FOSS ® LANDFORMS
TEACHER PREPARATION VIDEO TRANSCRIPT

<Larry Lowery Introduction to FOSS Program>
Lowery: Hello. Welcome to the Full Option Science System. This program was funded by the National Science Foundation. Its goal was to develop materials that would involve youngsters with both the processes and the content of science.

The program is developed with the Lawrence Hall of Science, with scientists, science educators and teachers working together as a team to develop the materials. The materials are tested in the hands of teachers and children in classrooms. It takes about two years to turn out a module.

Each module begins with firsthand experiences. This is done because it has been found that firsthand experiences are the best way for youngsters to learn about the concepts of science. As the module progresses, children are introduced to abstractions and reading materials. The sequence from firsthand experiences through reading materials is deliberate because it has been found that youngsters, when they have some experience before they read, learn and understand more from the reading. Authors of reading materials can then take youngsters to greater abstractions.

Trust the materials that you are getting acquainted with. They have been well tested. We found that they work extremely well in the hands of all teachers and are effective for youngsters in learning about science.

<Larry Lowery Introduction to Landforms>
Many of the interesting landforms that we see are brought about by the cause and effect interaction between water and earth materials. Water erodes the earth materials, wears it away, creating valleys, river canyons and it deposits the material in areas such as deltas and alluvial fans. This module provides students with experiences that model the forces of running water through earth materials. This is done so students can see in condensed time how valleys, canyons, deltas and some other identifiable landforms were created.

The cause and effect relationship of running water over land surfaces is not difficult for students to comprehend, especially when they have the opportunity to test their ideas with well designed materials. In addition to learning how some landforms were created, this module provides experience in converting three dimensional landforms to two dimensional landform drawings. This is done so students will be able to make and read topographic maps.

<Sue Jagoda Introduction to Module>
Narrator/Sue Jagoda: Hi, I'm Sue Jagoda. I'm here to help you get started with the landforms module. The landforms module consists of five investigations that introduce students to some of the fundamental ideas in earth science. Through these investigations students observe that certain landforms are created or changed by the interactions of water and solid earth materials. They also learn that maps and models can be used to show landforms.

Most of the equipment you'll need to teach this model comes in the kit. Everything you see here comes in these two boxes except for these stream tables, which come in a separate shipping box. There is enough permanent equipment in the kit for a class of 32 students and enough consumable equipment for at least two classes. You will need to check the inventory sheet in the materials folio to see which materials are consumable and which are permanent.

From the FOSS measurement kit you'll need basins, vials -- the size doesn't matter -- meter tapes, plastic cups, hand lenses, one liter containers and pitchers. You will need to provide transparent tape, lots of newspapers, aluminum foil, paper clips, a permanent black marking pen with a thin point, a clock or a watch with a second hand, scrap paper, lined paper, colored pencils, if you have them, tissue, paper towel and a local highway map, if you have one. You'll also find these posters of the Grand Canyon and Mt. Shasta in the kit.

Before you begin teaching this module, you should look through the entire Teacher's Guide. First you will find the Overview folio, which points out the national standards addressed in this module as well as information about how to make the best use of the Teacher Guide. It also includes valuable background information specially written for teachers who have not had extensive science training. The suggested teaching schedule in the overview will be particularly helpful as you plan.

Next you'll find the Materials folio. If you are the first teacher using a new kit, you'll want to turn to the section that describes the first time prep. If the kit has been used before, check the section called Preparing Your Kit for Your Classroom. Both of these sections will give you helpful hints that will save you lots of preparation time later.

The next five folios are the investigation folios. These are the heart of the program. Each takes one or two weeks to complete. The first page provides overview information. The At A Glance chart summarizes the investigations and helps you plan for assessment and extension activities.

Next you'll find background information specific to this investigation. There's a section called Teaching Children About which gives you some insight into research about how children think and learn. Each investigation has several parts. For each part of the investigation, you find a materials list, Getting Ready section and step-by-step instructions for how to proceed through the investigation. At the end of the folio, you'll find Interdisciplinary Extensions. You can do some of these extensions with the class or save them for students to use as projects at the end of the module.

Next are the investigation duplication masters. Each master is labeled with a number so it will be easy to find when you need it. Shortly before beginning this module, duplicate the Letter To Parents and send it home with the students. This letter tells parents about the module and suggests some activities that they can do at home with their children.

It's important to read the Assessment folio before you begin teaching. It describes a system for assessing students throughout the investigations and also gives you ideas for end-of-the-module testing or portfolio assembly. The folio contains scoring guides for each of the assessments suggested.

Next are the assessment duplication masters. Here you'll find all the masters for the assessment charts and end-of-the-module assessments. As part of the kit, there's a book of Science Stories for the students to read. The Science Stories folio gives you background information, recommends when to read the stories and suggests follow-up activities. You may want to read the Science Stories during a reading period rather than science time, especially if you only teach science a couple of times a week.

