



STUDENT'S GUIDE

NAME:

CLASS:

It's Hot Out Here: Exploring Heat in Our World

Notes about this guide:

- This guide provides space to record your thoughts and ideas throughout the series of lessons.
- Activities labeled "JOURNAL" are to help you develop your ideas. They do not have correct or incorrect answers. Record your thoughts in whatever format and language helps you express your ideas.
- There is a word list at the end of the guide with words that may be new to you or that may have specific definitions in science that are different from how we use the word in everyday life.

A. Heat and Me

Essential Question:

- What past experiences have you had with different surfaces having different temperatures?

JOURNAL: Write or draw about these questions. Use whatever language helps you share your ideas. Keep writing or drawing for the entire given time.

Have you ever walked barefoot or put your hands on the ground on a hot day?

- How did it feel?
- Were there any moments when your skin felt too hot?
- Where were you when your skin felt hot? What were you doing?
- What did you do to make your skin feel cooler?
- What questions do you have?

B. Heat in Our School

Essential Question:

- What patterns exist between temperature and different kinds of surfaces in our school?

Word List Terms: artificial surfaces, average, data, natural surfaces, patterns, temperature

1. Look around the classroom and outside the window.
 - What kinds of surfaces do you see?
 - What surfaces are artificial? What surfaces are natural?

In the table, write or draw a picture of the surfaces you notice.

Kinds of Surfaces in My Area	
Artificial Surfaces	Natural Surfaces

2. With a partner or group, find three to five different surfaces (for example, a desk, a carpet, a leaf) to measure the temperature of with an infrared thermometer.
 - Measure the temperature of each surface three times.
 - Record your results in this table. Find the average by adding the temperature from each trial and dividing that total by the number of trials ($[\text{Trial 1} + \text{Trial 2} + \text{Trial 3}] / 3$).

Surface	Natural or Artificial	Temperature: Trial 1	Temperature: Trial 2	Temperature: Trial 3	Average Temperature

3. Record each average temperature on a sticky note.
 - Use a green sticky note for natural surfaces and a yellow sticky note for artificial surfaces.
4. Follow the teacher's directions to combine your data with your class's data.
5. What patterns do you notice in the class data? What questions do you have about the results? Record your notes.

I notice . . .

One pattern I see is . . .

I wonder why . . .

6. JOURNAL: Write or draw about these journal questions. Use whatever language helps you share your ideas. Keep writing or drawing for the entire given time.
- What did you learn? What surprised you? What questions do you have? What should we do next to learn more?
 - Are there any areas or seats in the classroom that you think will feel warmer than others? Why? How might this affect us as members of the classroom?

C. Heat in Our Community: Part One

Essential Questions:

- What kinds of surfaces are in our community?
- How do the characteristics of the surface affect its temperature?
- How does this affect me and other members of my community?

Word List Terms: claim, evidence, heat energy, inputs, model, reasoning, relationship, satellite image, system

1. Look at the satellite image. This is a picture taken from space. Discuss these questions. Write or draw notes in the organizer.
 - What do you notice in this image?
 - What information does this image give?
 - What kinds of surfaces do you see?
 - What surfaces are artificial? What surfaces are natural?

Kinds of Surfaces in the Satellite Image	
Artificial Surfaces	Natural Surfaces
Other Observations:	

