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| **Subtopics** | **Content Expectations** | **Clarification/**  **Concepts** | **Instructional Examples/ Assessment Techniques** | **Unit 1 Vocabulary** | **NGSS** |
| What is environmental science? | **L3.p2B** Describe common ecological relationships between and among species and their environment  [***Ch 4 – Sec. 1; 127]*** | None | * Critique articles regarding environmental issues –discuss the impact the information may have on us. * Watch/discuss video “An Inconvenient Truth” * Have students write an opinion paper * Hold a discussion/debate on an environmental issue of choice | * greenhouse effect * fossil fuels * environment * exponential growth * more developed countries * less developed countries * resources * recycling * pollution * degradable * biodegradable * sustainable * extinction |  |
| *Why study environmental science? i.e. what does it have to do with me?* | **L3.p4A** Recognize that, and describe how, humans are part of Earth’s ecosystem. Note that human activities can deliberately or inadvertently alter the equilibrium in ecosystems (and the environment)  [***Pg. 16-22; Unit 4***]  **E1.2B** Identify and critique arguments about personal or societal issues based on scientific evidence  [***See feature articles***  ***listed on page xvi***] | None |

**12th Grade Environmental Science**

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**Unit** 1 **Topic:** *Humans and Nature – An Overview* **Weeks:** 1 week

**Big Ideas:** *This unit will introduce the student to the concepts and ideas that will be covered in this class. There will be a very brief review of some of the central ideas that will be covered that should be pre-requisite to taking this class.*

Green shaded text = Priority Expectations

**Unit** 2 **Topic:** *Scientific Principles and Concepts* **Weeks:** 2 ½ - 3 weeks

**Big Ideas:**

* *Matter transfer in ecosystems between living and non-living organisms provides the materials necessary for all life.*
* *Ecosystems usually establish equilibrium between their biotic inhabitants and abiotic factors.*
* *Processes and events on Earth result from energy transfer and movement of matter through interconnected*
* *Earth systems.*

| **Subtopics** | **Content Expectations** | **Clarification/**  **Concepts** | **Instructional Examples/**  **Assess. Techniques** | **Unit 2**  **Vocabulary** | **NGSS** |
| --- | --- | --- | --- | --- | --- |
| *Elements*  *Matter & Energy*  *Stored & Lost Energy*  *Eco systems*  *Biomes*  *Climate* | **B3.2A** – Identify how energy is stored in an ecosystem  ***[pg. 125-129]***  **B3.2B** – Describe energy transfer through an ecosystem, accounting for energy lost to the environment as heat  ***[pg. 129-131]***  **B3.3A-** Use a food web to identify and distinguish producers, consumers, and decomposers and explain the transfer of energy through trophic levels ***[pg. 130-131]***  **E2.1A** - Explain why the Earth is essentially a closed system in terms of matter  ***[pg. 63; 85]*** | **B3.2A** – Identification is limited to discussion of chemical bonds as stored energy structures  **B3.2B** – Describe energy transfer through an ecosystem, accounting for energy lost to environment as heat  **E2.1A** – The abundance of elements that make up greenhouse gases are essentially constant in the Earth System, but move between the four major systems. | Diagrams depicting the interactions of Earth’s major systems    Diagrams of carbon cycle, nitrogen cycle, and water cycle  Students carry out a series of lab explorations quantifying, replicate or simulate a variety of conversions of carbon from one form to another (e.g., crushing shells and gluing them together like formation of limestone; pouring acid on limestone and testing the acidity or alkalinity of the liquid collected; bubble carbon dioxide through water and test the pH of the water) etc.  Samples of the different forms of carbon and nitrogen | abiotic  components  atmosphere  aquifer  biogeochemical  cycles  biosphere  carbon cycle  equilibrium  freshwater  groundwater  hydrosphere  nitrogen cycle  reservoir  watershed  wetland | **HS-LS1-5** Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy [Emphasis is on illustrating inputs and outputs of matter and the transfer and transformation of energy in photosynthesis by plants and other photosynthesizing organisms]  *.*  **HS-LS2-5** Construct and revise an explanation based on evidence for the **cycling of matter** and flow of energy in aerobic and anaerobic conditions  **MS-ESS2-1** Develop a model to describe the cycling of Earth’s materials and the flow of energy that drives this process.  **MS-ESS3-1** Construct a scientific explanation based on evidence for how the uneven distributions of Earth’s mineral, energy and groundwater resources are the result of past and current geosciences processes. |

