Environmental Science Institute

The University of Texas at Austin

What's in the Water?
The History and Future of Barton Springs

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This file contains suggestions for incorporating material from this CD-ROM into curriculum using the Texas Essential Knowledge and Skills for Science.

§112.2. Science, Kindergarten.

(K.1) Scientific processes. The student participates in classroom and field investigations following home and school safety procedures. The student is expected to:

(A) demonstrate safe practices during classroom and field investigations; and

Scientists pictured in slides 27 and 43 are using life vests in their field work. A scientist uses gloves in the laboratory in slide 40.

(K.2) Scientific processes. The student develops abilities necessary to do scientific inquiry in the field and the classroom. The student is expected to:

(A) ask questions about organisms, objects, and events;

Why is the Barton Springs salamander not found in other parts of Texas? [slide 4]

(B) plan and conduct simple descriptive investigations;

What do karst landscapes look like? [slide 6]

How have humans modified the appearance of Barton Springs? [slide 14]

(K.3) Scientific processes. The student knows that information and critical thinking are used in making decisions. The student is expected to:

(A) make decisions using information

(B) discuss and justify the merits of decisions

(C) explain a problem in his/her own words and propose a solution.

Which kind of parking lot sealant should be used? What if one was much cheaper? [slides 37-41]

(K.10) Science concepts. The student knows that the natural world includes rocks, soil, and water. The student is expected to:

(A) observe and describe properties of rocks, soil, and water

Rocks – slides 6-7

Water – entire presentation

Students can observe the flow paths in sand versus cracked concrete. Simple experiments could be set up with a cup of water being poured through different mediums (e.g., clay, sand, marbles); students could use a stopwatch to determine which allows water to flow fastest. [slide 7]

(B) give examples of ways that rocks, soil, and water are useful.

Water is necessary for life and much of what we drink comes from aquifers. [slide 5] The presence of springs and the Colorado River even played a role in the development of Austin. [slide 10]

§112.3. Science, Grade 1.

(1.1) Scientific processes. The student participates in classroom and field investigations following home and school safety procedures. The student is expected to:

(A) demonstrate safe practices during classroom and field investigations; and

Scientists pictured in slides 27 and 43 are using life vests in their field work. A scientist uses gloves in the laboratory in slide 40.

(1.2) Scientific processes. The student develops abilities necessary to do scientific inquiry in the field and the classroom. The student is expected to:

(A) ask questions about organisms, objects, and events;

Why is the Barton Springs salamander not found in other parts of Texas? [slide 4]

Why are there springs in central Texas? [slides 11-13]

(B) plan and conduct simple descriptive investigations

What do karst landscapes look like? [slide 6]

How have humans modified the appearance of Barton Springs? [slide 14]

Do you live on top of the aquifer? Which part? [slide 13]

(C) gather information using simple equipment and tools to extend the senses

Determine the causes of turbidity. Take three closed jars of muddy water and let students shake one roughly and one gently; leave the third one untouched. Students are then asked to observe which has greatest turbidity (cloudiness).

(D) construct reasonable explanations and draw conclusions

From the experiment above, have the students decide what caused the jars to have different turbidity. While we can’t shake Barton Springs, what might cause it to increase in turbidity? [slide 22-24]

(1.3) Scientific processes. The student knows that information and critical thinking are used in making decisions. The student is expected to:

(A) make decisions using information;

(B) discuss and justify the merits of decisions

(C) explain a problem in his/her own words and identify a task and solution related to the problem.

Which kind of parking lot sealant should be used? What if one was much cheaper? [slides 37-41]

(1.5) Science concepts. The student knows that organisms, objects, and events have properties and patterns. The student is expected to:

(B) identify, predict, and create patterns including those seen in charts, graphs, and numbers.

What effect does rainfall have on the physical parameters of Barton Springs? [slides 22 and 23]

Does the flow rate of creeks affect the physical parameters of Barton Springs? [slide 24]

(1.10) Science concepts. The student knows that the natural world includes rocks, soil, and water. The student is expected to:

(A) identify and describe a variety of natural sources of water including streams, lakes, and oceans

The groundwater derived from karst aquifers [slides 7 and 8] is an important source of drinking water [slide 5]. Most of the water entering the Edwards aquifer in the Austin area is from 5 creeks in Austin. [slide 13]

(B) observe and describe differences in rocks and soil samples

The geology of central Texas controls the distribution of the Edwards aquifer. [slides 11-13] Note that the relatively impermeable Del Rio Clay coupled with the series of faults along the Balcones Fault Zone creates the opportunity for artesian aquifers. [slide 8]

(C) identify how rocks, soil, and water are used and how they can be recycled.

Water is continuously recycled in the ecosystem. As a result, contaminants that are added to water by humans return to us in our drinking water. [slide 31]

§112.4. Science, Grade 2.

(2.1) Scientific processes. The student conducts classroom and field investigations following home and school safety procedures. The student is expected to:

(A) demonstrate safe practices during classroom and field investigations; and

Scientists pictured in slides 27 and 43 are using life vests in their field work. A scientist uses gloves in the laboratory in slide 40.