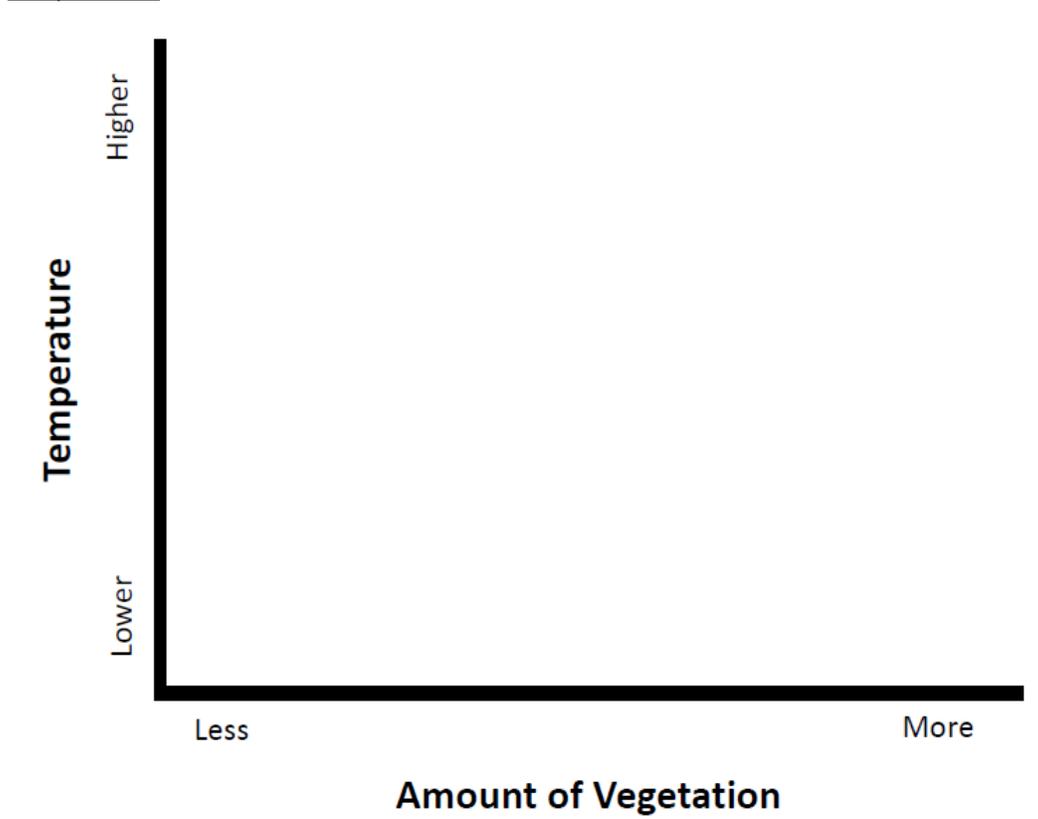
2. Based on our investigation of surfaces in our classroom and school, which area in the image do you think will be hottest?
 - Circle the area in the image that you think will be hottest compared to the areas around it.
 - Write a claim-evidence-reasoning statement to explain why you think that area will be hottest.

Claim	Evidence	Reasoning
I think the hottest area will be . . .	One piece of data that supports my claim is . . .	This data supports my claim because . . .

3. Examine the information in the Explore tab of the NASA Story Map interaction. Write a sentence describing the relationship between the kind of surface and the temperature.

Within the same town, areas with mostly artificial surfaces tend to be (hotter/colder) than areas with natural surfaces.