**Environmental Science Unit 2: Scientific Principles and Concepts cont’.**

| **Subtopics** | **Content Expectations** | **Clarification/Concepts** | **Instructional Examples/**  **Assessment Techniques** | **Unit 2**  **Vocabulary** | **NGSS** |
| --- | --- | --- | --- | --- | --- |
| *Watersheds* | **E4.p1B** – Analyze the flow of water between the elements of a watershed, including surface features (lakes, streams, rivers, wetlands) and groundwater ***[pg. 290-295]*** | none | Diagram the water cycle as it applies to groundwater and watersheds  Diagram of matter & element recycling in ecosystems  Diagrams of matter cycling and energy flow in an ecosystem  Draw a representation of a +/- feedback system |  | **MS-ESS2-4** Develop a model to describe the cycling of water through Earth’s systems driven by energy from the sun and the force of gravity  **HS-LS2-5** Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere. Examples of models could include simulations and mathematical models.  **HS-LS2-6** Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistence numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. |
| *Carbon,*  *Nitrogen,*  *and*  *Water*  *Cycles* | **B3.3b** – Describe environmental processes (i.e. cycles) and their role in processing matter crucial for sustaining life ***[pg. 132-136]***  **E2.3d** – Explain how carbon moves through the Earth system and how it may benefit (e.g. improve soils) or harm (e.g. act as a pollutant) society  ***[pg. 132-133]***  **E2.1B** – Analyze the interactions between the major systems (geosphere, atmosphere, hydrosphere, biosphere) that make up the Earth ***[Ch. 3]*** | **B3.3b** – Descriptions are limited to names of participants in the carbon and nitrogen cycles and how they are used and cycled through organisms  **E2.1B** – The systems interact through exchanges and transformation of matter/energy such as storage and release of Carbon |

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| ***UNIT 2 -- REAL WORLD CONTEXT: SCIENTIFIC PRINCIPLES AND CONCEPTS***   * Large quantities of carbon dioxide can be taken in by the Earth’s plants, algae, and remain dissolved in ocean water. The carbon cycle is a biogeochemical cycle that quantifies the movement of carbon through the four major Earth systems. * Nitrogen exists in several organic and inorganic forms throughout the Earth systems and can be depicted as one of the biogeochemical cycles known as the “Nitrogen-Cycle.” It is very important for ecosystems. Human actions such as burning of trees or fossil fuels, use of nitrogen fertilizer, impact the movement and storage of nitrogen. Detrimental results include nitrogen loading in waterways and increased nitrogen based pollutants including nitrous oxide, a greenhouse gas * Changes in relationships and populations of producers and consumers may occur as the result of the loss of one or more types of organisms in the ecosystem. The loss of any group of organisms from an ecosystem changes the flow of energy within that system. * The overall cycling of matter, specifically carbon and nitrogen, through ecosystems as it passes between living systems to abiotic components of ecosystems is very important because it shows the interdependence of organisms with their physical environment, and vice versa. * Human created disturbances in ecosystems or environments, including local and global climate change, uses of tilling and pesticides to favor human crops, human land use, harvesting of fish stocks, pollution, invasive species, and others are common to many ecosystems and represent problems that cause imbalances in the cycling of matter and the transformation of energy through ecosystems. * Watersheds are the main organizing concept for elements and process of surface hydrology, ground water and land use. |

**UNIT** 3 **TOPIC:** *Human Population* **Weeks**: 2 ½ - 3 Weeks

**BIG IDEAS:**

* *Populations relate to each other within their ecosystem – including humans*
* *Populations initially grow exponentially in a favorable environment, but all population growth will ultimately*