(2.2) Scientific processes. The student develops abilities necessary to do scientific inquiry in the field and the classroom. The student is expected to:

(A) ask questions about organisms, objects, and events

Why is the Barton Springs salamander not found in other parts of Texas? [slide 4]

Why are there springs in central Texas? [slides 11-13]

(B) plan and conduct simple descriptive investigations

What do karst landscapes look like? [slide 6]

How have humans modified the appearance of Barton Springs? [slide 14]

Do you live on top of the aquifer? Which part? [slide 13]

How does water get into an aquifer? [slides 8, 11-13]

(D) gather information using simple equipment and tools to extend the senses

Determine the causes of turbidity. Take three closed jars of muddy water and let students shake one roughly and one gently; leave the third one untouched. Students are then asked to observe which has greatest turbidity (cloudiness).

(E) construct reasonable explanations and draw conclusions using information and prior knowledge

From the experiment above, have the students decide what caused the jars to have different turbidity. While we can't shake Barton Springs, what might cause it to increase in turbidity? [slide 22-24]

(2.3) Scientific processes. The student knows that information and critical thinking are used in making decisions. The student is expected to:

(A) make decisions using information;

(B) discuss and justify the merits of decisions

(C) explain a problem in his/her own words and identify a task and solution related to the problem.

Does it make a difference what type of sealant is used on parking lots? Which do you think should be used and why? Would you change your mind if the one you think should be used was much more expensive? [slides 37-41]

(2.5) Science concepts. The student knows that organisms, objects, and events have properties and patterns. The student is expected to:

(B) identify, predict, replicate, and create patterns including those seen in charts, graphs, and numbers.

What effect does rainfall have on the physical parameters of Barton Springs? [slides 22 and 23]

Does the flow rate of creeks affect the physical parameters of Barton Springs? [slide 24]

(2.7) Science concepts. The student knows that many types of change occur. The student is expected to:

(D) observe, measure, and record changes in weather, the night sky, and seasons.

If your school has a creek nearby, visit it before and after it rains. Note the speed, height, and turbidity.

(2.9) Science concepts. The student knows that living organisms have basic needs.

(B) compare and give examples of the ways living organisms depend on each other and on their environments.

Barton Springs is home to some unique flora and fauna, including the Barton Springs salamander. [slide 4]

(2.10) Science concepts. The student knows that the natural world includes rocks, soil, water, and gases of the atmosphere. The student is expected to:

(A) describe and illustrate the water cycle

The groundwater derived from karst aquifers [slides 7 and 8] is an important source of drinking water [slide 5]. Most of the water entering the Edwards Aquifer in the Austin area is from 5 creeks in Austin [slide 13]. The geology of central Texas controls the distribution of the Edwards aquifer. [slides 11-13] Note that the relatively impermeable Del Rio Clay coupled with the series of faults along the Balcones Fault Zone creates the opportunity for artesian aquifers [slide 8]. Water is continuously recycled in the ecosystem. As a result, contaminants that are added to water by humans return to us in our drinking water. [slide 31]

§112.5. Science, Grade 3.

(3.1) Scientific processes. The student conducts field and laboratory investigations following home and school safety procedures and environmentally appropriate and ethical practices. The student is expected to:

(A) demonstrate safe practices during field and laboratory investigations; and

Scientists pictured in slides 27 and 43 are using life vests in their field work. A scientist uses gloves in the laboratory in slide 40.

(3.2) Scientific processes. The student uses scientific inquiry methods during field and laboratory investigations. The student is expected to:

(A) plan and implement descriptive investigations including asking well-defined questions, formulating testable hypotheses, and selecting and using equipment and technology

Why is the Barton Springs salamander not found in other parts of Texas? [slide 4] What factors are biogeographic barriers to other animals, such as mammals?

Why are there springs in central Texas? [slides 11-13]

Why are karst landscapes often associated with aquifers? [slides 6, 7]

Can aquifers occur in types of rocks?

How have humans modified the appearance of Barton Springs? [slide 14] How would you determine if humans have impacted the water quality at Barton Springs?

How does water get into an aquifer? [slides 9, 11-13]

(B) collect information by observing and measuring

Determine the causes of turbidity. Take three closed jars of muddy water and let students shake one roughly and one gently; leave the third one untouched. Students are then asked to observe which has greatest turbidity (cloudiness).

(C) analyze and interpret information to construct reasonable explanations from direct and indirect evidence

From the experiment above, have the students decide what caused the jars to have different turbidity. While we can't shake Barton Springs, what might cause it to increase in turbidity? [slide 22-24]

(D) communicate valid conclusions

(E) construct simple graphs, tables, maps, and charts to organize, examine and evaluate information.

Construct a chart showing the connection between how much the jars of muddy water were shaken and how long they take to clear up.

(3.4) Scientific processes. The student knows how to use a variety of tools and methods to conduct science inquiry. The student is expected to:

(B) demonstrate that repeated investigations may increase the reliability of results.

In the turbidity lesson above, different students will have different versions of “gently shaking.” Therefore repeating will increase the validity of their results.

(3.6) Science concepts. The student knows that forces cause change. The student is expected to:

(B) identify that the surface of the Earth can be changed by forces such as earthquakes and glaciers.

Although central Texas is calm now, there were many earthquakes in the past. The resulting faults are one of the dominant controls on the distribution of the Edwards aquifer. [slides 11 and 12]

(3.8) Science concepts. The student knows that living organisms need food, water, light, air, a way to dispose of waste, and an environment in which to live. The student is expected to:

(C) Describe environmental changes in which some organisms would thrive, become ill,
or perish; and

The Barton Springs salamander is an example of an organism that would perish if the Edwards Aquifer did not supply the springs with water.

(D) describe how living organisms modify their physical environment to meet their needs such as beavers building a dam or humans building a home.