In the Resource folio you will find lists of trade books, videos, computer software and other resources that you can use to enrich the program. The final tab is the FOSS website folio. On the website you'll find simulations, links, readings, puzzles and pictures to extend the investigation of each module in the program. The students can also contact scientists and Foss students across the country. You'll need to check the website to see the many features available there, including resources for teachers.

If you're the first teacher to use the landforms kit, you need to prepare the earth materials for Part 1. You may want to enlist the help of parents, students or aids to help you with this task. To prepare the earth material, add about one cup of powdered clay to one liter of sand. One liter of sand is one bag in the kit. Exact measurement is not critical.

Mix the materials until they are uniformly distributed. Then have a cup of water ready. Pour the water slowly into the earth materials. About halfway stop and mix the water and the earth materials. It's going to end up being about the texture of dry pie crust dough and be able to hold its shape when you smush it between your fingers. This is about the right consistency.

You're going to need to prepare one bag of earth material for each group of four students. The earth material should be dried and stored as permanent equipment at the end of Investigation 3. You may need to add more powdered clay to the mixture after several investigations with the stream table.

There are extra bags of sand and powdered clay in the kit. These can be used to replenish the earth material mixture as needed. Now you're ready to begin.

<Investigation 1, Part 1>
Narrator: This investigation begins with the students making a model of their school site. You'll want to set up a materials station for each part. Here is what you'll need for this part: From the kit the plastic trays, earth material mixture, which you put together, duct tape, wooden angles, plastic cubes, craft sticks and rulers.

From the measurement kit you'll need to get plastic cups and extra gram pieces. You'll need to provide a local highway map, if you have one available, lined paper, newspaper, tissues and paper towel. You'll need to make copies of the student sheet called Landforms Journal and make one copy of the Assessment Chart For Investigations 1 and 2.

Assessment opportunities are embedded throughout the module. Before you begin, take a look at the note in the Getting Ready section and also look at the Assessment folios so you can make the best choices for you and your class.

Be sure the earth material is ready for use. If the mixture has been used before, it may be crunchy. To prepare for the next session, scrape the earth material up and add just enough water to make it feel like dried pie crust dough. If too much water is added, use a newspaper to blot up the excess.

There are a couple of health and safety considerations to think about before you start this module. There are no toxic materials in the kit, only sand and clay. You'll probably want to have your students wash their hands after handling the material. Sometimes you'll get a student, though, who does have problems with the material, usually because they have dry skin. Then you can either have them wear rubber gloves or have the other students in the group handle the material.

There are 200 gram pieces in the kit. If you would like to add cubes, you can borrow the gram pieces from the measurement kit. Place the gram pieces in a cup for each group and put them at the materials station.

You may want to take a mini field trip with your students around the schoolyard or assign a school site survey as homework the day before you start the investigation. Familiarize yourself with the trays. One thing you should notice is the hole at the end of the tray. For this investigation you will need to place a piece of duct tape across the hole. This will keep the earth material from escaping out of the hole. Plan to demonstrate how to divide the earth material from one bag equally between the two ends of the trays. And use the wood angles to hold the material in place.

At the fifth and sixth grade level it's a good idea to teach students how to take careful notes in a journal. Prepare a Landforms Journal for each student by stapling about ten pages of lined paper to the journal cover that you duplicated.

Make a Project Folder for the class. As students come up with ideas for projects during the investigations, have them write their ideas down and put them in the folder so they have something to choose from at the end of the module. Prepare a Word Bank and Content/Inquiry charts using large sheets of paper or a flip chart. The session begins with the teacher asking the students for some examples of models.

Teacher: Okay. Today we're going to be talking about models. And what I would like you to do first is to give me some examples of some models you can think of from real life.
EJ?

Student: Statues.

Student: Airplanes.

Student: You know like the little toy cars.

Student: Forts.

Teacher: Okay. Models are smaller versions --

Narrator: The teacher adds to the discussion that models are sometimes smaller versions of large things that we can't bring into the classroom like rivers or things so small we can't see them like plant cells or an atom. She tells the students that their challenge will be to build a model of their schoolyard.

Teacher: After we go outside, you're going to be looking at the schoolyard. And when you come back in, you'll be using this tray of earth material in order to build a model of the schoolyard. Be making observations as you go. Look around.

Narrator: The teacher takes the class for a walk around the campus. The purpose is for the students to make careful observations so they can accurately show the features of the campus in their models. When the students complete their walk, the teacher reviews that they will be building a model of their schoolyard.

Teacher: Let me show you the equipment you're going to be using.

Narrator: She explains that one use of models is to help people understand and visualize what a large area looks like. She shows them the materials they will be using. After each group decides who'll be the getters, reporter and starter, Getter 1 goes to the material station and gets the equipment they need to get started.

The students spread newspaper under the tray on the table to catch any spilled earth material. They divide their earth material into two equal amounts in the tray. Each pair has at least 20 centimeters of their end of the tray to use for their model. They use the wood angles as boundaries. Each pair discusses how they will use the cubes and craft sticks and then starts modeling.