*level off (reach carrying capacity) when resources become limiting.*

| **Subtopics** | **Content Expectations** | **Clarification/Concepts** | **Instructional Examples/**  **Assessment Techniques** | **Unit 3**  **Vocabulary** | **NGSS** |
| --- | --- | --- | --- | --- | --- |
| *Population Dynamics* | **B3.5A** – Graph changes in population growth, given a data table  ***[ex: pg. 213]*** | none | Construct/interpret population tables & graphs e.g. graph exponential growth (J-curve) vs. stabilized population growth (S-curve)  ***Inquiry***: Tox-town computer site  ***Lab***: Investigate the effects of nitrogen fertilizers on the growth of algae  Design a science-based solution to a local environmental issue  Predict the effects of crowding on the growth of seedlings. In small groups, design and carry out an experiment that compares trays with different densities (concentration equally distributed) of plants (e.g. radishes). Observe the effects of crowding on the different populations of plants and the abiotic factors for which the plants were competing (e.g. light, water, nutrients, etc.)  Take a trip to a “natural area” then walk around the school. Talk about the differences & similarities between the two. What caused the differences and what impact do they have on the plants and animals in the area? | Biological adaptation  carrying capacity  equilibrium  exponential growth  groundwater  impermeable surface  limiting factor  reproductive capacity  stabilized population  urbanization | **HS-LS2-1** Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. *[Assessment boundary: Assessment does not include deriving mathematical equations to make comparisons]*  **HS-LS2-2** Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.[Assessment Boundary: Assessment is limited to provided data]  **HS-LS2-6** Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistence numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. |
| *Population Regulation and Distribution* | **B3.5B** – Explain the influences that affect population growth  **B3.5e** - Recognize and describe how the physical or chemical environment may influence the rate, extent, and nature of population dynamics within ecosystems.  **B3.5f** – Graph an example of exponential growth. Then show the population leveling off at the carrying capacity of the environment  ***[pg. 213-216]*** | **B3.5e** – Descriptions are limited to effects of abiotic factors (temperature, sunlight, pH, nutrient availability) on population dynamics |
| *Urbanization*  *Urban Environmental*  *Problems*  *Urban and Agricultural Land Use* | **B3.4C** - Examine the negative impact of human activities  **E4.1C** – Explain how water quality in both groundwater and surface systems is impacted by land use decisions ***[pg. 304-313]***  See next page for NGSS | **E4.1C** – Agricultural practices, urbanization and industrialization impact water quality  ***Note: will revisit & expand upon in Unit 6*** |
|  | | | | | **HS-LS2-7** Design, evaluate and refine a solution for reducing the impacts of human activities on the environment and biodiversity  **HS-LS4-6** Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity  **HS-LS2-8** Evaluate the evidence for the role of group behavior on individual and species’ chances to survive and reproduces. [Examples of behaviors could include flocking, schooling, herding and cooperative behaviors such as hunting, migrating and swarming] |

**UNIT** 4 **TOPIC:** *GLOBAL ISSUES* **WEEKS:** 2 ½ - 3 Weeks

**BIG IDEAS:**

* *The environment and its ecosystems are characterized by both stability and change, on which human population can have a great impact.*
* *External events can cause an ecosystem to change in many ways.*
* *Humans have created disturbances in most ecosystems and environments.*

| **Subtopics** | **Content Expectations** | **Clarification/Concepts** | **Unit 4 Instructional Examples/**  **Assessment Techniques** | **Unit 4**  **Vocabulary** | **NGSS** |
| --- | --- | --- | --- | --- | --- |
| *Deforestation*  *and loss of bio-diversity* | **B3.4B** Recognize and describe  that a great diversity of species increases the chance that at least some living organisms will survive in the face of cataclysmic changes in the environment  ***[pg. 260-262]***  **B3.4C** – Examine the negative impact of human activities  ***[pg. 264 as applies to diversity-this is a continuation of Unit 2]***  **E2.4B** – Explain how the impact of human activities on the environment can be understood through the analysis of interactions between the 4 Earth systems. | **B3.4B** – Descriptions will be limited to relationship between biodiversity and genetic variation as indicators of stability within an ecosystem.  **E2.4B** - Human impact on the environment can be analyzed through an Earth system science perspective that focuses on how matter and energy is transferred within and between Earth’s systems. | Predict positive and negative effects of human activities on a local ecosystem  DISCUSSION: “Paper or plastic?”  Analysis of quantitative data on biodiversity  Qualitative descriptions of biodiversity in different ecosystems and representations of loss of biodiversity | Atmosphere  Biodiversity  Biogeochemical  Cycles  Carbon Cycle  Carrying capacity  Climate change  Deforestation  Ecosystem stability  Emissions  Fossil fuels  Global warming  Greenhouse  effect  Greenhouse  gases  Hydrosphere  Methane  Nitrous Oxide  Ozone  (depletion)  Polar ice caps  Succession  Thermal energy | **HS-LS2-7** Design, evaluate and refine a solution for reducing the impacts of human activities on the environment and biodiversity [Examples of human activities can include urbanization, building dams and dissemination of invasive species. |