4. Draw a line to complete the graph showing the relationship between amount of vegetation and temperature.

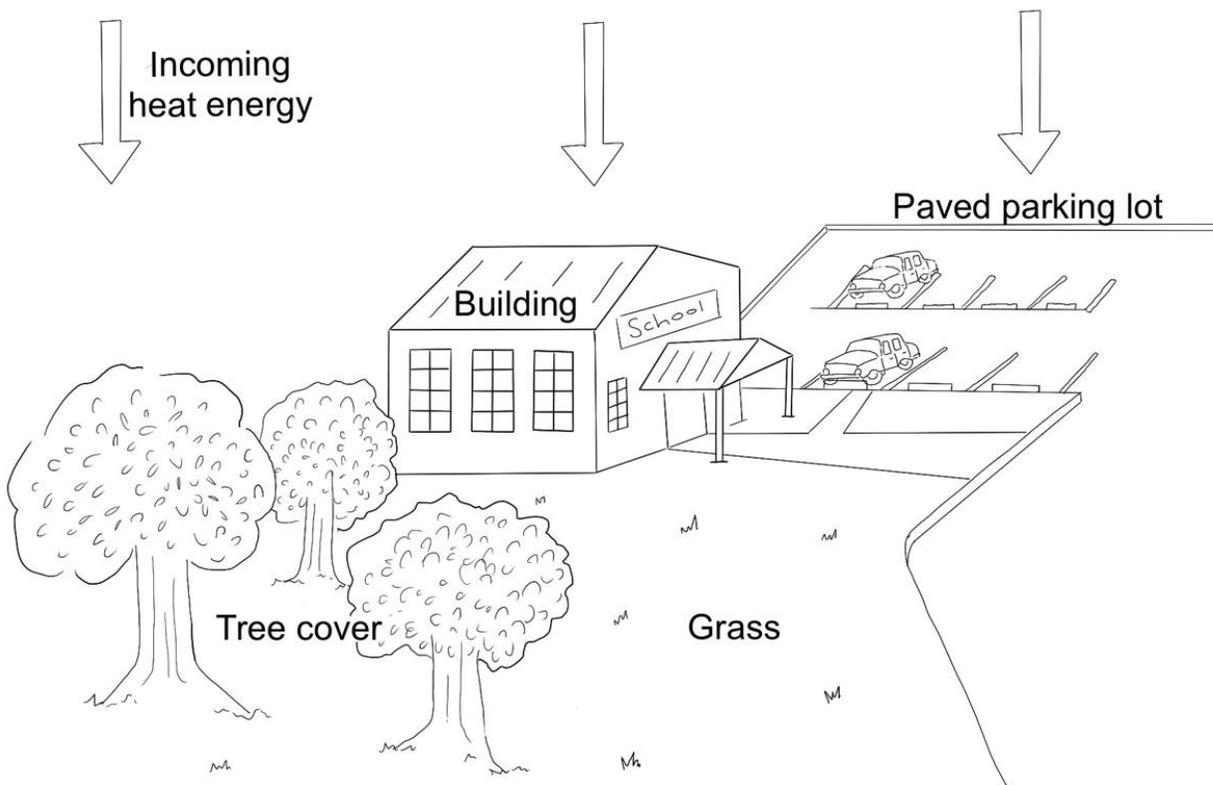


Describe the relationship you show in the graph.

My graph shows that . . .

When (temperature/amount of vegetation) increases, (describe what changes).

5. Draw a model showing how heat energy interacts with different kinds of surfaces around a school. Think about the activity questions and how they affect your model.
- What are the main parts of the system?
 - What are the inputs of heat energy? (Where does the heat energy come from?)
 - How does heat energy move and change throughout the system?
 - What happens when the heat energy interacts with surfaces on Earth?
 - How does the interaction between the heat energy and different surfaces affect people? (What is the outcome?)



6. Discuss these questions about your model. You do not need to write your answers.
 - What questions do you have about the relationships in your model?
 - What information would you need in order to answer those questions?

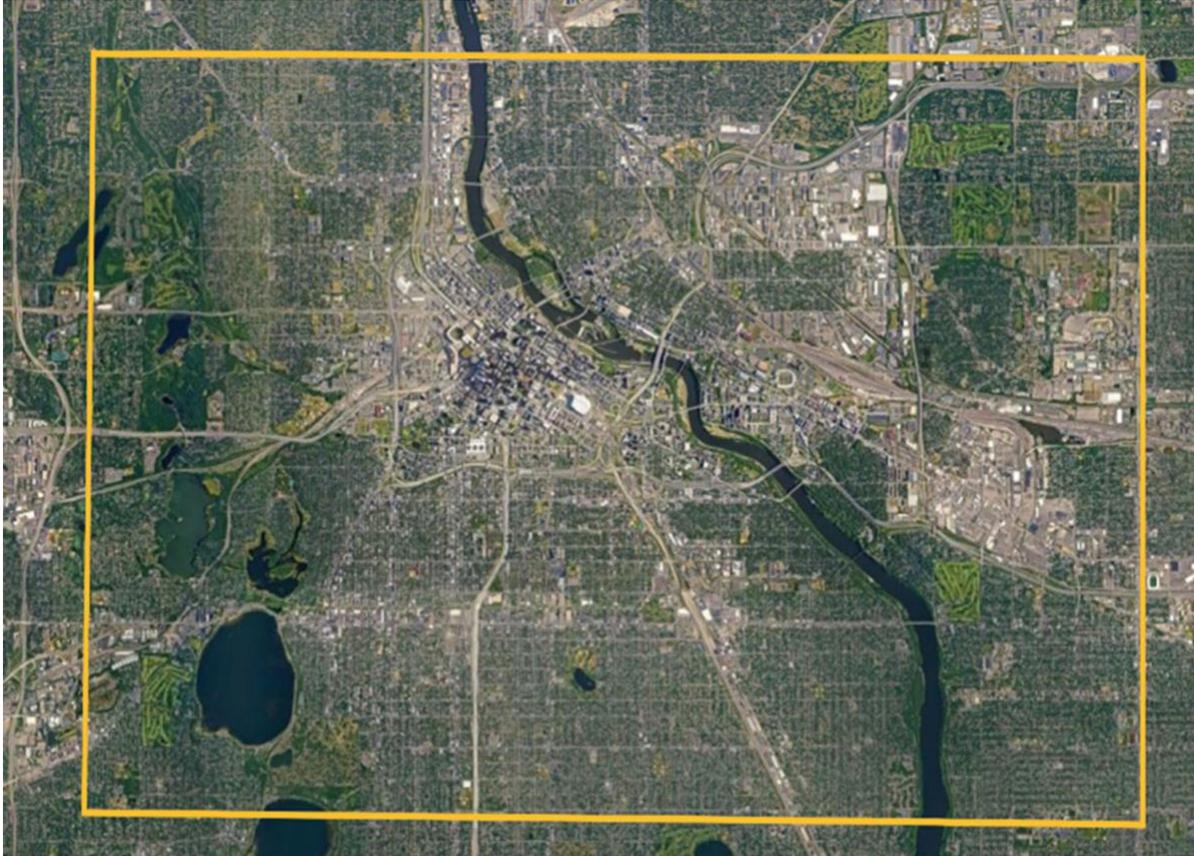
7. Use your new ideas to change or revise your model as needed.