Student: This is the water fountain. This is the (inaudible).

Teacher: Where are we? Where is our classroom?

Student: Right here.

Narrator: After the students put the final touches on their models, invite them to walk around the room to view the models made by other teams.

Student: And right here --

Student: This is the playground.

Student: These are portable (inaudible.)

Student: What are these?

Student: This is the parking lot.

Teacher: I would like you to think now about the models you saw compared to the one you did. Were you able to recognize the features on other peoples' models? Did you feel that other people showed the different features that you showed on your model?
Autumn?

Student: I noticed that some were used for -- the little blocks were used for houses, were used for holding up like tether balls, fences and the basketball courts.

Teacher: Jessica?

Student: I realized that I could recognize what the cubes were because most of them are classrooms.

Narrator: The teacher emphasizes that there's no right or wrong version of a schoolyard model. Each model may portray different details. After the students have viewed the other models, have the getters return the trays for storage until the next session.

Teacher: All right. While we've been building our models, we've used a couple of words that might be new to you. Can anybody think of some of the vocabulary words that we can put into our Word Bank that have to do with building models? Alisa?

Student: Model. It's something -- it's something that's like -- I don't know the definition. It's hard to explain. It's like a big object bringing it down to a smaller size so it will fit into something.

Teacher: Good answer. Definition of a model. Carmella?

Student: A smaller version of something.

Teacher: Good answer.

Student: Something made by hand.

Teacher: Okay. A model is frequently made by hand. Great, okay. Other vocabulary words? Marco?

Student: Boundary. It's something like a border like the one that surrounds our school.

Teacher: Good answer. Other words we can put into our Word Bank?
Jessica?

Student: A symbol, which represents something.

Teacher: Good answer. All right. Class, what are some things that we have learned today when we were doing our models of the schoolyard? Michael?

Student: I learned that you can bring bigger things inside your classroom. But it doesn't have to be the exact same thing. You can pretend that cubes are like houses or buildings.

Teacher: Good explanation. Okay. So we can -- what you talked about were symbols. You can say we used symbols to represent larger items in our school.

Narrator: In this part students learn a model is a representation of an object or process. Be sure to check the Science Stories folio and plan for time for the students to read the stories.

<Investigation 1, Part 2>
Narrator: In Part 2 of this investigation, students use their three dimensional models of the schoolyard to make two dimensional maps. Here is what you'll need for this part: From the kit you've already taken out the materials that the students have used to create the schoolyard models. That includes the earth material, the plastic trays, the gram cubes and the wooden angles. You'll also need the duct tape, overlay grids and overhead transparency pens. You will need to provide transparent tape, a local highway map, if you have one, newspaper, tissue and paper towel. You'll need to make copies of the student sheet called Response Sheet - Schoolyard Models and have your Assessment Chart For Investigations 1 and 2 handy.

18 overlay grid transparencies are supplied as equipment in the kit. They are not consumable so be sure that students use only overhead transparency or watercolor pens to write on them. Have the students clean the transparencies with a damp tissue at the end of the investigation. Additional grids can be made in a photo copier using Foss Duplication Master No. 3.

Begin this session by asking the students how they could make a version of their models that they could carry easily.

Teacher: Okay. When we built the models the other day, your models gave you a good idea of what the schoolyard looked like. But it would be very hard for you to carry around a large tray of earth material if you wanted to show somebody a model of the school. So what I want you to do is think about a way that we could take that model and make it into something that would be easy to carry around and easy to show other people. Does anybody have any ideas? Michael?

Student: Maybe we could get a paper and sketch it on our desk.

Teacher: Carmella?

Student: We could buy a map or make a map and show the person.

Teacher: Good idea. That was a great answer, giving the idea of making a map. As you know, a map is a way of expressing a location in a compact paper sort of way.

Narrator: The teacher explains that maps are drawings of the earth's surface. There are many different kinds of maps, including ones that show roads, structures and landforms. When you look at a map, you see what the land would look like if you were up in the air and looking straight down.

The teacher introduces the word cartographer as someone who makes maps. The teacher explains that the challenge today is for each group to begin making a map using their schoolyard models. Getters 1 get the models that were created in Part 1. Getters 2 get the materials they need to begin drawing the map. Each pair positions the overlay grid over their model and tapes it to the tray.

When the students have finished drawing on their overlay grids, have them remove the grids from the trays, stack the trays and store their maps. In this part students learn that maps are a way to show features of the earth on a flat surface. Before ending this session, introduce the Project Folder. Explain to the students that at the end of the module, they'll be choosing an investigation for further study. This is a good time for them to add questions and ideas to the folder.

<Investigation 1, Part 3>
Narrator: In Part 3, students transfer the information from their overlay grids to their paper map grids. Here is what you'll need for this part: From the kit you need the overlay grids the students completed in Part 2 and duct tape. You will need to provide the students' Landform Journals, tissue, newspaper, colored pencils, regular pencils, paper towel and a local highway map, if you have one. You'll need to make copies of the Student Sheet called Map Grid and have your Assessment Chart For Investigations 1 and 2 handy.