**Unit 4 cont.: Global Issues**

| **Subtopics** | **Content Expectations** | **Clarification/Concepts** | **Instructional Examples/**  **Assessment Techniques** | **Unit 4**  **Vocabulary** | **NGSS** |
| --- | --- | --- | --- | --- | --- |
| *Climate Change and Global Warming*  ***[pg. 363-369]*** | **B3.4e –** List the possible causes and consequences of global warming  **E5.4A –** Explain the natural mechanism of the greenhouse effect including comparisons of the major greenhouse gases (water vapor, carbon dioxide, methane, nitrous oxide, and ozone.  **E5.4C –** Analyze the empirical relationship between the emissions of carbon dioxide, atmospheric carbon dioxide levels and the average global temperature over the past 150 years.  E5.4g – Compare and contrast the heat-trapping mechanisms of the major greenhouse gases resulting from emissions as well as their abundance and heat trapping capacity. | None | **Continued from previous page:**  Students collect a variety of statements made about the connection between human carbon dioxide emission, the level of carbon dioxide in the atmosphere, and the average global temperature. They will identify the evidence sited for each statement, evaluate the validity and logic of the supporting arguments.  Satellite images and photographs of glaciers at different times, documenting melting of glacial ice.  Graphs of atmospheric CO2 over time  **Video: *An Inconvenient Truth*** |  | **MS-ESS3-5** Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century |

**Unit 4 cont.: Global Issues cont.’**

| **Subtopics** | **Content Expectations** | **Clarification/Concepts** | **Instructional Examples/**  **Assessment Techniques** | **Unit 4**  **Vocabulary** | **NGSS** |
| --- | --- | --- | --- | --- | --- |
| *Ozone Depletion* | **E2.4C –** Explain ozone depletion in the stratosphere and methods to slow human activities to reduce ozone depletion.  ***[pg.359-362]*** | None | Analyze data and images of stratospheric ozone levels over several decades and record observations ofnoted patterns. Generate and pursue questions from the patterns that explain changes over time.  Research and discuss levels of ozone depletion vs. incidence of skins cancer in areas of depletion |  | **HS-LS2-7** Design, evaluate and refine a solution for reducing the impacts of human activities on the environment and biodiversity [Examples of human activities can include urbanization, building dams and dissemination of invasive species.] |
| *Introduction of Non-native Species* | **B3.5C** – Predict the consequences of an invading organism on the survival of other organisms  ***[pg. 265]*** | **B3.5C –** Predictions are limited to the effect of a non-native species on the populations of native species. | Research and report on the effects of local invasions of non-native species such as Purple Loosestrife, Zebra Mussels, Gobie Fish, etc. |

