



## Clarifying Science through Natural Events: Comet Siding Spring

Grades: 6 - 12

Prep Time: ~15 minutes

Lesson Time: ~45-minutes



### WHAT STUDENTS DO: Determine the threats and/or benefits of a natural event/hazard.

Natural events (hurricanes, tsunamis, floods, earthquakes, volcanoes, forest fires, comets and asteroids, etc) provide engaging inquiry themes for learning science, technology, math, geography, and problem solving – and in the process students can examine their fears in the light of scientific knowledge. Students study a type of natural event, learn why it occurs, where the probable locations of occurrence are, what causes damage, what conditions create especially destructive events, and what the probability of a destructive event is. It is important that students spend some time thinking about possible ways to reduce the negative impact of damaging natural events to reduce fear and increase empowerment.

#### NGSS CORE & COMPONENT QUESTIONS

### How do Earth's surface processes and human activities affect each other?

*NGSS Core Idea ESS3: Earth and Human Activity*

### What is the universe, and what is Earth's place in it?

*NGSS Core Idea ESS1: Earth's Place in the Universe*

### How can one explain and predict interactions between objects and within systems of objects?

*NGSS Core Idea PS2: Motion and Stability: Forces and Interactions*

### How do engineers solve problems?

*NGSS Core Idea ETS1: Engineering Design*

#### INSTRUCTIONAL OBJECTIVES

*Students will be able to*

- IO1:** Use a model to explain a natural event or hazard and their impacts on the stability of the environment and populations
- IO2:** Investigate and describe viable methods to minimize impacts and maximize



## **How do natural hazards affect individuals and societies?**

*NGSS Core Idea ESS3.B: Natural Hazards*

## **What are the predictable patterns in the solar system?**

*NGSS Core Idea ESS1.B: Earth and the Solar System*

## **What underlying forces explain the variety of interactions observed?**

*NGSS Core Idea PS2.B: Types of Interactions*

## **What is the process for developing potential design solutions?**

*NGSS Core Idea ETS1.B: Developing Possible Solutions*

## **benefits of natural events**



## 1.0 Rationale

Hurricanes, tsunamis, floods, earthquakes, volcanoes, droughts, forest fires, sea level rise, and Near-Earth Object impacts have the potential to cause significant damage, disruption of lives, and death. Recent catastrophic events, such as hurricanes, tsunamis, forest fires, droughts, and an increase in tornados in the U.S. during the past few summers, have amplified concerns about personal safety, especially among children. Recent reports about global warming fuel the fear by predicting more - and more devastating - hurricanes, tornadoes, floods and drought.

Natural events provide engaging inquiry themes for learning science, technology, math, geography, and problem solving – and in the process students can examine their fears in the light of scientific knowledge. Students will study a type of natural event, learn why it occurs, where the probable locations of occurrence are, what causes damage, what conditions create especially destructive events, and what the probability of a destructive event is. It is important that students spend some time thinking about possible ways to reduce the negative impact of damaging natural events to reduce fear and empower themselves.

If there is sufficient time, it would be ideal to have students work in groups as “crisis managers” with available data and lessons learned from previous events to propose appropriate strategies before, during and after an event to mitigate destruction, loss of life, and human suffering. A better understanding of natural systems can mitigate the destructiveness of a natural event. For example, new forest management policies allow for controlled burns to eliminate ground fuel, decrease the damage of fires, and improve the health of forests. New forest harvesting methods reduce flooding. Building codes in earthquake zones requiring new materials and construction techniques reduce risks. Students can research and propose long-range solutions, as well as short-term strategies. When appropriate, students will propose strategies for their own location.

### Questions to be answered during Natural Events Lessons

- What is the event? Why does it occur?
- Where can it happen?
- What are possible threats and benefits?
- What are the probabilities of a range of events (e.g. small earthquakes more common than big)?
- What can be done to reduce the danger and damage and/or maximize the benefits of an event?

