D).	affect climate patterns near their shores, such as air temperature variation or lake effect snow (ESS2.C, D). Wisconsin climate and water temperature data can be analyzed for changes over time related to climate change and used to make predictions for the future (ESS2.D).
Engineering, Technology & Society Connections	Engineers develop solutions that are specific to environmental and climatic needs (de-icing an airplane, heating and cooling systems in houses).	The National Academy of Engineering suggests work with the "Grand Challenge" of providing access to clean water (water purification, small and large scale).	Engineers design systems to harness energy from water (hydropower), the Earth (geothermal), tides, solar, etc.	Engineering can generate and support solutions to a changing climate. Farmers minimize natural hazards in agriculture in multiple ways, using sprinkler systems in cranberry bogs to mist plants when there is frost danger in spring; wind machines at vineyards to displace cold air and reduce frost damage to budding vines in spring; practices to reduce soil erosion (no till farm fields; landscape designers using products to hold soil in place while new plantings grow).

Standard SCI.ESS3: Students use science and engineering practices, crosscutting concepts, and an understanding of the ***Earth and human activity*** to make sense of phenomena and solve problems.				
	K-2	**3-5**	**6-8**	**9-12**
SCI.ESS3: CONNECTIONS				
Example Wisconsin Connections	Citizens use groundwater in Wisconsin for drinking and to grow food (ESS3.A). Agriculture practices across Wisconsin vary	The world's reserves for nonrenewable fuel sources (crude oil, natural gas, and coal) are limited. Wisconsin is home to biofuels, frac sand mining, wind, solar, and hydropower (ESS3.A, C).	In the early 2010's, Wisconsin used about one-third of its corn crop to produce hundreds of millions of gallons of ethanol each year. There are costs and benefits from mining of Wisconsin sand for fracking and upgrading transmission	Historical ice in and ice out data for lakes across the state can be compared to global climate models (ESS3.D).

	based on soil type, climate, and culture (ESS3.A).		infrastructure across Wisconsin (ESS3.A). Ecological footprint calculators allow students to analyze how personal choices impact Earth's resources (ESS3.A, C, and D). Global climate change impacts wild rice harvest across Wisconsin (ESS3.A, C, and D). Historical WI weather service data on severe weather impacts are available (ESS3.B).	
Engineering, Technology & Society Connections	Engineers identify solutions to provide alternatives that reduce human impacts on the environment.	Engineers create designs to lessen impacts of extreme events, such as earthquake resistant structures and Tsunami warning systems.	Engineers work on harnessing energy from new sources and improve existing means to get energy.	A National Academy of Engineering Grand Challenge is to develop carbon sequestration methods. Engineer development looks to balance different, and often competing, needs against an awareness of the environmental, social and economic limitations we face as a society.