***UNIT 4 REAL- WORLD CONTEXT***: ***GLOBAL ISSUES ON NEXT PAGE***

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| ***UNIT 4 REAL-WORLD CONTEXT: GLOBAL ISSUES***   * Human-created disturbances in ecosystems or environments, including local and global climate change, uses of tiling and pesticides to favor human crops, human land use, harvesting of fish stocks, pollution, invasive species, and others are common to many ecosystems and represent problems that cause imbalances in the cycling of matter and the transformation of energy through ecosystems. * There is a relationship between the stability of an ecosystem and its biodiversity. External events, either natural or man-made, can cause an ecosystem to change in many ways. These external forces affect ecological succession adversely, but if the ecosystem is then left undisturbed it will ultimately revert to it earlier from through stages of succession. * Humans have created disturbances in most ecosystems and environments. These disturbances have been as varied as local and global climate change, altering the land to favor crops, human land uses, harvesting of fish stocks, causing various forms of pollution and aiding in the introduction of invasive species. Invasive species and nutrient loading has changed the population dynamics of species within the Great Lakes. These disturbances change the population dynamics of species within an ecosystem. * Examples of human impact on other species include reducing the amount of Earth’s surface available as habitats, interfering with food sources, changing the temperature and chemical composition of habitats, introducing foreign species into ecosystems, and altering organisms directly through selective breeding and genetic engineering. * A displaced organism will be tested when it encounters a new environment, but its ability to survive will depend on the degree to which the new surroundings meet its physiological needs and the amount of competition it encounters from native species. If it is able to establish a new niche, it can be successful….so successful, in fact, that it may place stress on the natural inhabitant. * Many scientists believe the zebra mussel colonization of the Great Lakes is concentrating biomass and nutrient energies in the benthic or bottom region of the lakes. This is biomass that was once available to other (often native) species. The full implications of zebra mussel colonization of the Great Lakes are still playing out and are not yet fully understood. There is growing evidence that the mussels are responsible for the decline of the native aquatic invertebrate Dioperia, which are an important food item for many fish in the Great Lakes. The changing populations of fish will bring their consequences, creating a cascade effect. Zebra mussels attach to most substrates including sand, silt, and harder substrates. Other examples of the interdependence of organisms include relationships between the environment and public health and between migration and the potential spread of diseases. |
| * Carbon dioxide is a major greenhouse gas that makes Earth warm enough to sustain life as we know it. Human industrialization has dramatically increased the percentage of carbon dioxide in the atmosphere, making the Earth warmer and altering the climate system. * Nitrogen exists in several organic and inorganic forms throughout the Earth systems and can be depicted as one of the biogeochemical cycles known as the ”Nitrogen Cycle”. It is very important for ecosystems. Human actions such as burning of trees or fossil fuels, use of nitrogen fertilizer, impact the movement and storage of nitrogen. Detrimental results include nitrogen loading in waterways and increased nitrogen-based pollutants including nitrous oxide, a greenhouse gas. * Deforestation can result in less humidity in the air, more carbon dioxide in the air, greater soil erosion, which in turn can change the chemical and physical conditions of streams, lakes, and groundwater. * the choice of paper or plastic bag in the grocery store is not simple if all the steps in making and disposing of it are considered. Paper has often been touted as the better choice environmentally, but understanding the trade-offs should require one to consider a number of issues such as how well the paper manufacturing plant is operated and what bleaching agents are used in making the paper. * The development of automobiles that run on alternative fuels (hydrogen, electricity) will reduce carbon dioxide emissions but involve other environmental trade-offs. * Burning of fossil fuels releases carbon once stored in ancient biomass. This carbon can exist in several main forms and reside in different reservoirs of the Earth system. Releasing carbon dioxide into the atmosphere promotes greater plant growth, moving carbon from the atmosphere into plants. More carbon dioxide in the atmosphere also results in more of it dissolving in water of the oceans, lakes, and rain. However, the burning of biomass both releases more carbon dioxide into the air and reduces the biosphere’s capacity to remove carbon dioxide through photosynthesis. * The current warming trend is resulting in the melting of glacial ice. Other possible effects include the melting of permafrost (releasing methane) and also warming oceans which melts methane hydrates of the ocean floor. Melting of glacial ice affects Earth systems in many ways. * The effects of sea level rise are most profound when ice is land-based. Increasing water density drives the thermohaline current (initiating the North Atlantic Deep Water) and plays a major role distributing Earth’s heat. Increased fresh water in the North Atlantic Ocean due to melting ice decreases sea water salinity and therefore water density. Resulting changes in global heat distribution would impact climate on land regionally, a hypothesis supported by studies of ancient climates. The melting of ice reduces Earth’s average albedo (the reflectivity of Earth’s surface materials) and therefore increases the amount of energy absorbed by the Earth. |

**UNIT** 5 **TOPIC**: *RESOURCES & RESOURCE MANAGEMENT* **WEEKS**: 2 ½ - 3 Weeks

**BIG IDEAS:**

* *Protecting the human interests of health, safety and resource management depends upon an understanding of natural hazards and human impact on Earth systems.*
* *All sources of energy used for human consumption have benefits, cost, and environmental impact*
* *Extracting and using natural resources causes elements to be released from reservoirs and can cause environmental impacts.*
* *Extracting and using natural resources causes energy to change form and/or become distributed in a way that can cause environmental impacts*.