These general questions can be focused for each type of event.



## 2.0 Materials

### Required Materials

#### Please supply:

- Computer or tablet and Internet Access – 1 per team
- Optional: Computer and Projection System

#### Please Print:

##### From Student Guide

- (A) Student Sheet 1: What Do You Know and Need to Know – 1 per group
- (B) Student Sheet 2: Learning about the Natural Event – 1 per group
- (C) Student Sheet 3: Research Resources – 1 per group
- (D) Student Sheet 4: Credible Sources Evaluation – 1 per group
- (E) Student Sheet 5: Recording Evidence – 1 per group
- (F) Student Sheet 6: Report Assignment – 1 per group
- (G) Student Sheet 7: Evaluation – 1 per person

### Optional Materials

##### From Teacher Guide

- (H) Student Sheet 8: Planetary Bodies
- (L) “Clarifying Science through Natural Events” NGSS Alignment
- (M) “Clarifying Science through Natural Events” CCSS Alignment
- (N) “Clarifying Science through Natural Events” 21<sup>st</sup> Century Skill Alignment
- (O) “Clarifying Science through Natural Events” NGSS Rubric
- (P) “Clarifying Science through Natural Events” CCSS Rubric
- (Q) “Clarifying Science through Natural Events” 21<sup>st</sup> Century Skill Rubric
- (R) Placement of Instructional Objective and Learning Outcomes in Taxonomy



### 3.0 Vocabulary

<b>Biased Language</b>	words chosen to influence or cause the reader to react a certain way that is sympathetic to the author's cause using emotion or stereotypes.
<b>Catastrophic</b>	sudden or great danger.
<b>Credible</b>	able to be believed.
<b>Loaded Language</b>	words chosen to influence or cause the reader to react a certain way that is sympathetic to the author's cause using emotion or stereotypes.
<b>Misconception</b>	view or opinion that is incorrect because it is based on faulty thinking or understanding.
<b>Mitigate</b>	make less severe.
<b>Periodical</b>	magazine, newspaper, or journal published at regular intervals.
<b>Primary Source</b>	original materials not filtered or interpreted by another person or organization.
<b>Secondary Source</b>	commentary, analysis, discussion, or opinion about the primary source.



## 4.0 Procedure

### PREPARATION: (~20 minutes)

- A. Create a list of Research Resources (credible websites) or use those provided, where students can access more information about the natural event.
- B. If using a news article, tape it to *(A) Student Sheet 1: What Do You Know and Need to Know* prior to photocopying as the Engagement resource.

### STEP 1: ENGAGE (~20 minutes)

#### Prior Knowledge

- A. Design an engagement that presents the context of the Natural Event. You might show a recent short video of the type of event (hurricane, Tornado, earthquake, etc), a brief news clipping, or take advantage of an opportunity as students discuss a natural disaster they've read about recently.
- B. Hand out *(A) Student Sheet 1: What Do You Know and Need to Know* and *(B) Student Sheet 2: Learning about Natural Events*.
- C. Ask students to complete the engagement activity and work as a group to record what they know about the type of event and what they would need to learn to answer the *Important Questions* listed on *(B) Student Sheet 2: Learning about Natural Events*.
- D. Have groups share what they know about the event and what they would need to learn, then record on white board.

 **Teacher Tip:** This is an opportunity for you to identify student misconceptions regarding the type of natural event. Which is a significant step in the process to correcting those misconceptions.

### STEP 2: EXPLORE (~25 minutes)

#### Research, Reporting, and Credibility.

- A. Hand out *(C) Student Sheet 3: Research Resources*, *(D) Student Sheet 4: Credible Sources Evaluation*, *(E) Student Sheet 5: Recording Evidence* and *(F) Student Sheet 6: Report Assignment*.
- B. Tell students that the web sites on the *(C) Student Sheet 3: Research Resources* are a beginning to their research. They can use other sources, but they must make sure the other resources are valid. They can use the *(D) Student Sheet 4: Credible Sources Evaluation* tool to validate the credibility of the sources they choose.