Understanding Check-In

Essential Questions:

- How does the structure of a city affect the temperatures in different areas?

This is a satellite image of the city of Minneapolis, Minnesota.



© 2022 Google, Imagery date: 6/13/21
<https://earth.google.com/web/search/Minneapolis>

1. Circle one area that you think will have hotter temperatures than the city average. Label that area "1."
2. Circle one area that you think will have colder temperatures than the city average. Label that area "2."
3. Explain your reasoning.

I think area 1 will be hotter because . . .

I think area 2 will be colder because . . .

D. Heat in Our Community: Part Two

Essential Questions:

- What kinds of surfaces are in my community and the areas around it?
- How does this affect me and other members of my community?

Word List Terms: community, distributed, impact, impervious surfaces, minority, neighborhood, redlining, tree cover

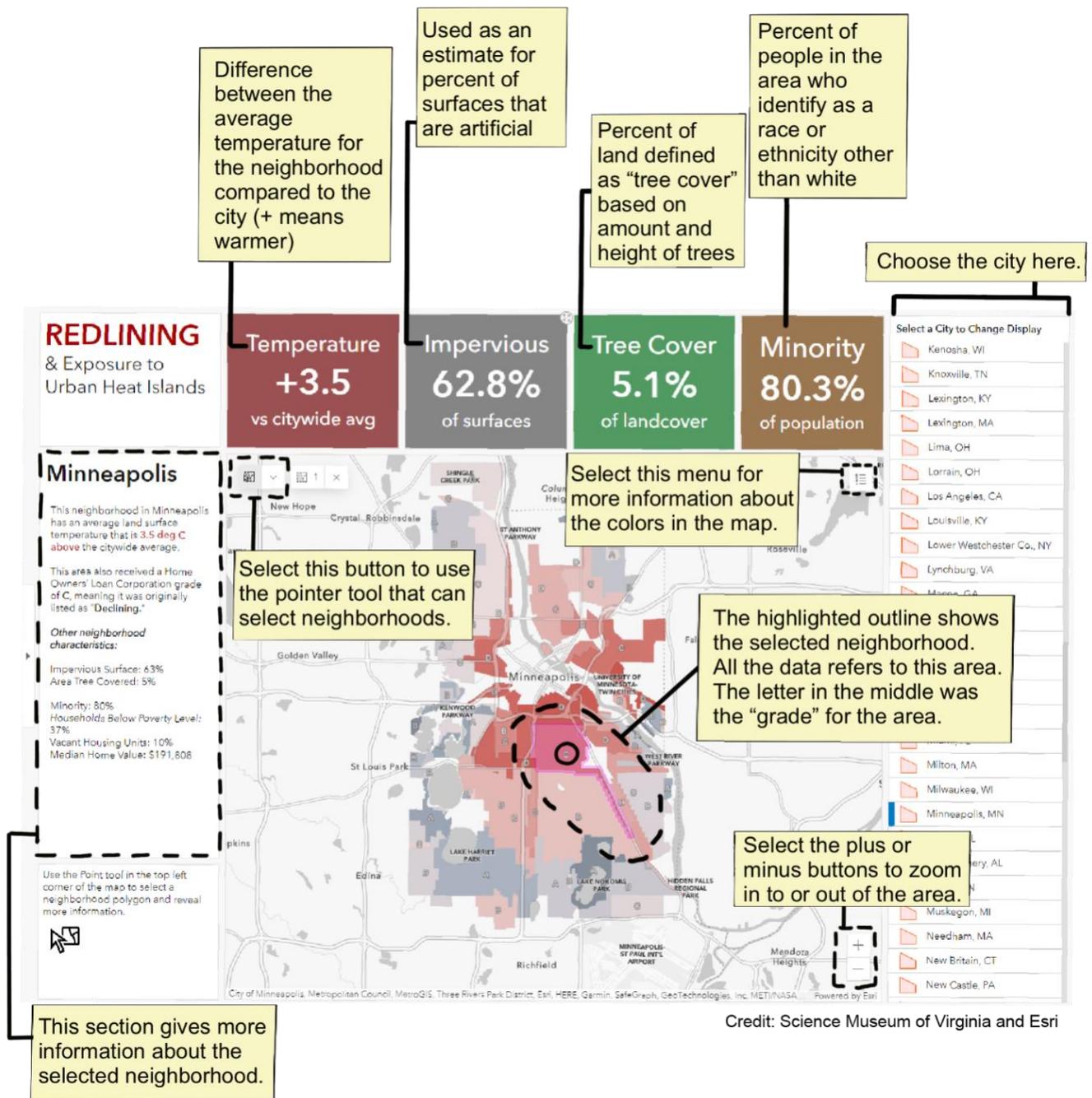
1. **JOURNAL:** Think about a time when it was hot in your community. Write or draw your ideas about these questions. Use whatever language helps you share your ideas. After you have finished your journaling, use the table on the next page to organize your notes.
 - How do you feel when it is really hot?
 - How do hotter temperatures affect you, your family, and people in your community?