How have humans modified the appearance of Barton Springs? Why have we done this? [slide 14] If wells can reduce the flow of water at central Texas springs, why have we dug wells at places such as Catfish Farms? [slide 8]

(3.11) Science concepts. The student knows that the natural world includes earth materials and objects in the sky. The student is expected to:

(A) identify and describe the importance of earth materials including rocks, soil, water, and gases of the atmosphere in the local area and classify them as renewable, nonrenewable, or inexhaustible resources;

The groundwater derived from karst aquifers [slides 7 and 8] is an important source of drinking water [slide 5]. Most of the water entering the Edwards aquifer in the Austin area is from 5 creeks in Austin [slide 13]. The geology of central Texas controls the distribution of the Edwards aquifer. [slides 11-13] Note that the relatively impermeable Del Rio Clay, coupled with the series of faults along the Balcones Fault Zone creates the opportunity for artesian aquifers [slide 8]. Water is continuously recycled in the ecosystem. As a result contaminants put in water by humans returns to us when we drink. [slide 31]

§112.6. Science, Grade 4.

(4.1) Scientific processes. The student conducts field and laboratory investigations following home and school safety procedures and environmentally appropriate and ethical practices. The student is expected to:

(A) demonstrate safe practices during field and laboratory investigations; and

Scientists pictured in slides 27 and 43 are using life vests in their field work. A scientist uses gloves in the laboratory in slide 40.

(4.2) Scientific processes. The student uses scientific inquiry methods during field and laboratory investigations. The student is expected to:

(A) plan and implement descriptive investigations including asking well-defined questions, formulating testable hypotheses, and selecting and using equipment and technology;

Why is the Barton Springs salamander not found in other parts of Texas? [slide 4] What factors are biogeographic barriers to other animals, such as mammals?

Why are there springs in central Texas? [slides 11-13]

Why are karst landscapes often associated with aquifers? [slides 6, 7] Can aquifers occur in types of rocks?

How have humans modified the appearance of Barton Springs? [slide 14] How would you determine if humans have impacted the water quality at Barton Springs?

How does water get into an aquifer? [slides 9, 11-13]

(B) collect information by observing and measuring;

Determine the causes of turbidity. Take three closed jars of muddy water and let students shake one roughly and one gently; leave the third one untouched. Students are then asked to observe which has greatest turbidity (cloudiness).

(C) analyze and interpret information to construct reasonable explanations from direct and indirect evidence;

From the experiment above, have the students decide what caused the jars to have different turbidity. While we can't shake Barton Springs, what might cause it to increase in turbidity? [slide 22-24]

(D) communicate valid conclusions; and

(E) construct simple graphs, tables, maps, and charts to organize, examine, and evaluate information.

Construct a chart showing the connection between how much the jars of muddy water were shaken and how long they take to clear up

(4.6) Science concepts. The student knows that change can create recognizable patterns. The student is expected to:

(A) identify patterns of change such as in weather, metamorphosis, and objects in the sky

If your school has a creek nearby, visit it before and after it rains. Note the speed, height, and turbidity. How does the increase flow rate compare to the rain event? Does the water go down immediately or persist after the rain stops? Does the increased flow rate last the same duration as the rain?

(4.10) Science concepts. The student knows that certain past events affect present and future events. The student is expected to:

(A) identify and observe effects of events that require time for changes to be noticeable including growth, erosion, dissolving, weathering, and flow

If you pour water on limestone for the entire academic year, you probably wouldn't notice any rock being dissolved, however, it does happen. Over thousands and millions of years, water has carved openings in rocks that range from microscopic to enormous, as in the case of caves. [slide 6]

§112.7. Science, Grade 5.

(5.1) Scientific processes. The student conducts field and laboratory investigations following home and school safety procedures and environmentally appropriate and ethical practices. The student is expected to:

(A) demonstrate safe practices during field and laboratory investigations; and

Scientists pictured in slides 27 and 43 are using life vests in their field work. A scientist uses gloves in the laboratory in slide 40.

(5.2) Scientific processes. The student uses scientific methods during field and laboratory investigations. The student is expected to:

(A) plan and implement descriptive and simple experimental investigations including asking well-defined questions, formulating testable hypotheses, and selecting and using equipment and technology;

Why is the Barton Springs salamander not found in other parts of Texas? [slide 4] What factors are biogeographic barriers to other animals, such as mammals?

Why are there springs in central Texas? [slides 11-13]

Why are karst landscapes often associated with aquifers? [slides 6, 7] Can aquifers occur in other types of rocks?

How have humans modified the appearance of Barton Springs? [slide 14] How would you determine if humans have impacted the water quality at Barton Springs?

How does water get into an aquifer? [slides 9, 11-13]

(B) collect information by observing and measuring;

Determine the causes of turbidity. Take three closed jars of muddy water and let students shake one roughly and one gently; leave the third one untouched. Students are then asked to observe which has greatest turbidity (cloudiness).

(C) analyze and interpret information to construct reasonable explanations from direct and indirect evidence;

From the experiment above, have the students decide what caused the jars to have different turbidity. While we can't shake Barton Springs, what might cause it to increase in turbidity? [slide 22-24]

(D) communicate valid conclusions; and

(E) construct simple graphs, tables, maps, and charts using tools including computers to organize, examine, and evaluate information.