- C. Tell students that they should read the *(F) Student Sheet 6: Report Assignment* to make sure their research provides information for a good report.
- D. Have students do research and record information on the *(E) Student Sheet 5: Recording Evidence* sheet.

🍷 **Teacher Tip:** If you have sufficient time, it would be ideal for students to spend more time researching the event, and work as “crisis managers” with available data and lessons learned from previous events to propose appropriate strategies before, during and after an event to mitigate destruction, loss of life, and human suffering.

### **STEP 3: EXPLAIN** (~30 minutes as homework)

#### **Reporting New Knowledge.**

- A. **(Option 1)** Using the *(F) Student Sheet 6: Report Assignment*, have students prepare a brief written report that can be attached to a bulletin board and shared or shared through electronic media (blogs?).
- B. **(Option 2)** Using the *(F) Student Sheet 6: Report Assignment*, have students prepare a brief oral report that can be given in the next class period.

### **STEP 4: ELABORATE**

#### **Application.**

- A. Policy discussion – given limited resources what action plan(s) should be implemented?
- B. Use *(H) Student Sheet 8: Planetary Bodies and these Natural Events* to discuss other celestial bodies that have the same type of natural phenomena.

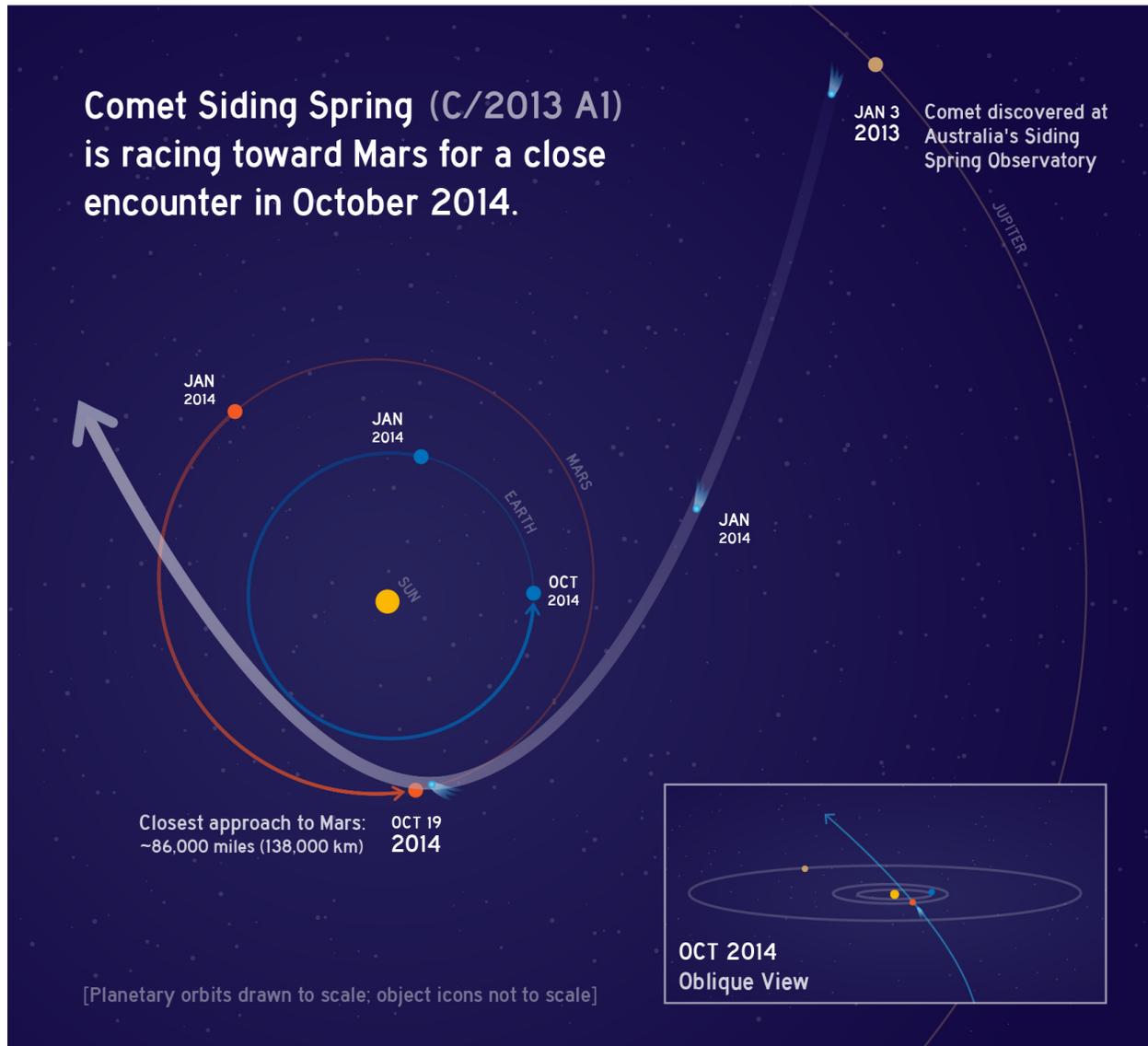
### **STEP 5: EVALUATE**

#### **Evaluate Plans and Prior Misconceptions.**

- A. Handout *(G) Student Sheet 7: Evaluation* and ask students to evaluate their plans.
- B. Have students review *(A) Student Sheet 1: What Do You Know and Need to Know* and identify their misconception/s about the Natural Event if they had any. Add this misconception to the *(F) Student Sheet 6: Report Assignment* and explain their new understanding about the event.