Start this session with a discussion about maps. Tell the students that they are going to be making a paper map with the information they recorded on their overlay grids. The teacher distributes the student sheet called Map Grid and the getters get their overlay grids. After the students compare the two grids, you'll see that both sheets have the same number of squares but the squares on the map grid are smaller than those on the overlay grid. Here the students are transferring the information from their overlay grids to the paper map grid.

Student: Don't forget to put lines on the portable (inaudible).

Narrator: The teacher introduces the need for a map key. She explains that a map key is an explanation of symbols used on a map. The students create a key for their maps.

When the students have finished with their maps, you may have them take apart their models, unless you want to save them for display with the overlay grids and paper map grids. Have them keep the earth material in the trays. The earth material and the trays should be stored together for Investigation 2. Before storing the overlay grids, have the students wipe them off with tissues.

In this part students should learn that a map is a way to show landforms and structures on a flat surface and a map key explains what the symbols mean on a map. This brings us to the end of Investigation 1. Be sure to choose several of the Interdisciplinary Extensions for your students and have them do the math problem of the week before moving on.

<Investigation 2, Part 1>
Narrator: In the first part of this investigation, students set up a stream table and observe what happens when water flows over earth materials. Here is what you'll need from this part: From the kit you'll need the plastic trays with the earth material mixture, the Grand Canyon poster, rulers, wood angles, the standard water source, duct tape, the Standard Stream Table Set-Up poster and the Landform Vocabulary poster.

From the measurement kit you'll need the hand lenses, meter tapes, one liter containers, pitchers and basins. You will need to provide water, the students' Landform Journals, newspaper and paper towels. If you have one available, a map of the United States that shows the Colorado Plateau is nice to have, too.

You'll need to make copies of the student sheets called Colorado Plateau Map, Standard Stream Table Set-Up and Landform Vocabulary. Have your Assessment Chart For Investigations 1 and 2 handy.

Make sure that each group has a level surface on which to put their stream table. Have newspaper available so that they can put this under their stream tables and under the catch basins. After this part, you can dump the water outside so that the earth material doesn't clog up your drains.

Look at the water sources that come in the kit. There are two different one-half liter containers: The standard water source and the flood water source. Notice that the hole in the standard water source is smaller than the hole in the flood water source. You need the standard flow for this investigation. You may want to color code them. It's a good idea to practice with the stream tables before you start this investigation with your students.

To set up the stream table, you need to push the earth material to within 20 centimeters of the end of the tray that's away from the hole. Use the wooden block to bulldoze the material up to 20 centimeters. Then flatten the surface making it smooth and even all the way across. Next you tape the ruler with duct tape onto the ends of the tray just far enough so when you put the standard water source on here, it will sit there without falling through.

Remember to take the duct tape off the hole at the end of the tray before you start running water in the stream table. Look over the two posters, Standard Stream Table Set-Up and Landform Vocabulary. You may also want to blow up a copy of Student Sheet No. 6, the Colorado Plateau map, for display. The area within the shaded line is the Colorado Plateau.

It's a good idea to practice with the stream table to become familiar with the landforms and the texture of the earth material after several uses. Plan to drain the stream tables by tipping them up on the wood angles at the end of the session. After the water has drained, cover the drain hole with duct tape.

Keep the earth material in the trays between sessions. The earth material will become crunchy as it dries. To prepare for the next session, scrape the earth material up and add just enough water to make it feel like dried pie crust dough. If too much water is added, use a newspaper to blot up the excess.

Begin this session by introducing the Grand Canyon. Tell the students that they are going to be studying a model of this world famous landform.

Teacher: Girls and boys, as you know, we've explored using models of our schoolyard to find out how scientists explore things that might be too large or too small to study. Today we're going to become earth scientists and we're going to be studying a world famous landform. Here is a poster of the Grand Canyon. Is there someone who could point out the Grand Canyon on our United States map?

Student: The Grand Canyon.

Teacher: Great. Thank you. Scientists have an idea that the Colorado River might have been responsible for forming the Grand Canyon. If you look on the poster here, you will see the canyon and the river in the background.

Narrator: The teacher points out the Colorado River, the brown strip of water at the bottom of the canyon. The Colorado River flows over the Colorado Plateau, a high flat landform. She continues to point out that there are many rivers that flow across the plateau and eventually into the Colorado River. The system of rivers and streams is called a drainage basin.

Much of the water that falls on the Colorado Plateau as rain, snow and other precipitation, eventually drains into the Colorado River. The teacher explains that the Grand Canyon is almost two kilometers deep in places and geologists are very curious about how it formed. After listening to the students' ideas about how it may have formed, the teacher explains that one way geologists study the earth is to set up working models in their labs. The Grand Canyon can't be brought into the classroom. But you can make a model using the stream table.