Construct a chart showing the connection between how much the jars of muddy water were shaken and how long they take to clear up

(5.4) Scientific processes. The student knows how to use a variety of tools and methods to conduct science inquiry. The student is expected to:

(A) collect and analyze information using tools including calculators, microscopes, cameras, sound recorders, computers, hand lenses, rulers, thermometers, compasses, balances, hot plates, meter sticks, timing devices, magnets, collecting nets, and safety goggles.

In addition to animals like the Barton Springs salamander [slide 4], the Barton Springs area is home to a huge variety of insects. Using collecting nets, collect insects at Barton Springs or other areas that have water nearby. With hand lenses, have the students examine the different body parts.

(5.5) Science concepts. The student knows that a system is a collection of cycles,
structures, and processes that interact. The student is expected to:

(A) Describe some cycles, structures, and processes that are found in a simple system.

The water flow through the Edwards aquifer is part of the water cycle.

(5.6) Science concepts. The student knows that some change occurs in cycles.

(B) identify the significance of the water, carbon, and nitrogen cycles.

The groundwater derived from karst aquifers [slides 7 and 8] is an important source of drinking water [slide 5]. Most of the water entering the Edwards aquifer in the Austin area is from 5 creeks in Austin [slide 13]. The geology of central Texas controls the distribution of the Edwards aquifer. [slides 11-13] Note that the relatively impermeable Del Rio Clay coupled with the series of faults along the Balcones Fault Zone creates the opportunity for artesian aquifers [slide 8]. Water is continuously recycled in the ecosystem. As a result contaminants put in water by humans returns to us when we drink. [slide 31]

(5.7) Science concepts. The student knows that matter has physical properties.

(C) identify changes that can occur in the physical properties of the ingredients of solutions such as dissolving sugar in water; and

[slides 22-24]

(5.9) Science concepts. The student knows that adaptations may increase the survival of members of a species

(C) predict some adaptive characteristics required for survival and reproduction by an organism in an ecosystem

What adaptations are needed for an organism to live in Barton Springs? [slide 4]

(5.11) Science concepts. The student knows that certain past events affect present and future events. The student is expected to:

(A) identify and observe actions that require time for changes to be measurable, including growth, erosion, dissolving, weathering, and flow
If you pour water on limestone for the entire academic year, you probably wouldn't notice any rock being dissolved, however, it does happen. Over thousands and millions of years, water has carved openings in rocks that range from microscopic to enormous, as in the case of caves. [slide 6]
(C) identify past events that led to the formation of the Earth's renewable, non-renewable, and inexhaustible resources.
Water is a very important resource, and the distribution of the Edwards aquifer is controlled by geology events that mainly took place millions of years ago. [slides 10-13]

(5.12) Science concepts. The student knows that the natural world includes earth materials and objects in the sky. The student is expected to:
(A) interpret how land forms are the result of a combination of constructive and destructive forces such as deposition of sediment and weathering;
Karst landscapes develop because of the destructive force of water dissolving rock. Many features within caves, such as stalagmites and stalactites, are the result of the opposite process – water deposits rock that was dissolved elsewhere. [slides 6, 9]

§112.22. Science, Grade 6.

(6.1) Scientific processes. The student conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices. The student is expected to:
(A) demonstrate safe practices during field and laboratory investigations; and
Scientists pictured in slides 27 and 43 are using life vests in their field work. A scientist uses gloves in the laboratory in slide 40.

(6.2) Scientific processes. The student uses scientific inquiry methods during field and laboratory investigations. The student is expected to:
(A) plan and implement investigative procedures including asking questions, formulating testable hypotheses, and selecting and using equipment and technology
Why is the Barton Springs salamander not found in other parts of Texas? [slide 4] What factors are biogeographic barriers to other animals, such as mammals?
Why are there springs in central Texas? [slides 11-13]
The location of Austin and many other cities in central Texas was based largely on the presence of water – Colorado River and Barton Springs. [slides 9-13] Hypothesize whether development is still dependent on the proximity to water. Using GIS, examine whether patterns of development have changed.
Why are karst landscapes often associated with aquifers? [slides 6, 7] Can aquifers occur in other types of rocks?

How have humans modified the appearance of Barton Springs? [slide 14] How would you determine if humans have impacted the water quality at Barton Springs?
How does water get into an aquifer? [slides 9, 11-13]

(B) collect data by observing and measuring

While most of the data collection discussed in the presentation cannot be done in K-12 classrooms, inexpensive water kits can be purchased. If you have a creek nearby, make multiple measurements at various times of the year. Also, keep track of the days it rains. Inexpensive rain gages can be purchased to monitor rainfall throughout the year.

(C) analyze and interpret information to construct reasonable explanations from direct and indirect evidence

Is the water quality of your creek constant year-round? Is there a different result when the test is done soon after a rainfall? [slides 22-23]

(D) communicate valid conclusions

Have the students give a verbal/written summary of their findings, and give them the results of the Barton Springs study. Ask them to describe what is different about swimming at Barton Springs after a rainfall . [slides 22-24]

(E) construct graphs, tables, maps, and charts using tools including computers to organize, examine, and evaluate data.

Graph the results from the creek water quality tests. Indicate when major rainfall events occurred. [slides 22-24]

(6.4) Scientific processes. The student knows how to use a variety of tools and methods to conduct science inquiry. The student is expected to:

(A) collect, analyze, and record information using tools including beakers, Petri dishes, meter sticks, graduated cylinders, weather instruments, timing devices, hot plates, test tubes, safety goggles, spring scales, magnets, balances, microscopes, telescopes, thermometers, calculators, field equipment, compasses, computers, and computer probes; and

Safety goggles should be used when doing the water quality testing mentioned above. If your creek is relatively clean, it will have a diverse assemblage of microinvertebrates. Examine these with microscopes to estimate the diversity.