- C. Use the rubric in The Alignment document to evaluate student work.

**(A) Student Sheet 1: What Do You Know and Need to Know**

On Sunday, 19 October 2014 Comet 'Siding Spring' will make a close fly-by of Mars. The comet's closest approach will be at 11:28 am (PT), 12:28 pm (MT), 1:28 pm (CT), 2:28 pm (ET).



Current estimates are that Siding Spring will be only ~82,000 miles (132,000 km) from the surface of Mars.

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To give some perspective, the Moon is about 240,000 miles (385,000 km) from Earth – 3 times the distance Comet Siding Spring will be from Mars.

At the scale of our Solar System, Comet Siding Spring will be very, very close to Mars.

The comet will not hit Mars, but the cloud of dust particles surrounding the comet's nucleus (called the coma) may be big enough to envelop Mars and therefore the spacecraft orbiting it.

Five orbiters are currently active at Mars:

NASA Orbiters:

Mars Reconnaissance Orbiter (MRO)

Mars Odyssey (ODY)

Mars Atmospheric and Volatile Evolution (MAVEN)

ESA Orbiters:

Mars Express

India Orbiters:

Mars Orbiter Mission (MOM)

Also, NASA has two rovers on the surface of Mars, Opportunity and Curiosity.

(Information primarily from NASA Mars Education (<http://mars.nasa.gov/comets/sidingspring/>)  
September 20, 2014.



## (B) Student Sheet 2: Learning About the Close Encounter between Mars and Comet Siding Spring

**Instructions:** Use the Resources provide by your teacher to fill in the table about Comet Siding Spring. Use the *Important Questions* as a guide.

### **Important Questions**

1. How could Comet Siding Spring affect Mars, Martian satellites, or Earth?
2. What are the potential threats and benefits?

What do I know about Comet Siding Spring?	What would I need to learn to answer the Important Questions?

