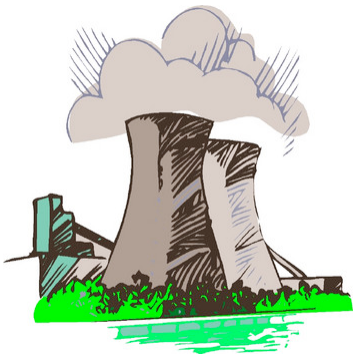
Where Does the Waste Go?



Nuclear energy is one of the cleaner and more efficient forms of energy on Earth. Compared to the use of fossil fuels, nuclear energy is less harmful to the atmosphere and does not contribute to climate change. Nuclear power plants only need refueling once every 12 – 18 months. The new store of fuel constitutes about 2 metric tons, or 6 truckloads of uranium. Coal power plants require a new trainload of about 100 tons of coal every day. Since nuclear power plants use so little fuel, the volume of nuclear waste is much smaller than the volume of waste from fossil fuel power plants. Even though nuclear waste is highly radioactive, its small volume enables safe isolation from society.

Nuclear energy usually has a bad reputation, though, because people are scared of controlling the waste management. If nuclear waste is mismanaged, it can cause damage to the surrounding land, vegetation, and humans. If nuclear waste is stored correctly, it can go undetected indefinitely. Storing the nuclear waste in a safe manner involves picking a perfect location. This location usually is not exposed to extreme temperatures, is very dry, and is not at risk for disturbance by earthquakes or volcanic eruptions. As the whole world realized in 2011, placing a nuclear power plant on or near a plate boundary is not a good idea. The Japanese earthquake that hit on March 11, 2011, was not only devastating because the Japanese nuclear power plant was located there, but the inevitable tsunami that followed was shattering.

The National Nuclear Waste Commission is currently looking for a new place to store nuclear waste. Your job is to propose a site for the nuclear waste containment. Once a decision has been made, you need to persuade the National Nuclear Waste Commission to store the waste at your proposed site based on an essay, presentation, brochure or video that displays your findings. Please be precise! The safety of American lives is in your hands. Good luck!

Where Does the Waste Go? *Rubric*

	Novice	*Apprentice*	*Practitioner*	*Expert*
Fault Lines	• Defines three major fault lines • identifies them by type and force	Identifies the site's closest major fault lines. This includes: • type of fault line • force associated with the fault line • how far away they are	Identifies the site's closest major fault lines, labeled on a Google map. This includes: • type of fault line • force associated with the fault line • how far away they are • how each force creates the fault line	All of *Practitioner* plus: the minor fault lines, their types, their forces and how far away they are
Features	Describes features associated with the general fault lines but not specific to the site	Identifies the features associated with the fault lines. They may include: • earthquakes • volcanoes	Identifies the features associated with the fault lines. They may include: • earthquakes • volcanoes • possible rivers • mountains	All of *Practitioner* plus: Identifies what feature is more likely and why
Geological History	Includes a geological time line of the past that notes earthquakes and volcano eruptions	Includes a geological time line of past, noting: • earthquakes and volcano eruptions • their distance to the site	Includes a geological time line of past, using hyperlinked data and images to show: • earthquakes, including magnitude • volcano eruptions, including type of volcano • their distance to the site	All of *Practitioner* plus: Includes a hypothesis about the future for this site

Experiments	• Explains what the student did in each experiment • Explains outcomes • Answers the question, "Is this what you expected?"	• Describes what the student did in each experiment • Explains outcomes • Answers the question, "why did each outcome happen the way they did?"	• States the problem • Explains each experiment in relation to the problem • Answers the question, "How do the outcomes help solve your problem?"	All of *Practitioner* plus: Creation of original experiment to support plate tectonics or causes of earthquakes.
Climate, vegetation, animal life	Identifies the average temperature of the site	Identifies: • the temperature ranges of the site • the potential hazard to the waste	Identifies: • temperature ranges of the site, displayed in a graph created from a Google sheet of data • potential hazards to the waste • types and amounts of vegetation and animal life.	All of *Practitioner* plus: Explains the potential impact of the loss of potential vegetation and animal life.
Population and Proximity to Water	• Identifies a water source near the site • Includes cities near the site	• Identifies closest water source • Includes closest cities and includes major cities	• Includes distance from water source, marked on Google map • Includes the population of the area, including closest cities and major cities, marked on Google map	All of *Practitioner* plus: • Describes the potential impact of contamination of water source • outlines a potential evacuation route in case of a nuclear waste leak

Where Does the Waste Go? *Scaffold*

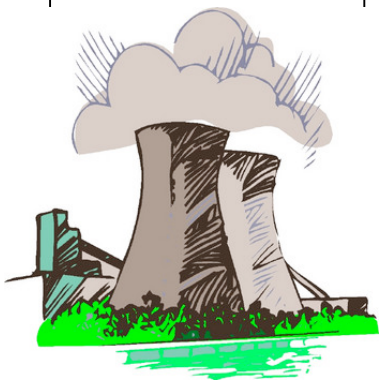
Learning Centers
- Viscosity of Lava Lab
- Continental Puzzle
- Measuring Earthquakes Lab
- Convection Currents
- Exploration of Yucca Mountain storage facility