| **Subtopics** | **Content Expectations** | **Clarification/Concepts** | **Instructional Examples/**  **Assessment Techniques** | **Unit 5**  **Vocabulary** | **NGSS** |
| --- | --- | --- | --- | --- | --- |
| *Perpetual & Renewable Energy Resources* | **E2.2B –** Identify differences in the origin and use of renewable (e.g. .solar, water, wind) and non-renewable (e.g. fossil fuels nuclear [U-235]) sources of energy***. [Ch. 17 & 18; pgs. 466-505]***    **E2.4A** Describe renewable and nonrenewable sources of energy for human consumption (electricity, fuels), compare their effects on the environment. (include overall costs and benefits- *this part will be covered in Unit 7*)  ***[Ch. 17 & 18]*** | **None**  **E2.4A** All sources of energy used for human consumption have benefits, costs and environmental impact. Detailed and quantified comparisons allow for more informed decisions about the tradeoffs involved. | Diagram our energy source from origin to our homes  Diagram the life cycle of a manufactured product  Energy diagrams depicting production and consumption of natural resources or consumable products  Brainstorm various ways that we can conserve our natural resources, both renewable and non-renewable | Biomass  Chemical  Energy  Deforestation  Ethanol  Fossil fuels  Geothermal  energy  Hydroelectric  energy  Invading  Species  Nuclear  energy  Resources:  Renewable &  Nonrenewable  Solar energy | **MS-ESS3-3** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage, land usage, and pollution. |
| *Non-Renewable Resources*  *Mineral Resources*  *Solid Waste* | **E2.4A See previous page** |  | Investigate new uses for solid waste |  | **MS-ESS3-4** Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth’s systems  **HS-LS2-7** DesIgn, evaluate and refine a solution for reducing the impacts of human activities on the environment and biodiversity [includes dissemination of invasive species] |
| *Food Resources*  *(including Genetically Modified Foods* | **B3.5C –** Predict the consequences of an invading organism on the survival of other organisms  **[pg. 417-420; 437]** | **B3.5C –** Predictions are limited to the effect of a non-native species on the population of native species | Research and discuss/debate the pros and cons of genetically modified foods | Genetically  modified  foods  Invasive  species |

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| ***UNIT 5 REAL-WORLD CONTEXT : RESOURCES & RESOURCE MANAGEMENT***   * The development of automobiles that run on alternative fuels (hydrogen, electricity) will reduce carbon dioxide emissions, but involve other environmental trade-offs. * Changes in relationships and populations of producers and consumers may occur as the result of the loss of one or more types of organisms in the ecosystem. The loss of any group of organisms from an ecosystem changes the flow of energy within that system. * Depletion of ground water can impact streams and biological viability. Landscapes can establish equilibrium inconsistent with emerging climatic patterns. Changes in climatic patterns or human diversions of water will shift equilibrium and produce changes in the characteristics of streams, ground water and landscapes. * While water quality can be reduced by land use in many ways, the effects of agricultural practices are perhaps most profound. * Loss of soil not only diminishes the agricultural viability of land, but may greatly increase stream water turbidity which increases absorption of thermal energy and therefore water temperature. Dissolved oxygen levels drop as water temperature rises. * Organic and synthetic fertilizer from surface run off adds nitrates to stream water which can cause algal blooms. Algae are eventually broken down by aerobic bacteria that consume great quantities of dissolved oxygen. Such occurrences can be inferred from a high biochemical oxygen demand (B.O.D.) and lower percent saturation of dissolved oxygen. * The “dead zone” in the Gulf of Mexico is one of many off shore areas on Earth where coastal ecosystems suffer from extremely low amounts of dissolved oxygen. The depletion of oxygen begins in the spring, swells to a maximum size in summer and disappears in the fall. A major cause is excessive nutrients from agriculture in the Mississippi watershed. * Ground water systems are sustainable when input is equal to or exceeds out put. Major sections of the Midwest are practicing unsustainable agriculture due to excessive down draw of the Ogallala aquifer. Some areas experience topographic subsidence due to excessive and continuous ground water withdrawal. * Ground water quality suffers from industrial chemicals and saline infiltration. The United States superfund sites are prioritized locations suffering from dangerous levels of ground water pollution. |