**(C) Student Sheet 3: Research Resources**

<b>Plate Tectonics</b>	<b>Climate Change</b>	<b>Siding Spring</b>	<b>Other Natural Events</b>
<a href="http://earthquake.usgs.gov/earthquakes/">http://earthquake.usgs.gov/earthquakes/</a>	<a href="http://www.pbs.org/wgbh/warming/">http://www.pbs.org/wgbh/warming/</a>	<a href="http://mepag.nasa.gov/cdp/cdp08_Comet%20Siding%20Spring%20Environment.pdf">http://mepag.nasa.gov/cdp/cdp08_Comet%20Siding%20Spring%20Environment.pdf</a>	<a href="http://www.ngdc.noaa.gov/hazard/">http://www.ngdc.noaa.gov/hazard/</a>
<a href="http://earthquake.usgs.gov/earthquakes/map/">http://earthquake.usgs.gov/earthquakes/map/</a>	<a href="http://www.ucsusa.org/global_warming/solutions/fight-misinformation/global-warming-materials-for.html#gulf">http://www.ucsusa.org/global_warming/solutions/fight-misinformation/global-warming-materials-for.html#gulf</a>	<a href="http://mars.nasa.gov/comets/sidingspring/">http://mars.nasa.gov/comets/sidingspring/</a>	<a href="http://www.ngdc.noaa.gov/nndc/sruts/form?t=101650&amp;s=1&amp;d=1">http://www.ngdc.noaa.gov/nndc/sruts/form?t=101650&amp;s=1&amp;d=1</a>
<a href="http://volcano.si.edu/reports_weekly.cfm">http://volcano.si.edu/reports_weekly.cfm</a>	<a href="http://www.worldwildlife.org/threats/climate-change">http://www.worldwildlife.org/threats/climate-change</a>	<a href="http://science.nasa.gov/science-news/science-at-nasa/2014/12aug_marscomet/">http://science.nasa.gov/science-news/science-at-nasa/2014/12aug_marscomet/</a>	<a href="http://www.thirteen.org/edonline/lessons/global/index.html">http://www.thirteen.org/edonline/lessons/global/index.html</a>
<a href="http://www.nhc.noaa.gov/">http://www.nhc.noaa.gov/</a>	<a href="http://www.apa.org/science/about/publications/climate-change.aspx">http://www.apa.org/science/about/publications/climate-change.aspx</a>	<a href="http://www.planetary.org/blogs/guest-blogs/2014/0909-so-close-and-yet-so-far-siding-spring.html">http://www.planetary.org/blogs/guest-blogs/2014/0909-so-close-and-yet-so-far-siding-spring.html</a>	<a href="http://dawn.jpl.nasa.gov/DawnClassrooms/index.asp">http://dawn.jpl.nasa.gov/DawnClassrooms/index.asp</a>
<a href="http://www.wunderground.com/hurricane/">http://www.wunderground.com/hurricane/</a>	<a href="http://www.earthscienceliteracy.org/">http://www.earthscienceliteracy.org/</a>	<a href="http://www.planetary.org/blogs/emily-lakdawalla/2014/08131401-mars-orbiters-siding-spring.html">http://www.planetary.org/blogs/emily-lakdawalla/2014/08131401-mars-orbiters-siding-spring.html</a>	<a href="http://www2010.atmos.uiuc.edu/(Gh)/guides/mtr/hurr/home.rxml">http://www2010.atmos.uiuc.edu/(Gh)/guides/mtr/hurr/home.rxml</a>