Health Impacts of Hotter Temperatures			
	Impacts on You	Impacts on Your Family	Impacts on Your Community
Health			
Transportation			
Energy Use			
Recreation or Play			
Other			

2. JOURNAL: You are going to watch a short video about a practice called redlining. After the video, think about the journal questions. Write or draw your thoughts.
- What is redlining?
 - Who was harmed by redlining in the past? Who is harmed by redlining now?
 - What harm was done?
 - What was the cause of the harm?
 - How do you think this relates to the patterns we have been noticing between kinds of surfaces and temperatures?

The Disturbing History of the Suburbs Video:
<https://www.youtube.com/watch?v=ETR9qrVS17g&t=15s>

- Explore the redlining map at [this website](#). The map shows several kinds of information about a specific area. This image explains some of the information you will find on the map.



Redlining and Exposure to Urban Heat Islands map:
<https://www.arcgis.com/apps/dashboards/73e329457b6644e7aef13ecce43c8d8>

Explore the redlining map. Select a variety of neighborhoods and examine the data for each one. Use this table to record your data. You can use the blank columns to record additional categories of information if you like.

Area	Redlining Grade	Temperature vs. Average (degrees C)	Impervious Surfaces (%)	Tree Cover (%)	Minority (% of population)			
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

- What patterns did you notice because of what neighborhoods you picked? Would the patterns be different if you had picked different neighborhoods? How can you make sure you are noticing the pattern that best applies to the whole city?

- Who is harmed most by this phenomenon? How are the impacts of temperature distributed across people?

5. JOURNAL: Think about the relationships you noticed in all the maps and the impact heat has on you and other members of your community. Write or draw about any of these journal questions. Write or draw for the entire given time.
- How did this make you feel?
 - What did you learn?
 - What surprised you?
 - What do you have questions about?
 - What do you think we should do next?

E. Engineering Justice in the Community

Essential Question:

- How can we address the impacts of heat on people in my community?

Word List Terms: constraints, criteria, factors, ideal, limitation, pitch, problem, solution

1. JOURNAL:

Imagine something better: Think about the relationships you have been learning about between kinds of surfaces, heat energy, and people in your community. Write or draw your thoughts about this journal question. Use whatever language helps you share your ideas.

What does an ideal community look/feel/sound like for you?

2. **Define and describe the problem:** Fill out the table with information about the problem.

Question	Notes
A. What is the problem you want to solve? <i>or</i> What is the need?	
B. Why do you want to solve this problem?	
C. How would you know that the problem is solved or improved?	