After the teacher demonstrates how to set up the stream table, the getters get the materials they need. The students place the stream table on newspaper they have spread at one end of the table. They use the wood angle like a bulldozer to push the earth material into the last 20 centimeters of the tray on the side away from the drain hole.

The students pat the material into a smooth even surface making sure they have the same depth all the way across. Getters get a ruler, a standard water source and two pieces of duct tape. The students tape the ruler to the stream table so it will support the water source. The students place the stream table at the edge of the table with a basin on the floor to catch the water that flows out of the stream table. They pull the tape off of the hole.

Teacher: Girls and boys, the earth material represents --

Narrator: The teacher demonstrates how to add water to the water source. She explains that the one liter of water they will run through the system represents the water of the Colorado River flowing over the Colorado Plateau for at least one million years. Be sure the students have the basins placed on newspaper and that it is directly under the hole of the stream table before they begin.

The investigation begins. The teacher reminds students that they will run only one liter of water through their stream table system. Once they begin, they should not move their water source and they should not touch anything on the tray or shake the desks.

Student: It's decaying.

Student: It's breaking apart.

Student: And water is starting to flow down.

Narrator: The teacher reminds students to check the water flowing through the drain hole.

Student: This is going that way.

Teacher: Oh, let's take a look. What do you see happening?

Student: It's mixing.

Teacher: It pushed the land. So erosion was happening, wasn't it? It was wearing away earth material. And do you see a canyon down there?

Student: Yes.

Teacher: Great. And this area here where the earth material is spreading out, that would be the delta.
Can you point out where deposited material is, John?

Student: Right there.

Teacher: So there's the canyon. And where did it deposit that sand and clay?

Student: (Inaudible.)

Teacher: You're right. So that's called the deposition process.

Narrator: When all of the water has run through the stream table, the teacher asks each group to hold a two-minute discussion to review what they have observed. With the entire class, the teacher goes over the meanings of delta, canyon, valleys, flood plains, meanders and the mouth of the stream. The getters get a copy of the Landform Vocabulary sheet and the students look for examples of the landforms in their stream tables.

Student: That's a valley.

Student: Yeah.

Student: That's a valley.

Student: There's no plateaus.

Student: I think this is the plateau or something.

Student: Yeah.

Student: See that. And then that -- it's got the crate and then the curve just like on the map.

Narrator: While the students are working with the Landform Vocabulary sheets, the teacher tells them that water running over the earth's surface and wearing it away is called erosion. They have just seen this happening in their stream tables. She explains that some materials like loose sand and soil erode very quickly but other materials like hard rocks erode more slowly. The cutting of the plateau to form a canyon in the stream table model is an example of erosion.

To start cleaning up, the teacher asks the students to drain their trays by propping them up on the wood angles. The getters return the rest of the materials to the materials station. When the stream tables have drained, the students place a piece of duct tape over the hole in the tray. The getters dump the water in the basins outside and clean the table tops. The students store their trays until the next session.

Teacher: Girls and boys, now we're going to compare our stream tables to the Grand Canyon. So I have some questions to ask you to think about and discuss. First of all, how are your stream tables like the picture of the Grand Canyon?
Ashley?

Student: The landform -- the river flows from the Grand Canyon, then flows back -- flows around and then -- by the valleys and the mountains and then by the flood plain.

Teacher: The flood plain.

Student: Plain, yes.

Teacher: Good. It creates a flood plain as it goes.

Student: The landform formed crates in ours. Like it made a slope when the water came down just like it did on the Grand Canyon.

Teacher: So a gentle slope like a beach.

Student: Yeah.

Teacher: Dalton?

Student: It has waterfalls just like the Grand Canyon from the rivers leading to rocks and to a waterfall.

Student: They had lots of valleys and some rivers.

Teacher: Girls and boys, what happened to the earth material that once was on the plateau? Scott?

Student: It formed beaches and the rock eroded and formed a little canyon and it made dunes and plateaus.

Teacher: So the water traveled over the plateau and it eroded or wore away some of the earth material. Girls and boys, after doing our model, how do you think that the Colorado River might have formed the Grand Canyon?

Student: It pressured down -- like the water, it like -- all of the force pressed it down so then it would form different like shapes.

Teacher: Like the canyon that it carved out by moving the earth material?

Student: Uh-huh.

Teacher: Great. We're going to create a Word Bank of some of the new terms that we have learned through this experiment. Who has a word that they would like to put in our Word Bank today?
Erica?

Student: Canyon.

Teacher: A canyon.

Narrator: The teacher takes a little extra time with the Word Bank today. There are a lot of new words and she discusses the words, pronunciation and meanings at length with the students. In this part, students learn water flowing over earth materials may erode them and rivers can create landforms called canyons and deltas. Be sure to check the Science Stories folio and plan for time for your students to read the stories.

<Investigation 2, Part 2>
Narrator: In this part, students set up another investigation in their stream tables and they focus on deposition and how the water flows. Here is what you'll need for this part: From the kit you'll need the plastic trays with the earth material mixture, the Grand Canyon poster, rulers, wooden angles, food coloring, the standard water source, duct tape, cotton swabs, Landform Vocabulary poster and the Standard Stream Table Set-Up poster.