**UNIT** 6 **TOPIC:** *Pollution* **Weeks:** 2 ½ - 3 Weeks

**BIG IDEAS:**

* *Protecting the human interests of health and safety depends upon an understanding of natural hazards and human impact on Earth systems*
* *Finding solutions to problems related to water resources requires an understanding of the dynamics and interconnectedness of the components of the hydrosphere and the impact created by human activity.*
* *Ecosystems are characterized by both stability & change, on which human populations have an impact*

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| **Subtopics** | **Content Expectations** | **Clarification/Concepts** | **Instructional Examples/**  **Assessment Techniques** | **Unit 6**  **Vocabulary** | **NGSS** |
| *Pesticides and Pest Control* | **B3.4C – (Re)e**xamine the negative impact of human activities    **E2.3b** – Explain why small amounts of some chemical forms may be beneficial for life but are poisonous in large quantities  **[pg. 308; 555]** | None | This would also be a good place to apply the student-designed experiment testing the effects of crowding on the growth of seedlings  Research the negative impact of pollution on human health: respiratory disease, waterborne GI disease, etc.  Field trip to local waste water treatment plant | Aquifers  Biogeochemical  Dissolved  oxygen  Freshwater  Reservoirs  Groundwater  Hydrosphere  Riparian  Runoff  Turbidity  Water quality  Water table  Wetlands | **MS-ESS3-3** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage, land usage, and **pollution**. |
| *Air Pollution* |  |  | Lab: Test air quality of your school using various techniques | Acid Rain  Ozone  CFC’s |
| *Soil Pollution* |  |  | Research local brown field areas  Research and report on  phytoremediaton; design a lab to test this practice | Brown field  Phyto-  remediation  Landfills |
| **Subtopics** | **Content Expectation** | **Clarification/Concepts** | **Instructional Examples/Assessment Tech.** | **Unit 6 Vocabulary** | **NGSS** |
| *Water* | **E4.1C –** Explain how water quality in both groundwater and surface systems is impacted by land use decisions ***[pg. 304-313]***  **E2.3b –** Explain why small amounts of some chemical forms may be beneficial for life but are poisonous in large quantities. (e.g. fluoride in water)  **E2.3 c –** Explain how nitrogen is part of Earth system  **[pg. 71; 134-36; 73]** | **E4.1C** Agricultural practices, urbanization and industrialization impact water quality  **E2.3c –** Nitrogen is part of nutrients that affect water quality | Bar graphs of water quality data for interpretation of trends over time, natural seasonal variation and impact of land use.  Groundwater flow maps & profiles  Study the natural and human land use features of a watershed and hypothesize the character of water quality based on those features in terms of dissolved oxygen, fecal coliform, turbidity, and temperature. Gather water quality data to test the hypothesis.  Use depths to water table data of several wells to draw contour lines and interpret flow direction of ground water in a scenario where a pollutant is moving with a ground water system. Research the technology used to solve ground water pollution problems. |  |  |

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| ***UNIT 6 REAL-WORLD CONTEXT: POLLUTION***   * Ground water quality suffers from industrial chemicals and saline infiltration. The United States superfund sites are prioritized locations suffering from dangerous levels of ground water pollution. * While water quality can be reduced by land use in many ways, the effects of agricultural practices are perhaps most profound. * The “dead zone” in the Gulf of Mexico is one of many off shore areas on Earth where coastal ecosystems suffer from extremely low amounts of dissolved oxygen. The depletion of oxygen begins in the spring, swells to a maximum size in summer and disappears in the fall. A major cause is excessive nutrients from agriculture in the Mississippi watershed. * Organic and synthetic fertilizer from surface run off adds nitrates to stream water which can cause algal blooms. Algae are eventually broken down by aerobic bacteria that consume great quantities of dissolved oxygen. Such occurrences can be inferred from a high biochemical oxygen demand (B.O.D.) and lower percent saturation of dissolved oxygen. * Humans have created disturbances in most ecosystems and environments. These disturbances have been as varied as local and global climate change, altering the land to favor crops, human land uses, harvesting of fish stocks, causing various forms of *pollution* and aiding in the introduction of invasive species. Invasive species and *nutrient loading* has changed the population dynamics of species within the Great Lakes. These disturbances change the population dynamics of species within an ecosystem. |