Draw a model that shows how the problem formed and what factors affect the problem. (Feel free to use your model from Lesson C.) As you draw your model, consider these questions:

- What are the main parts of the system?
- What are the inputs of heat energy? (Where does the heat energy come from?)
- How does heat energy move and change throughout the system?
- What happens when the heat energy interacts with surfaces on Earth?
- How does the interaction between the heat energy and different surfaces affect people? (What is the outcome?)

3. **Frame the problem:** Write the problem as a question. The question should be open-ended but specific.

How might we (action needed) in order to (outcome wanted)?

How might we change the school day in order to have more fun while we learn?

4. **Brainstorm:** Use the space to write or draw as many ideas for a solution as you can. Write down everything you can think of, even if the idea isn't perfect. Use whatever language helps you share your ideas.

5. **Develop a solution:** Pick one idea from your brainstorm that you want to explore more. Fill out the table for that idea.

Question	Notes
What is the idea?	
How does this idea impact the problem?	
What criteria/constraints does this solution meet? (Look back at question C in the table of step 2 of this lesson)	
What are the limitations of this idea? What parts of the problem are not solved by this idea?	

6. **Share your solution:** Write a 30-second pitch telling someone what your idea is and why you think it works for this problem.

This idea is . . .

I think this idea will work because . . .

End-of-Unit Reflection

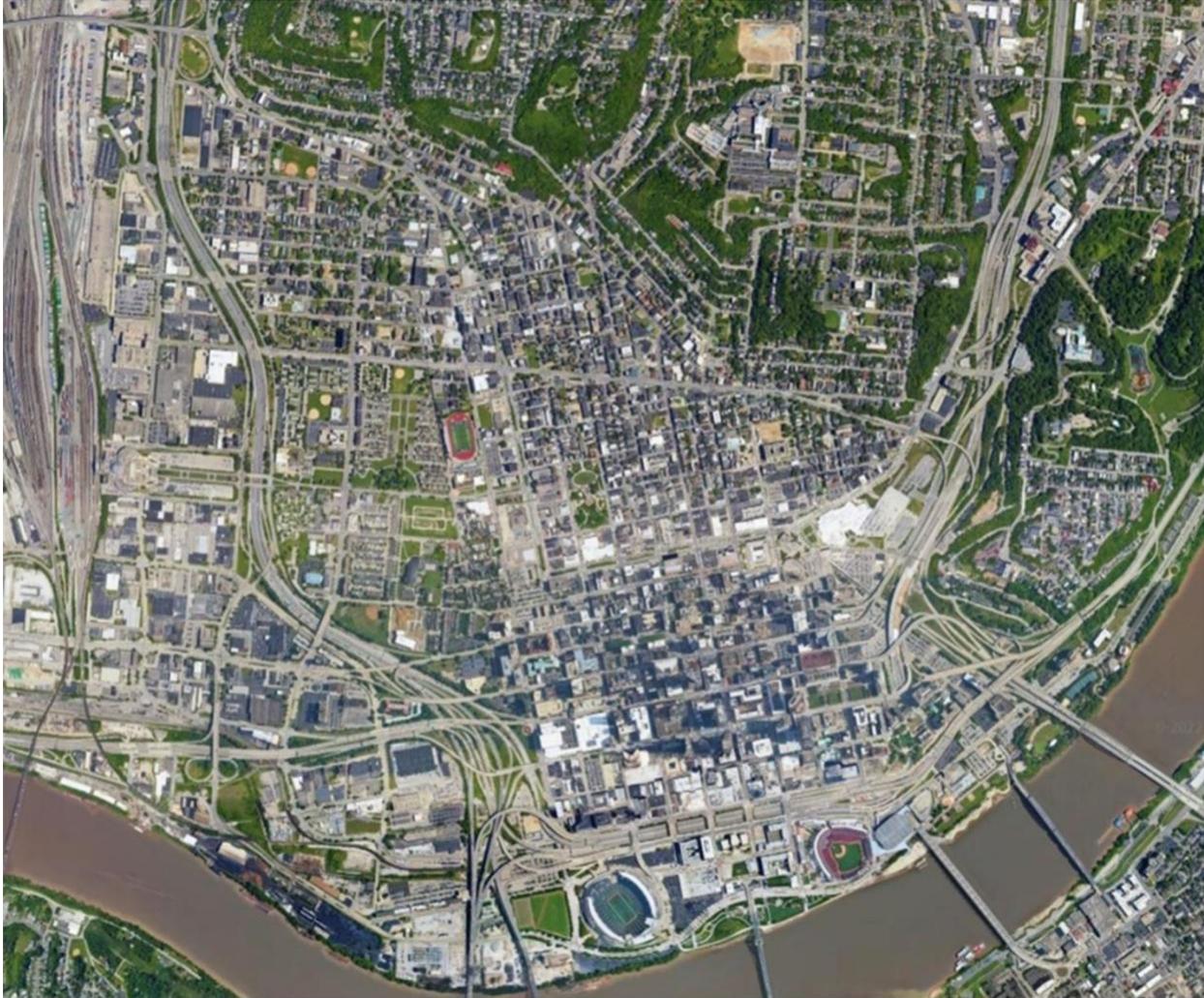
Essential Questions:

- How does the structure of a city affect the temperature in different areas?
- How can we fairly reduce the effects of heat in the most impacted areas?
- What was important to you from this unit?

The scenario: The city of Hotsville needs your help. The city has experienced several significant heat waves in the past five years. The city managers know there will be more heat waves in the future. The heat waves are affecting people in some areas of the city more than others.

The problem: Heat waves are affecting people in the city. People in some areas are affected more than others.

Satellite Image of the City



© 2022 Google. <https://earth.google.com/web/@39.10835922,-84.51714048,164.80823293a,6046.68040672d,35y,0h,0t,0r>

1. City planners in Hotsville want to focus on an area of the city where heat waves are affecting people the most.
 - Circle two areas in the city that are likely hotter than other areas in the city on the same day.
 - Explain your choices: Why do you think these areas will be hotter?

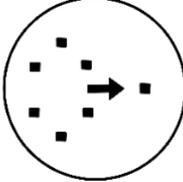
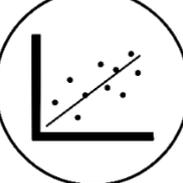
2. The city planners want to design a solution that will lower the temperature in the areas of the city that they choose.
 - Draw and/or describe one potential solution the city could use. Include in your drawing/description what the solution is and why it will lower the temperature in that area.

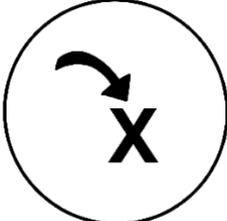
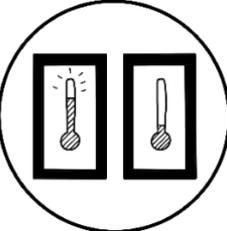
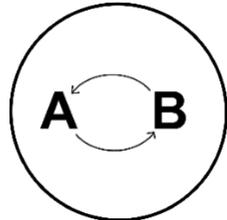
- What other things should the city think about before choosing a solution? What other information should they get?

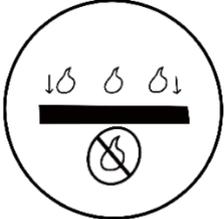
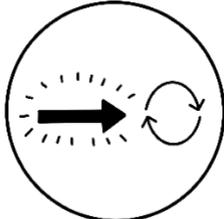
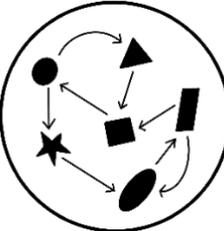
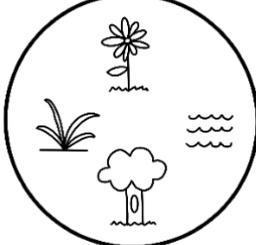
3. Some people are concerned because the solution will impact only some areas of the city. They do not think it is fair to improve only part of the city.
 - Do you agree or disagree? Why?

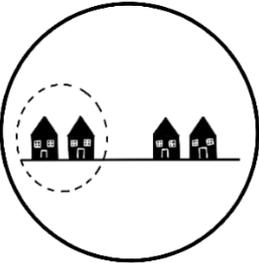
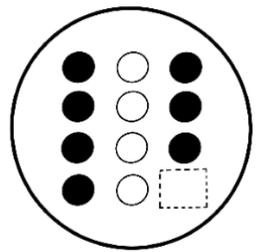
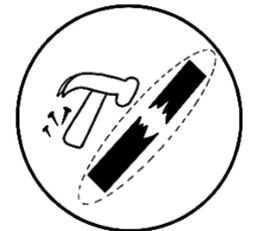
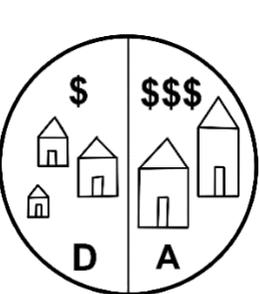
4. Write or draw any thoughts you have about this unit. What did you like? What didn't you like? What surprised you or impacted you? What questions do you still have?