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<b>Plate Tectonics</b>	<b>Climate Change</b>	<b>Siding Spring</b>	<b>Other Natural Events</b>
<a href="http://neo.jpl.nasa.gov/">http://neo.jpl.nasa.gov/</a>	<a href="http://www.climate.gov/">http://www.climate.gov/</a>	<a href="http://blogs.esa.int/mex/2014/02/07/mars-express-team-readies-for-siding-springs/">http://blogs.esa.int/mex/2014/02/07/mars-express-team-readies-for-siding-springs/</a>	<a href="http://www.nhc.noaa.gov/prepare/">http://www.nhc.noaa.gov/prepare/</a>
<a href="http://www.jpl.nasa.gov/multimedia/neo/neo_flash.cfm">http://www.jpl.nasa.gov/multimedia/neo/neo_flash.cfm</a>	<a href="http://www.climatecentral.org/">http://www.climatecentral.org/</a>	<a href="http://www.nasa.gov/mission_pages/asteroids/main/#.VBtE4S5dVzh">http://www.nasa.gov/mission_pages/asteroids/main/#.VBtE4S5dVzh</a>	<a href="http://www.nssl.noaa.gov/education/">http://www.nssl.noaa.gov/education/</a>
<a href="http://www.tsunami.noaa.gov/">http://www.tsunami.noaa.gov/</a>		<a href="http://photojournal.jpl.nasa.gov/catalog/PIA12830">http://photojournal.jpl.nasa.gov/catalog/PIA12830</a>	<a href="http://www.cotf.edu/ete/modules/weathernot/weathernot.html">http://www.cotf.edu/ete/modules/weathernot/weathernot.html</a>
<a href="http://activefiremaps.fs.fed.us/">http://activefiremaps.fs.fed.us/</a>		<a href="http://solarsystem.nasa.gov/planets/">http://solarsystem.nasa.gov/planets/</a>	<a href="http://www.usgs.gov/natural_hazards/">http://www.usgs.gov/natural_hazards/</a>
<a href="http://inciweb.nwcg.gov/">http://inciweb.nwcg.gov/</a>		<a href="https://www.youtube.com/watch?v=2R4yj7DtQbM&amp;feature=youtu.be">https://www.youtube.com/watch?v=2R4yj7DtQbM&amp;feature=youtu.be</a>	<a href="http://www.disastercenter.com/guide/thunder.html">http://www.disastercenter.com/guide/thunder.html</a>
<a href="http://www.water.weather.gov/ahps/">http://www.water.weather.gov/ahps/</a>			<a href="http://www.epa.gov/students/">http://www.epa.gov/students/</a>
			<a href="http://www.stopdisastersgame.org/en/home.html">http://www.stopdisastersgame.org/en/home.html</a>

**(D) Credible Sources Evaluation**

**Instructions:** Use the following to identify Credible Resources for your research.

What's the difference between a **primary source** and a **secondary source**? For science research, primary sources are original materials not filtered or interpreted by another person or organization. Examples include papers, dissertations, interviews, lab notebooks, study reported in a journal article, and technical reports. A secondary source provides commentary, analysis, discussion, or opinion on the primary source. Examples include review articles, blogs, opinion editorials, newspapers, and news media sources.

URL #1:		
URL #2:		
URL #3:		
<b>Check if Yes</b>		
✓		
<b>Source #1</b>	<b>Source #2</b>	<b>Source #3</b>
<b>Criteria for a credible source</b>		
		1. Is the website an organization [.org], educational institution [.edu], or government [.gov] site? <b>If not, see #2, otherwise go to #3.</b>
		2. Is the website hosted by a <b>periodical</b> , such as a science journal or magazine that publishes science research?
		3. In <b>Google</b> , type <b>link://</b> in front of the home page URL and hit enter. The number in the search result is how many times that page has been linked to as a reference or resource. Is that a big number, such as hundreds of thousands or more? <b>If yes, see #4, otherwise go to 5.</b>
		4. Investigate the sources (URL's) that have linked to the page. Start at the first link that is not the same as the home page URL. Are most of them considered credible sources, such as other .org, .edu, or .gov sites?
		5. Read the "About us" section. Is there a list of names for the contributors to the site? <b>If yes, see #6, otherwise go to 7.</b>
		6. Do a search for one of those contributors. Are you able to find information about that person and verify their experience they are advertising on the website? Does their experience match the purpose of the website.
		7. Do links on the page work, meaning they are unbroken?
		8. Is the source a primary source?
		9. Total Score for each resource (total # of checkmarks for each column)