**UNIT** 7  **TOPIC:** *Environment and Society*  ***Weeks:***  1 Week

**BIG IDEAS:**

* *Decisions on policy and investment in energy systems for human consumption take into account many factors such as cost and access of natural resources, carbon emissions, technology, impact on society and the challenges of pollution.*
* *All sources of energy used for human consumption have benefits, costs and environmental impact.*
* *Predicting and mitigating the potential impact of global climate change requires an understanding of the mechanisms of Earth’s climate.*

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| **Subtopics** | | **Content Expectations** | **Clarification/Concepts** | **Unit 7 Instructional Examples/**  **Assessment Techniques** | **Unit 7**  **Vocabulary** | **NGSS** | |
| *Risk, Human Health and Hazardous Waste*  ***Ch. 20***  ***The Individual***  *Economics and Environment*  *Ch. 21:*  *United States*  *(National)*  *~*  *International* | | **B2.3C –** Explain how (internal homeostasis) stability is challenged by changing physical, chemical and environmental conditions  ***[pgs. 331-333, 338, 361, 367, 418, 422-437, 529, 532, 553-561, 571]***  **E2.4A –** Describe renewable and nonrenewable sources of energy for human consumption (electricity, fuels), compare their effects on the environment], **and include overall costs and benefits.**  **E2.4d -** Describe the life cycle of a product, including the resources, production, packaging, transportation, disposal and pollution | **E2.4A** – All sources of energy used for human consumption have benefits, costs and environmental impact. Detailed and quantified comparisons allow for more informed decisions about the tradeoffs involved  **E4.1C –** Agricultural practices, urbanization and industrialization impact water quality  *(This will be a matter of highlighting this topic which was covered in the unit on pollution)* | **\***Satellite images, which can show extent of problems as well as progress on solutions (such as improvements in the stratospheric ozone layer).  **\*** Diagrams of public energy systems (e.g. power plants) showing quantities and qualities of energy flow.  **\*** Diagrams of public sewer and drainage systems.  **\*** Energy diagrams depict production and consumption of natural resources or consumable products  **\*** Design a possible future energy system for a local community that utilizes natural resources.  Research various human-induced causes of environmental decline and discuss what can be done on a local level to begin to change it. | Dose  Epidemiology  Host  infectious  Particulates  Pathogen  Risk  assessment  Toxicology  Transmission  Vector  Biodiversity  Carbonic acid  Economics  Geosphere  Limestone  Lobbying  Sustainability | **MS-ESS3-3** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage, land usage, and pollution | |
| ***Politics and Environment***  **(Policies)**  ***World View, Ethics and Environment*** | | **E4.1C –** Explain how water quality and surface systems is impacted by land use *decisions*  ***🡪*** |
| ***UNIT 7 REAL-WORLD CONTEXT: ENVIRONMENT AND SOCIETY***   * *Humans have created disturbances in most ecosystems and environments. These disturbances have been as varied as local and global climate change, uses of tilling and pesticides to favor crops, human land uses, harvesting of fish stocks, causing various forms of pollution and aiding in the introduction of invasive species. Invasive species and nutrient loading has changed the population dynamics of species within the Great Lakes. These disturbances represent problems that cause imbalances in the cycling of matter and the transformation of energy through ecosystems, as well as change the population dynamics of species within an ecosystem.* * *Examples of human impact on other species include reducing the amount of Earth’s surface available as habitats, interfering with food sources, changing the temperature and chemical composition of habitats, introducing foreign species into ecosystems, and altering organisms directly through selective breeding and genetic engineering.* * *The Intergovernmental Panel on Climate Change (IPCC) assesses scientific, technical and socioeconomic information related to climate change and produces comprehensive reports on the potential impacts and options for adaptation and mitigation.* * *The endeavor to predict the consequences of global warming depends greatly on the Earth system science perspective.* * *The development of automobiles that run on alternative fuels (hydrogen, electricity) will reduce carbon dioxide emissions but involve other environmental trade offs.* | | | | | |