How-To Sheets
- Drawing the layers of the Earth
- Conducting an experiment
- Calculating force
- Adding and subtracting time

Screencasts
- The Theory of Plate Tectonics
- Tsunamis
- Hot Spots
- Adding and subtracting time

Podcasts
- The Theory of Plate Tectonics
- Hot Spots
- Nuclear accident survivor stories

Homework
- Mapping Plates
- Research



Interactive Web Sites
- Spreading Plates
- Other types of plate movements
- Exploration sites ie. Google Earth

Benchmark Lessons
- Locating an earthquake epicenter
- Types of Faults

Peer Tutoring
- Peer review of persuasive piece
- Peer review of final product

Small-Group Mini-Lessons
- Measuring Distance
- Calculating force
- Brainstorming important characteristics of good storage location
- Understanding nuclear power

Technology Uses
- iPads
- Library search engines
- Interactive websites
- Document and photo editing software

Individual Tasks
- Read about nuclear energy and fill out the analyzing evidence diagram
- Complete and answer questions

Group Tasks
- Order the Earth event cards
- Continental Drift
- Understanding Plate Boundaries
- Peer editing

IDE INNOVATIVE DESIGNS FOR EDUCATION

Where Does the Waste Go? *Content Facilitation Grid*

Names	Mapping Plates	Types of Faults	Locating an Earthquake Epicenter	Adding and Subtracting time	Read about nuclear energy and fill out the analyzing evidence diagram	Understanding Plate Boundaries	Drawing the layers of the Earth	Viscosity of Lava Lab Complete and answer questions	Continental Puzzle	Measuring Earthquakes Lab	Convection Currents	The Theory of Plate Tectonics	Tsunamis	Hot Spots	Spreading Plates	Other types of plate movements	Order the Earth Event Cards	Continental Drift

Where Does the Waste Go? *Content Facilitation Questions*

Comprehension	Can you identify three major fault lines and the forces associated with them? Can you name different land formations and which ones are associated with which fault line? Can you identify the geological history of your site and explain its significance? Can you explain each of your experiments and their outcomes? Can you identify the average temperature for your site and the types of vegetation an animal life? Can you identify your sites closest water site? Can you identify your sites population and nearest major city?
Application	What type of fault line is in associated with your site? Ho are the plates moving to cause this fault line? What land formations can be expected in the future if this fault line continues? How does the geological history of your site predict what will happen in the future? How do your experiments relate to your chosen site? How do the average temperature, vegetation and animal life affect your choice in site location? How does population affect your choice in site location?
Connection	Why do you think Yucca Mountain was considered as a viable option? If your site is chosen, how will it impact the country?
Synthesis	What criteria can scientists use in the future to pick viable sites? Should current sites be reviewed and held to your standard? Is that realistic? Why was Japan's nuclear power plant site chosen? Are there any other potential disastrous sites in the world? Can you design different experiments to test for disastrous sites?
Metacognition	How did you decide on your site? What did you learn from your activities to support your decision? Is there anything you would have done differently? Would you redesign any of the experiments?

Where Does the Waste Go? *Teacher Notes*

<table>
<tr><td>Target Content</td><td rowspan="3">Common Core State Standards Addressed

RST.6-8.1 – Key Ideas and Details: Cite specific textual evidence to support analysis of science and technical texts.
RST.6-8.2 – Key Ideas and Details: Determine the central ideas or conclusions of a
text; provide an accurate summary of the text distinct from prior knowledge or opinions.
RST.6-8.3 – Key Ideas and Details: Follow precisely a multistep procedure when
carrying out experiments, taking measurements,
or performing technical tasks.
RST.6-8.4 – Craft and Structure: Determine the meaning of symbols, key terms,
and other domain-specific words and phrases as
they are used in a specific scientific or technical
context relevant to grades 6–8 texts and topics
RST.6-8.7 – Integration of Knowledge and Ideas: Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table)
RST.6-8.9 – Integration of Knowledge and Ideas: Compare and contrast the information gained from experiments, simulations, video, or
multimedia sources with that gained from reading
a text on the same topic</td></tr>
<tr><td>Plate tectonics
Earthquakes
Geological Time Line</td></tr>
<tr><td>Related Content</td></tr>
<tr><td>Temperature
Vegetation
Population
Geography</td><td>Core Curriculum Content Standards

Science Practices
- Understand Scientific Explanations
- Generate Scientific Evidence Through Active Investigations
- Reflect Scientific Knowledge
- Participate Productively in Science
Earth Systems Science
- History of Earth
- Tectonics
- Climate and Weather
- Biogeochemical Cycles</td></tr>
<tr><td>Enduring Understandings & Essential Questions</td><td>21st Century Skills Addressed</td></tr>
<tr><td>What are advantages and disadvantages to nuclear power?
Where should nuclear power plants store their waste?
How do fault lines affect the surrounding community?
How do earthquakes happen and are they predictable?</td><td>Critical Thinking
Collaborating
Communication
Creativity
Using Media
Using Technology
Independent Learning
Problem Solving</td></tr>
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