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Check if Yes ✓			Criteria for a <i>non-credible</i> source
Source #1	Source #2	Source #3	
			1. Is the website a .com or .net site?
			2. Is the website hosted by a blog, satire site (spoof or parody sites that exaggerate truth using humor), or an opinion editorial page?
			3. Does the site use <b>loaded language</b> or <b>biased language</b> ? (These are words that are chosen to influence the reader to react a certain way that is sympathetic to the author's cause using emotion or stereotypes)
			4. Investigate the sources (URL's) that have linked to the page. Are most of them considered non-credible sources?
			5. Is there a list of sponsors or paid for advertisements for the website? <b>If yes, see #6, otherwise go to 7</b>
			6. Are the sponsors biased toward one opinion, goal, or cause?
			7. Are links broken and/or has the page not been updated recently?
			8. Is the source a secondary source?
			9. Total Score for each resource (total # of checkmarks for each column)

Now, compare the total checkmarks for each URL. For each URL, put a checkmark in either "It's Credible, It Might be Credible, or It's Not Credible." You can only choose one.

URL	# of Credible Marks	# of non-Credible Marks	It's Credible (2 or fewer checkmarks in the non-Credible Marks column)	It might be Credible (checkmarks are somewhat even in both columns)	It's Not Credible (5 or more marks in the non-Credible Marks column)
#1					
#2					
#3					

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**(E) Student Sheet 5: Recording Evidence**

**Instructions:** As you do your research record the information you find in the evidence column. This will be used to prepare your report. In the second column record the source of your information. Give the title of your source, who prepared the information, and when. If your source is a web site copy the URL. For each source not provided by your teacher, you will need to complete the (D) *Student Sheet 4: Credible Sources Evaluation* to ensure it is a high quality source.

Evidence	Source

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Evidence	Source

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**(F) Student Sheet 6: Report Assignment**

**Instructions:** Prepare a report that describes the threat and benefit of the event and a plan that would reduce the harm or maximize the benefit. Your report should include the following information.

- What is the event? Why does it occur?
- Where can it happen?
- What are possible threats and benefits?
- What are the probabilities of a range of events (e.g. small earthquakes more common than big)?
- What can be done to reduce the danger and damage and/or maximize the benefits of an event?

**(G) Student Sheet 7: Evaluation**

**Instructions:** Using careful thought, evaluate how well you have described the close encounter of Comet Siding Spring with Mars, what the possible threats and benefits are, and how well your plan will work.

Although you have learned much about Comet Siding Spring, you are not an expert in this field. The emphasis of your evaluation should be to use careful thought and to explain your thinking. For example, don't say "I did a good job." or "I didn't do well," explain why you think you did well or didn't do well. Don't be afraid to say you didn't do well – there may have been good reasons. Perhaps you thought of many questions about the event that you thought were important, but you couldn't find satisfactory answers. Just remember to explain what your questions were and why they were important.

Once you have evaluated your plan, review *(A) Student Sheet 1: What Do You Know and Need to Know* and identify one misconception you had about Comet Siding Spring. If you didn't have any misconceptions, choose one that another group had. On the back of this page, list the misconception and explain what you now understand about the event that you didn't know before that allowed your misconception.

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**(H) Student Sheet 8: Planetary Bodies with these Natural Events**

Noteworthy Bodies	Earthquakes	Volcanoes	Wildfires	NEO's	Floods	Cyclones	Tornadoes	Tsunami	Climate Change
Mercury	?			✓					
Venus	?			✓					✓
Luna (Moon)	✓			✓					
Mars	?			✓					✓
Vesta	?	✓		✓					
Jupiter				✓					?
Io	✓	✓		✓					
Europa	✓			✓					
Saturn				✓					
Titan	?	?		✓					?
Enceladus	?			✓					
Uranus				✓					
Neptune				✓					
Pluto				✓					

Legend: Empty box indicates a lack of evidence.  
 ? indicates there is some evidence, but has not been confirmed.  
 ✓ indicates confirmed evidence

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