From the measurement kit you'll need the hand lenses, meter tapes, vials -- there are two different sizes -- plastic cups, one liter containers, pitchers and basins. You need to provide water, the students' Landform Journals, newspaper and paper towels. You'll need to make copies of the student sheet called Response Sheet - Stream Tables. Have your Assessment Chart For Investigations 1 and 2 handy.

You may want to practice adding food coloring to the water before you begin this part. Place five or six drops of red, blue or green food coloring in a plastic cup. Put a cotton swab in the food coloring. Dip the swab in the water directly over the hole in the water source. You can repeat this as often as you like. The food coloring lets you see the flow of the water better. At the end of the session, remember to drain the stream tables by tipping them up on the wood angles. After the water has drained, tape the hole.

Begin this session by suggesting to the students that they set up another stream table investigation, only this time watching where the material eroded from the plateau ends up. When the groups have completed their observations the teacher asks where the eroded earth material ended up. The students report that most of it formed a delta, some of it ended up spread out in the tray and some reached the basin.

Looking more closely, the students realize that the delta is mostly sand and that a lot of the eroded clay ended up in the water that drained into the basin. The teacher introduces deposition as the process in which eroded earth material settles out of water. But why were the sand and clay deposited at different locations? To find out why, the teacher suggests that each group conduct a shake test.

First they fill a vial about half full with earth material from the stream table. Then the students pour water into the vial until it is almost full. They put the lid on tightly and shake the vial for five seconds. This represents the water moving in the stream.
They place the vial on the table and observe what happens. After several minutes, the students can see the sand and clay separate. The sand is deposited on the bottom. The clay settles on top of the sand or stays suspended in the water. The students are asked to explain what they observed.

Student: The clay and the sand were mixed together but now they are separate.

Student: In the tube when they put the clay in, they mixed it. Then they got the water over there. And then when they shook it, it got all mixed together. And then like the dark part, since it's like a little bit more like heavier, the water got lighter so the white stuff went up to the surface.

Teacher: Girls and boys, what did you see in your vial that helped explain what happened in your stream table?

Student: I saw that the water and --

Narrator: The students observe that the water slowed down at the mouth of the river where the delta formed. The teacher suggests that as water slows down, the sand starts to settle out. As the water slows down even more, the clay begins to settle. She goes on to explain that the materials that have been deposited are called sediments. Sediments are usually deposited in low areas of the earth's crust. These low places are called basins.

Teacher: Okay. Girls and boys, where do you think the land went that was on the Colorado Plateau after it was moved by the river? Catherine?

Student: It could have flowed into the river and flowed like -- and gone along the sides to form like different parts that weren't part of the -- that went out of the Colorado River and could have gone into Mexico.

Teacher: Balshar?

Student: The water like carried it away and like formed new land.

Teacher: Is a canyon created by erosion or deposition?

Student: Well, I think it's caused by erosion. Because when I saw in the tray, it was pushing it. And I guess it's caused by erosion.

Teacher: Okay. So what did you see being pushed?

Student: The earth materials.

Teacher: What was doing the pushing?

Student: The water.

Teacher: Great. Thanks.
Matt?

Student: Whenever something forms a canyon, it erodes, it takes away land.

Teacher: All right. Girls and boys, how about a delta? Do you think a delta is formed by erosion or by deposition?
Scott?

Student: I think it's caused by deposition because the water, when it hits, it's eroding and then it's bringing the sand and the clay and the rock and stuff with it and putting it in a new place.

Teacher: Great. Thanks, Scott.

Narrator: This is a good time to break or if you have time, you may want to have the students run the stream table one more time now. The teacher introduces this session by asking students how the water traveled over the earth material in the stream table. As students respond, the teacher focuses on the fact that the water didn't always travel in the same course.

She suggests that the students set up a standard stream table again and run one liter of water through it, this time watching carefully to see where the water travels. This time they get to add a small amount of food coloring to the water to help them see where the water travels.

Student: Look how it's flowing.

Student: It's moving slower.

Student: It's almost gone.

Student: This is cool.

Student: It's like --

Narrator: After the students observe the stream tables, the teacher asks them to describe the path taken by the water.

Student: Last time it was going straight and now it kind of curved.

Teacher: Why does water meander?

Student: The rocks and minerals caused the meander. Because they like block it.

Student: It doesn't go straight because there's other curvy spots right there. And the water has to push over there.

Student: It's going to go the soft way because it doesn't like getting blocked.

Teacher: What happens when water runs into a barrier?

Student: The water stops and it goes around it. So it curves.

Narrator: Help the students understand that the reason water moves the way it does is because it always tries to flow to the lowest place. If it runs into a barrier, such as some rocks or sediments, it will try to find a way around.

Teacher: Geologists say that the Grand Canyon was formed by the Colorado River. Would you agree with them and why or why not?