(B) identify patterns in collected information using percent, average, range, and frequency.

Combine the chemical water quality data with the microinvertebrate survey. What percent of poor quality days had a diverse fauna? Have multiple students assessing the diversity – plot the average values and show the range.

(6.6) Science concepts. The student knows that there is a relationship between force and motion. The student is expected to:

(C) identify forces that shape features of the Earth including uplifting, movement of water, and volcanic activity.

Although central Texas is calm now, there were many earthquakes in the past. The resulting faults are one of the dominant controls on the distribution of the Edwards aquifer. [slides 11 and 12]

The underground movement of water created the pore spaces that now contain the water of the Edwards aquifer.

(6.14) Science concepts. The student knows the structures and functions of Earth systems. The student is expected to:

(B) identify relationships between groundwater and surface water in a watershed

What is a watershed? Have students locate their watersheds at the EPA 'Know Your Watershed' website (http://www.ctic.purdue.edu/KYW/KYW.html). What is a recharge zone? Do all watersheds include recharge features? [slide 13]

§112.23. Science, Grade 7.

(7.1) Scientific processes. The student conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices. The student is expected to:

(A) demonstrate safe practices during field and laboratory investigations; and

Scientists pictured in slides 27 and 43 are using life vests in their field work. A scientist uses gloves in the laboratory in slide 40.

(7.2) Scientific processes. The student uses scientific inquiry methods during field and laboratory investigations. The student is expected to:

(A) plan and implement investigative procedures including asking questions, formulating testable hypotheses, and selecting and using equipment and technology

Why is the Barton Springs salamander not found in other parts of Texas? [slide 4] What factors are biogeographic barriers to other animals, such as mammals? What are barriers for dispersal for plants? Design an experiment to test your proposed barriers.

Why are there springs in central Texas? [slides 11-13]

The location of Austin and many other cities in central Texas was based largely on the presence of water – Colorado River and Barton Springs. [slides 9-13] Hypothesize whether development is still dependent on the proximity to water. Using GIS, examine whether patterns of development have changed.

Why are karst landscapes often associated with aquifers? [slides 6, 7] Can aquifers occur in other types of rocks?

How have humans modified the appearance of Barton Springs? [slide 14] How would you determine if humans have impacted the water quality at Barton Springs?

How does water get into an aquifer? [slides 9, 11-13] Propose an experiment to determine how long it takes rainwater to go from a creek, into the Edwards aquifer, and into Barton Springs.

(B) collect data by observing and measuring

While most of the data collection discussed in the presentation cannot be done in K-12 classrooms, inexpensive water kits can be purchased. If you have a creek nearby, make multiple measurements at various times of the year. Also, keep track of the days it rains. Inexpensive rain gages can be purchased to monitor rainfall throughout the year.

(C) organize, analyze, make inferences, and predict trends from direct and indirect evidence

Is the water quality of your creek constant year-round? Is there a different result when the test is done soon after a rainfall? [slides 22-23] What would you expect the water quality to be after the next rainfall? Does the same pattern hold true for other creeks?

(D) communicate valid conclusions

Have the students give a verbal/written summary of their findings, and give them the results of the Barton Springs study. Ask them to describe what is different about swimming at Barton Springs after a rainfall. [slides 22-24]

(E) construct graphs, tables, maps, and charts using tools including computers to organize, examine, and evaluate data.

Graph the results from the creek water quality tests. Indicate when major rainfall events occurred. [slides 22-24]

(7.4) Scientific processes. The student knows how to use tools and methods to conduct science inquiry. The student is expected to:

(A) collect, analyze, and record information to explain a phenomenon using tools including beakers, Petri dishes, meter sticks, graduated cylinders, weather instruments, hot plates, dissecting equipment, test tubes, safety goggles, spring scales, balances, microscopes, telescopes, thermometers, calculators, field equipment, computers, computer probes, timing devices, magnets, and compasses; and

Safety goggles should be used when doing the water quality testing mentioned above. If your creek is relatively clean, it will have a diverse assemblage of microinvertebrates. Examine these with microscopes to estimate the diversity.

(B) collect and analyze information to recognize patterns such as rates of change.

Combine the chemical water quality data with the microinvertebrate survey. What percent of poor quality days had a diverse fauna? Have multiple students assessing the diversity – plot the average values and show the range. How quickly can water quality change? How quickly can diversity change?

(7.12) Science concepts. The student knows that there is a relationship between organisms and the environment. The student is expected to:

(C) Describe how different environments support different varieties of organisms; and

The unique situation of the Barton Creek ecosystem is reflected in its biota. [slide 4]

(7.14) Science concepts. The student knows that natural events and human activity can alter Earth systems. The student is expected to:

(B) analyze effects of regional erosional deposition and weathering

Karst landscapes develop because of the destructive force of water dissolving rock. Many features within caves, such as stalagmites and stalactites, are the result of the opposite process – water deposits rock that was dissolved elsewhere. [slides 6, 9]

(C) make inferences and draw conclusions about effects of human activity on Earth's renewable, non-renewable, and inexhaustible resources.

Is water a renewable, nonrenewable, or inexhaustible resource? As the population grows, do we have enough water to satisfy everyone's wants and needs? Have a discussion about this question and have students make inferences on the topic.

