TEACHER LESSON PLAN

Hydraulic Fracturing Lesson

Developed by Jon Olson and Sabrina Ewald

Course(s) **AP Environmental Science, Earth and Space Science, and Environmental Science**

Grade Level 9th – 12th

Time Requirements (2) 1.5 hr blocks or (4) 50-55 min class periods

Standards

NGSS		AP Environmental Science		ESS			Environmental Science			
HS-ETS1-1	HS-ESS2-3	5.9	6.4	1.A	4.A	12.E	1.A	3.B	6.B	12.E
HS-ETS1-2	HS-ESS3-1	5.11	6.5	1.D	4.B	13.A	1.B	3.C	6.C	
HS-ETS1-3	HS-ESS3-2	6.1	6.6	1.F	4.C	13.B	1.D	4.A	6.E	
HS-ESS1-6	HS-ESS3-3	6.2	6.10	2.D	9.B		1.G	4.B	10.A	
HS-ESS2-1	HS-ESS3-4	6.3		3.B	9.D		2.C	4.C	12.A	
							2.D	6.A	12.C	

Learning Objectives

- Define hydraulic fracturing and evaluate the technology and engineering necessary for drilling a fracking well.
- Explain the importance of proppant and how engineers determine the appropriate size and quantity of proppant required.
- Investigate the quantity of water used in one production well and compare to the water consumed in other industrial activities and municipal water consumption.
- Complete a personal water consumption analysis and compare to the water consumption in hydraulic fracturing.
- Research and explain other advanced drilling techniques used to obtain oil and create a comparative analysis of each technique.
- Develop an in-depth analysis of advanced drilling techniques, including hydraulic fracturing, and provide an objective evaluation of these methods.
- Understand how engineering and technology developed for hydraulic fracturing is now being applied to the development geothermal energy production and carbon storage and sequestration projects.

Background Information	Hydraulic Fracturing is a hot topic in our society, but many do not fully understand the process and often rely on social media and nonexperts to obtain their information. The engineering and technology of hydraulic fracturing has in fact been around for decades, the first documented commercial use was in 1950. Oil and gas reserves once thought of as unattainable are now accessible because this technology helped revolutionize the way we retrieve oil and natural gas. In addition, the engineering innovations made over the years has now open the door for advanced geothermal energy systems. The drilling technology developed for hydraulic fracturing is now being used to construct geothermal power plants in regions that do not have magma near the surface to provide intense heat for generating electricity. Using knowledge of temperature gradients throughout the United States, we can evaluate potential locations for developing low heat geothermal energy facilities.
Day 1 Teacher Notes	On Day 1, teachers can use the Hydraulic Fracturing Overview notes to introduce students to the topic, its history, and how it is used to extract oil and natural gas. Students can read more about **Hydraulic Fracturing** in the Energy Excursions course *How Much Water Does It Take?* Provide the **link** to the topic page for the students to read. After introducing Hydraulic Fracturing, students complete the Water Use and Hydraulic Fracturing Assignment to assess the use of water consumption and compare it to personal water consumption. Students will evaluate the data to create a detailed analysis comparing water consumption of hydraulic fracturing to water consumed by people each day. *Teachers can also have students simulate hydraulic fracturing using Jell-O. Learn more about this activity here -> **Jell-O Fracking Activity**
Day 1 Resources	**Notes and Discussion**: **Hydraulic Fracturing Overview** **What is Hydraulic Fracturing** topic page in *How Much Water Does It Take?* Course **Assignment**: **Water Use and Hydraulic Fracturing Assignment**
Day 2 Teacher Notes	On Day 2, teachers can facilitate a brief recap of Hydraulic Fracturing and the information they learned completing the water use assignment. Introduce students to the Hydraulic Fracturing, Other Advanced Techniques, and Future Applications assignment. This assignment can be completed individually or students can work as a pair to complete the work. This assignment was constructed in a Google Slides files, which enables students to provide their responses and work directly on each slide. To complete the assignment, a copy of the presentation can be provided. The goal of this assignment is for students to learn more about hydraulic fracturing and other advanced drilling techniques. Students are to organize the environmental and economic advantages and disadvantages.

	To integrate the Geothermal Energy Project, the students' completed work on the first assignment can be reviewed and checked for accuracy and completeness. If the work is completed is satisfactory, students can be assigned the Geothermal Project. The project can be completed outside of class or if time permits, carried over to the next class period for students to complete.
Day 2 Resources	**Assignment**: **Hydraulic Fracturing, Other Advanced Techniques, and Future Applications** **Project**: **Geothermal Energy Project**
Additional Resources	Here are some fact sheets provided by AGI (American Geosciences Institute) • Geoscientists in Petroleum and Environment • Land Use of the Oil and Gas Industry • Induced Seismicity from Oil and Gas Production • Using Water in the Oil and Gas Industry • Water Sources for Hydraulic Fracturing • Groundwater Protection in Oil and Gas Production • Using Produced Water These fact sheets can be used to create jigsaw activity or gallery walk.