Student: Yes, I think that the Colorado River created the Grand Canyon because the way it's flowing through and how it's -- the Grand Canyon is formed by the way the Colorado River is flowing through. There's deltas and beaches and stuff. And I don't think that that could be there naturally unless something caused it.

Student: I agree with them because I think that the Colorado River was strong. And at the time the Grand Canyon was just one mountain. And it was all made out of dirt. And then a lot of water from the Colorado River came. And it wiped it out. And all the rocks just fell into the river. And it formed the Grand Canyon.

Student: I say yes because the water forced -- the waters force it -- the force went into the rock and it washed it away.

Student: I disagree because you can think that some rain, hard rain, can smash -- like if the Grand Canyon was big, it could have smashed the rock.

Narrator: This answer shows good thinking because rain does cause erosion. Some students still find it difficult to believe a river could form the Grand Canyon.

Student: How can the river form the Grand Canyon? It's like impossible to form that part as the rocks could have or people could have just formed them itself.

Teacher: How can we find more evidence --

Narrator: The teacher asks how can we find more evidence to prove that the Colorado River did or did not form the Grand Canyon.

Student: Well, you would have to -- well, go again and see what happens the most.

Student: You could research by asking people if they were around then. Or you could just like try and study the artifacts, see if they have water soaked in them.

Narrator: These are good ideas to add to the Project Folder. Remember to have the students drain the water and tape the holes before storing the trays. After this part, students should understand that earth materials eroded by rivers are deposited as sediments. Heavier earth materials like sand are deposited before lighter materials like clay. And water in a river follows the lowest channel.

We've now completed Investigation 2. Be sure to choose several of the Interdisciplinary Extensions with your students and have them do the math problem of the week.

<Investigation 3, Part 1>
Narrator: In this part, students continue their stream table experiments by investigating how slope of the land affects erosion and deposition. Here is what you'll need for this part: From the kit you'll need the plastic trays with the earth material mixture, the Grand Canyon poster, rulers, wood angles, the standard water source, duct tape, the Standard Stream Table Set-Up poster and the Landform Vocabulary poster. From the measurement kit you'll need the hand lenses, meter tapes, one liter containers, pitchers and basins.

You need to provide water, the students' Landform Journals, newspaper, a clock or a watch with a secondhand, scratch paper and paper towel. You'll need to make copies of the student sheet called Stream-Table Map. Make one copy of the Assessment Chart For Investigation 3.

Begin this part by referring to the Grand Canyon poster and explaining to the students that geologists are still trying to figure out how the Colorado River could have carved such a deep canyon. One of their ideas is that the Colorado Plateau might actually have been tilted up over time so that it now has a steeper slope. The students' challenge today is to figure out by using the stream tables whether slope does affect erosion.

Teacher: The Grand Canyon is an example of erosion on a large scale. Scientists are still trying to figure out how the Colorado River could have carved such a deep canyon in the Colorado Plateau. One suggestion is that the slope might have caused that deep carving. Slope is when the land angles downward.

Narrator: After the teacher asks the students for ideas as to how they could test for slope, they agree to use the wood angle to prop up the stream table creating a slope. Half of the groups will create a slope and half will leave their stream tables flat. When Getter 1 brings the stream table to the group, the students begin to set up their investigation. The students pack and smooth the earth materials and measure it to make sure it is 20 centimeters long.

Student: That's 20.

Student: Yeah.

Student: Okay. That's 20.

Student: Okay. That's 20.

Narrator: Half the groups create a slope by placing their stream tables on the wooden angles. At the signal go, the reporter writes down the starting time. The getters watch for changes to report to the reporter. The reporter records the event and the time. The students will record all of this information in their journals later.

Student: Two canyons.

Student: It's breaking.

Student: See from here it's going all the way down here.

Student: It creates valleys. Oh, my gosh. What's the time?

Student: 9:29.

Student: Seven seconds.

Student: All of the sand is going on the bottom.

Student: Look right there. There's a hill.

Student: Well, we ended at 9:34 and we started at 9:24 so that's about --

Student: Ten minutes.

Student: Yeah.

Student: Yesterday it was only like -- it was going in different places. But now it's like just going down one place and making hills.

Student: See if it shrunk anymore.

Student: Yeah.

Student: Yeah, it shrunk. 18 centimeters.

Student: It shrunk 2 centimeters.

Teacher: Girls and boys, let's talk about --

Narrator: The teacher guides the discussion with questions like these: What was the first event that you observed? When did water start flowing downstream? Did a delta form and when? What similarities and differences did you observe between the standard and flood results?

Teacher: Nicholas?

Student: Like the people who did the slopes, that they had a bigger delta.

Teacher: What did you notice that was the same about these two experiments?

Student: Sand and clay had canyons and deltas.

Teacher: Deante?

Student: I noticed that they had beaches and like floods. Flood plains and valleys and stuff like that.

Teacher: Great. Thanks.

Student: The people with the slopes, canyons and valleys were bigger than the people with standard.