§112.24. Science, Grade 8.

(8.1) Scientific processes. The student conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices. The student is expected to:

(A) demonstrate safe practices during field and laboratory investigations

Scientists pictured in slides 27 and 43 are using life vests in their field work. A scientist uses gloves in the laboratory in slide 40.

(8.2) Scientific processes. The student uses scientific inquiry methods during field and laboratory investigations. The student is expected to:

(A) plan and implement investigative procedures including asking questions, formulating testable hypotheses, and selecting and using equipment and technology

Why is the Barton Springs salamander not found in other parts of Texas? [slide 4] What factors are biogeographic barriers to other animals, such as mammals? What are barriers for dispersal for plants? Design an experiment to test your proposed barriers.

Why are there springs in central Texas? [slides 11-13]

The location of Austin and many other cities in central Texas was based largely on the presence of water – Colorado River and Barton Springs. [slides 9-13] Hypothesize whether development is still dependent on the proximity to water. Using GIS, examine whether patterns of development have changed.

Why are karst landscapes often associated with aquifers? [slides 6, 7] Can aquifers occur in types of rocks?

How have humans modified the appearance of Barton Springs? [slide 14] How would you determine if humans have impacted the water quality at Barton Springs?

How does water get into an aquifer? [slides 9, 11-13] Propose an experiment to determine how long it takes rainwater to go from a creek, into the Edwards aquifer, and into Barton Springs.

(B) collect data by observing and measuring

While most of the data collection discussed in the presentation cannot be done in K-12 classrooms, inexpensive water kits can be purchased. If you have a creek nearby, make multiple measurements at various times of the year. Also, keep track of the days it rains. Inexpensive rain gages can be purchased to monitor rainfall throughout the year.

(C) organize, analyze, evaluate, make inferences, and predict trends from direct and indirect evidence
Is the water quality of your creek constant year-round? Is there a different result when the test is done soon after a rainfall? [slides 22-23] What would you expect the water quality to be after the next rainfall? Does the same pattern hold true for other creeks?
(D) communicate valid conclusions
Have the students give a verbal/written summary of their findings, and give them the results of the Barton Springs study. Ask them to describe what is different about swimming at Barton Springs after a rainfall. [slides 22-24]
(E) construct graphs, tables, maps, and charts using tools including computers to organize, examine, and evaluate data.
Graph the results from the creek water quality tests. Indicate when major rainfall events occurred. [slides 22-24]

(8.4) Scientific processes. The student knows how to use a variety of tools and methods to conduct science inquiry. The student is expected to:
(A) collect, record, and analyze information using tools including beakers, Petri dishes, meter sticks, graduated cylinders, weather instruments, hot plates, dissecting equipment, test tubes, safety goggles, spring scales, balances, microscopes, telescopes, thermometers, calculators, field equipment, computers, computer probes, water test kits, and timing devices; and
Safety goggles should be used when doing the water quality testing mentioned above. If your creek is relatively clean, it will have a diverse assemblage of microinvertebrates. Examine these with microscopes to estimate the diversity.
(B) extrapolate from collected information to make predictions.
Combine the chemical water quality data with the microinvertebrate survey. What percent of poor quality days had a diverse fauna? Have multiple students assessing the diversity – plot the average values and show the range. How quickly can water quality change? How quickly can diversity change? Predict the impact on diversity given arbitrary levels of water quality.

(8.11) Science concepts. The student knows that traits of species can change through generations and that the instructions for traits are contained in the genetic material of the organisms.
(A) identify that change in environmental conditions can affect the survival of individuals and of species
Based on your water quality testing and biodiversity assessment at your school, what does contamination of Barton Springs imply for animals such as the Barton Spring salamander? [slides 27-41]

(8.14) Science concepts. The student knows that natural events and human activities can alter Earth systems. The student is expected to:
(A) predict land features resulting from gradual changes such as mountain building, beach erosion, land subsidence, and continental drift
Karst is the result of the slow process of rock dissolution. [slide 6]

(C) describe how human activities have modified soil, water, and air quality.
[slides 27-41]

§112.42. Integrated Physics and Chemistry.

(2) Scientific processes. The student uses scientific methods during field and laboratory investigations. The student is expected to:

(A) plan and implement investigative procedures including asking questions, formulating testable hypotheses, and selecting equipment and technology
How have humans modified the appearance of Barton Springs? [slide 14] How would you determine if humans have impacted the water quality at Barton Springs?
How does water get into an aquifer? [slides 9, 11-13] Propose an experiment to determine how long it takes rainwater to go from a creek, into the Edwards aquifer, and into Barton Springs.

(B) collect data and make measurements with precision
While most of the data collection discussed in the presentation cannot be done in K-12 classrooms, inexpensive water kits can be purchased. If you have a creek nearby, make multiple measurements at various times of the year. Also, keep track of the days it rains. Inexpensive rain gages can be purchased to monitor rainfall throughout the year.

(C) organize, analyze, evaluate, make inferences, and predict trends from data;
Is the water quality of your creek constant year-round? Is there a different result when the test is done soon after a rainfall? [slides 22-23] What would you expect the water quality to be after the next rainfall? Does the same pattern hold true for other creeks?

(D) communicate valid conclusions
Have the students give a verbal/written summary of their findings, and give them the results of the Barton Springs study. Ask them to describe what is different about swimming at Barton Springs after a rainfall. [slides 22-24]

(3) Scientific processes. The student uses critical thinking and scientific problem solving to make informed decisions.