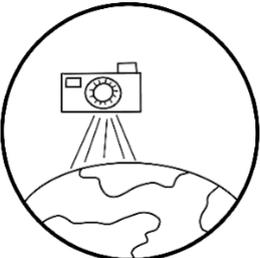
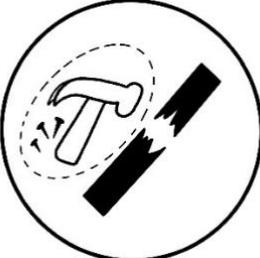
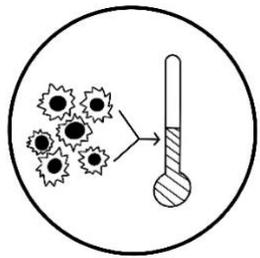
Word List

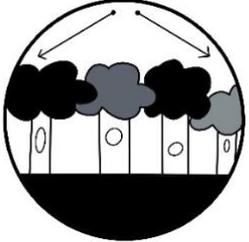
Term	Symbol	Academic Definition
Artificial surfaces		Materials manufactured or made by people
Average		A calculated value that combines several data points for a measurement into one value that represents the set of data; can also mean “typical” or “normal”
Claim		Statement that makes an argument or interprets data
Community		A group of people that share some common characteristic, often the place where they live
Constraints		Factors that limit an engineering design or solution; for example, cost
Criteria		Standards that a design solution must meet (for example, how much a solution should reduce the temperature of an area)
Data		Information or observations about a question or phenomenon

Distributed		How something, like an impact, is spread across people, places, or time
Evidence		Data or observations that support a specific claim
Factors		Characteristics or conditions that affect the impact or outcome
Heat energy		A form of energy that results from objects having different temperatures (“heat” describes when energy moves from something with a higher temperature to something with a lower temperature)
Ideal		Something that is perfect
Impact		How an object, person, or process affects something else

<p>Impervious surfaces</p>		<p>Materials that water cannot move through or soak into; used to estimate area of artificial surfaces</p>
<p>Inputs</p>		<p>The sources of matter or energy into a model</p>
<p>Limitations</p>		<p>Factors that restrict the usefulness of a product or process</p>
<p>Minority</p>		<p>Person who identifies themselves in the U.S. Census as Black, American Indian, Asian, Pacific Islander, Hispanic, Other, or Two or more races.</p> <p>*Note this definition is based on the definition used by the U.S. Census Bureau when they collected the data used in Lesson D. This definition describes the data used in these activities and is not a universal definition.</p>
<p>Model</p>		<p>A diagram, formula, or physical object that describes a phenomenon</p>
<p>Natural surfaces</p>		<p>Materials that exist on Earth without being made by people; often mean plant-based materials</p>

<p>Neighborhoods</p>		<p>Small areas within a city or town</p>
<p>Patterns</p>		<p>Something that repeats in a predictable way</p>
<p>Pitch</p>		<p>A short description of an argument, like why a product is useful</p>
<p>Problem</p>		<p>An issue that needs to be fixed or improved</p>
<p>Reasoning</p>		<p>An explanation for why a set of evidence supports a claim</p>
<p>Redlining</p>		<p>A historical practice that systemically denied people of color financial resources and access to equitable housing opportunities</p>

Relationship		How two or more things affect each other
Satellite image		An image of Earth's surface taken from space by a satellite
Solution		An object, tool, or process that fixes a problem or addresses a need
System		A set of interconnected processes or objects that affect one another
Temperature		The average amount of heat energy in the particles of an object

Tree cover	 A circular diagram showing a cross-section of a forest. The ground is a solid black semi-circle at the bottom. Several trees with dark grey canopies and thin trunks are shown. Two arrows originate from the top edge of the circle, pointing outwards to the left and right, indicating the horizontal extent of the tree canopy. The trees are of varying heights and are clustered together.	An area defined as “tree cover” based on the amount and height of trees in the area
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