(A) analyze, review, and critique scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information;
Are humans to blame for contamination of Barton Springs? Are normal rain events instead the culprit? [slides 25-41]

(7) Science concepts. The student knows relationships exist between properties of matter and its components. The student is expected to:

(A) investigate and identify properties of fluids including density, viscosity, and buoyancy;
[slides 20-24]

(C) identify constituents of various materials or objects such as metal salts, light sources, fireworks displays, and stars using spectral-analysis techniques;
[slides 25-41]

(8) Science concepts. The student knows that changes in matter affect everyday life. The student is expected to:

(A) distinguish between physical and chemical changes in matter such as oxidation, digestion, changes in states, and stages in the rock cycle;
What stage of the rock cycle is represented by the process of karstification? [slide 6]

(9) Science concepts. The student knows how solution chemistry is a part of everyday life. The student is expected to:

(A) relate the structure of water to its function as the universal solvent
It is water's ability to dissolve that forms the pore spaces of the Edwards aquifer. [slide 6]

(C) simulate the effects of acid rain on soil, buildings, statues, or microorganisms
The geological record is a great proxy for the effects of acid rain. Rainwater becomes acidic when it passes through soil. The result is dissolution of rock.

<u>§112.43. Biology.</u>

(2) Scientific processes. The student uses scientific methods during field and laboratory investigations. The student is expected to:

(A) plan and implement investigative procedures including asking questions, formulating testable hypotheses, and selecting equipment and technology;
Why is the Barton Springs salamander not found in other parts of Texas? [slide 4] What factors are biogeographic barriers to other animals, such as mammals? What are barriers for dispersal for plants? Design an experiment to test your proposed barriers.
Design an experiment to determine if contamination of Barton Springs has affected the diversity of the local flora/fauna.

(12) Science concepts. The student knows that interdependence and interactions occur within an ecosystem. The student is expected to:

(A) analyze the flow of energy through various cycles including the carbon, oxygen, nitrogen, and water cycles;
Groundwater is one stage of the water cycle.

<u>§112.44. Environmental Systems.</u>

(2) Scientific processes. The student uses scientific methods during field and laboratory investigations. The student is expected to:

(A) plan and implement investigative procedures including asking questions, formulating testable hypotheses, and selecting equipment and technology;

Why is the Barton Springs salamander not found in other parts of Texas? [slide 4] What factors are biogeographic barriers to other animals, such as mammals? What are barriers for dispersal for plants? Design an experiment to test your proposed barriers.

The location of Austin and many other cities in central Texas was based largely on the presence of water – Colorado River and Barton Springs. [slides 9-13] Hypothesize whether development is still dependent on the proximity to water. Using GIS, examine whether patterns of development have changed.

How have humans modified the appearance of Barton Springs? [slide 14] How would you determine if humans have impacted the water quality at Barton Springs?

How do water and contaminants get into an aquifer? [slides 9, 11-13] Propose an experiment to determine how long it takes contaminants to get into the Edwards aquifer and into Barton Springs, and how long the contamination lasts.

(B) collect data and make measurements with precision;

While most of the data collection discussed in the presentation cannot be done in K-12 classrooms, inexpensive water kits can be purchased. If you have a creek nearby, make multiple measurements at various times of the year. Also, keep track of the days it rains. Inexpensive rain gages can be purchased to monitor rainfall throughout the year.

(C) organize, analyze, evaluate, make inferences, and predict trends from data; and

Is the water quality of your creek constant year-round? Is there a different result when the test is done soon after a rainfall? [slides 22-23] What would you expect the water quality to be after the next rainfall? Does the same pattern hold true for other creeks?

(D) communicate valid conclusions

Have the students give a verbal/written summary of their findings, and give them the results of the Barton Springs study. Ask them to describe what is different about swimming at Barton Springs after a rainfall . [slides 22-24] Graph the results from the creek water quality tests. Indicate when major rainfall events occurred.

(4) Science concepts. The student knows the relationships of biotic and abiotic factors within habitats, ecosystems, and biomes. The student is expected to:

(A) identify indigenous plants and animals, assess their role within an ecosystem, and compare them to plants and animals in other ecosystems and biomes;

Although the Barton Springs salamander is not widespread, its biological niche is filled elsewhere. What animals fill it and what adaptations are required.

(B) make observations and compile data about fluctuations in abiotic cycles and evaluate the effects of abiotic factors on local ecosystems and biomes

See the water quality testing of a local creek above.

(5) Science concepts. The student knows the interrelationships among the resources within the local environmental system. The student is expected to:

(B) identify source, use, quality, and conservation of water

The Edwards aquifer is a major source of water in central Texas. As the population grows, do we have enough water? As the population grows, how can we keep the water clean?

(C) document the use and conservation of both renewable and non-renewable resources

Is water a renewable resource? Since wells reduce the amount of groundwater in aquifers, how should their use be regulated, if at all? [slide 8]

§112.45. Chemistry.

(2) Scientific processes. The student uses scientific methods during field and laboratory investigations. The student is expected to:

(A) plan and implement investigative procedures including asking questions, formulating testable hypotheses, and selecting equipment and technology;

How have humans modified the appearance of Barton Springs? [slide 14] How would you determine if humans have impacted the water quality at Barton Springs?

How does water get into an aquifer? [slides 9, 11-13] Propose an experiment to determine how long it takes rainwater to go from a creek, into the Edwards aquifer, and into Barton Springs.

(B) collect data and make measurements with precision;

While most of the data collection discussed in the presentation cannot be done in K-12 classrooms, inexpensive water kits can be purchased. If you have a creek nearby, make multiple measurements at various times of the year. Also, keep track of the days it rains. Inexpensive rain gages can be purchased to monitor rainfall throughout the year.

(D) organize, analyze, evaluate, make inferences, and predict trends from data

Is the water quality of your creek constant year-round? Is there a different result when the test is done soon after a rainfall? [slides 22-23] What would you expect the water quality to be after the next rainfall? Does the same pattern hold true for other creeks?

(E) communicate valid conclusions.

Have the students give a verbal/written summary of their findings, and give them the results of the Barton Springs study. Ask them to describe what is different about swimming at Barton Springs after a rainfall. [slides 22-24]

§112.46. Aquatic Science.

(2) Scientific processes. The student uses scientific methods during field and laboratory investigations. The student is expected to:

(A) plan and implement investigative procedures including asking questions, formulating testable hypotheses, and selecting equipment and technology;

How does water get into an aquifer? [slides 9, 11-13] Propose an experiment to determine how long it takes rainwater to go from a creek, into the Edwards aquifer, and into Barton Springs.

How have humans modified the appearance of Barton Springs? [slide 14] How would you determine if humans have impacted the water quality at Barton Springs?

(4) Science concepts. The student knows the components of aquatic ecosystems. The student is expected to:

(B) research and identify biological, chemical, geological, and physical components of an aquatic ecosystem

Barton Springs is located in the Edwards Limestone. [slides 11-13]

(C) collect and analyze baseline quantitative data such as pH, salinity, temperature, mineral content, nitrogen compounds, and turbidity from an aquatic environment.

If you have a creek nearby, make multiple measurements at various times of the year. Also, keep track of the days it rains. Inexpensive rain gages can be purchased to monitor rainfall throughout the year. Is the water quality of your creek constant year-round? Is there a different result when the test is done soon after a rainfall? [slides 22-24] What would you expect the water quality to be after the next rainfall? Does the same pattern hold true for other creeks? Have the students give a verbal/written summary of their findings, and give them the results of the Barton Springs study. How do they compare?

(5) Science concepts. The student knows the relationships within and among the aquatic habitats and ecosystems in an aquatic environment. The student is expected to:

(A) observe and compile data over a period of time from an established aquatic habitat documenting seasonal changes and the behavior of organisms

See the water quality testing of a local creek above.

(8) Science concepts. The student knows that aquatic environments change. The student is expected to:

(A) predict effects of chemical, organic, physical, and thermal changes on the living and nonliving components of an aquatic ecosystem

If chemical contamination continues, what will be the impact on the flora and fauna?

(D) analyze and discuss human influences on an aquatic environment including fishing, transportation, and recreation.

In what ways have humans impacted Barton Springs? Are there negative consequences of these actions? Should these actions be halted? Can they be halted?

(9) Science concepts. The student knows that geological phenomena and fluid dynamics affect aquatic systems. The student is expected to:

(C) research and describe fluid dynamics in an upwelling.
Students can look at how artesian wells work, and compare and contrast fluid dynamics of karst and sandstone aquifers.

(10) Science concepts. The student knows the origin and use of water in a watershed. The student is expected to:
(A) identify sources and determine the amounts of water in a watershed including groundwater and surface water;
[slide 13]
(B) research and identify the types of uses and volumes of water used in a watershed
(C) identify water quantity and quality in a local watershed.
Much of this data is maintained by the US Geological Survey and the City of Austin; it is available online. It can be compared to water quality restrictions and guidelines.

§112.49. Geology, Meteorology, and Oceanography.

(2) Scientific processes. The student uses scientific methods during field and laboratory investigations. The student is expected to:
(A) plan and implement investigative procedures including asking questions, formulating testable hypotheses, and selecting equipment and technology;
Why are there springs in central Texas? [slides 11-13]
The location of Austin and many other cities in central Texas was based largely on the presence of water – Colorado River and Barton Springs. [slides 9-13] Hypothesize whether development is still dependent on the proximity to water. Using GIS, examine whether patterns of development have changed.
Why are karst landscapes often associated with aquifers? [slides 6, 7]
Can aquifers occur in other types of rocks?
How does water get into an aquifer? [slides 9, 11-13] Propose an experiment to determine how long it takes rainwater to go from a creek, into the Edwards aquifer, and into Barton Springs.

(7) Science concepts. The student knows the origin and composition of minerals and rocks and the significance of the rock cycle. The student is expected to:
(C) classify rocks according to how they are formed during a rock cycle; and
The process of karstification and cave development involves two stages of the rock cycle – weathering and deposition. [slide 6]

(8) Science concepts. The student knows the processes and end products of weathering. The student is expected to:
(A) distinguish chemical from mechanical weathering and identify the role of weathering agents such as wind, water, and gravity;
Which kind of weathering forms karst landscapes? What is the agent?
(B) identify geologic formations that result from differing weathering processes; and

Karst landscapes and caves are the result of chemical weathering by water.

(10) Science concepts. The student knows the interactions that occur in a watershed. The student is expected to:

(A) identify the characteristics of a local watershed such as average annual rainfall, run-off patterns, aquifers, locations of river basins, and surface water reservoirs;

[slide 13]

(C) describe the importance and sources of surface and subsurface water.

Groundwater is a major source of drinking water for much of the world.