Student: You have more deeper canyons and more deltas.

Teacher: Where did you find deeper canyons, in the standard or the ones with the slope?

Student: The ones with the slope.

Teacher: Great. Thanks.

Narrator: The teacher explains that each student will fill out a stream table map labeling it either standard or slope. They will draw a map showing how the stream tables looked after the water had run through it. They will record a written sequence of the important events and the time at which they happened. They each record the reporter's notes in their journals and use them to complete the student sheet.

Student: It's 33 centimeters.

Student: Because this one is cut off.

Student: So let's make a V shape all over the place. Because we made quite a few.

Student: That's a big canyon there.

Student: Right here. The flood plain is right there. The flood plain is at the beach.

Student: What about the changing course; that was a pretty big thing?

Student: The changing course.

Student: The plateau.

Narrator: When the maps are complete, ask students to make some statements about the difference between the two stream tables. They should see in the sloped table the earth materials eroded faster and moved farther, the valley was different. Introduce the word alluvial fan to describe the fan shaped deposit that occurs in arid regions where rivers flowing through steep canyons slow down when they reach a flatter slope on the valley floor. Ask the students to think about what effect slope would have on the carving of the Grand Canyon. Focus on the discussion on the idea that if the slope of the Colorado Plateau had increased, the Colorado River could have flowed faster and more erosion could have occurred.

In this part, students should learn that water flowing through channels with steep slopes causes more erosion. And canyons are deeper and deltas are longer in a stream table with a steep slope. Be sure to check the Science Stories folio and plan for some time for your students to read the stories.

<Investigation 3, Part 2>
Narrator: In this part, students continue to experiment with their stream tables, this time testing for the effect of floods. Here is what you'll need for this part: From the kit you'll need the plastic trays with the earth material mixture, the Grand Canyon poster, rulers, the wooden angles, the flood water source with the large hole, duct tape, the Landform Vocabulary poster and the Standard Stream Table Set-Up poster.

From the measurement kit you'll need the hand lenses, meter tapes, one liter containers, pitchers and basins. You need to provide water, the students' Landform Journals, newspaper, a clock or a watch with a secondhand, scratch paper and paper towel. You'll need to make copies of the students' sheets called Stream Table Map and Response Sheet - Go With The Flow. Have your Assessment Chart For Investigation 3 handy.

To begin this part, explain to the students that sometimes huge thunderstorms happen in the area around the Grand Canyon sending great amounts of water down side canyons. These events are called flash floods. Then show them the flood water container and the larger hole at the bottom. Tell them that they'll be able to use this container to simulate a flood in their stream tables.

Student: It made a delta in the canyon.

Narrator: The teacher shows the students the flood water source. The students decide they should set up a standard stream table, except they will use the flood water source. They may want to set up a controlled standard group as they did last time. But since they still have their notes in their journals, it's okay to set up the control but not necessary. They make careful notes of important events.

Student: Then there are these two, right?

Student: Those are delta.

Student: Delta right here. Delta right there.

Student: So then those two are canyons?

Student: Yeah.

Narrator: The students use their Landform Vocabulary sheets to confirm their observations and the accuracy of their notes. As students complete their flood maps, the teacher asks students to describe how the flood and slope investigations were similar and how they were different. During a closing discussion, the students report that as the water slows and material is deposited, a delta is formed. When there's a flash flood in the Grand Canyon, more erosion might occur and the canyon might become deeper.

By the end of this part, students should understand that floods cause more earth material to be eroded. Continue to add student ideas to the Project Folder.

<Investigation 3, Part 3>
Narrator: In this part students design and carry out their own stream table investigations to discover how human modifications affect stream processes. Here is what you'll need for this part: From the kit you'll need the plastic trays with the earth material mixture, the Grand Canyon poster, rulers, the wooden angles, the gram pieces, the flood water source, the standard water source, duct tape, the Landform Vocabulary poster and the Standard Stream Table Set-Up poster.

From the measurement kit you'll need the hand lenses, the meter tapes, one liter containers, pitchers and basins. You need to provide water, the students Landform Journals, newspaper, a clock or a watch with a secondhand, scratch paper, paper towel and any other materials that students request for their investigations.

You'll need to make copies of the student sheets called Stream-Table Ideas, Stream-Table Plan, and Stream-Table Map. Have your Assessment Chart For Investigation 3 handy. You will need several sessions to complete this part.

Each group will decide on a variable they would like to explore. They may request materials that you do not have in the classroom. They may bring materials from home or they may be available in other parts of the school. During the second session, the students set up and carry out the investigation. They can also begin planning their presentation of their investigation plan and results.

During another session, each group gives their presentation during a scientific conference. This part can be used as a performance assessment. If you plan to do that, you need to think about it ahead of time. Make a copy of the Assessment Chart For Investigation 3 to carry with you as you talk to your students during the investigation.

Begin this session by asking students to think about the changes humans make to rivers and streams. The teacher asks the students why someone would want to build a home next a river and what kinds of problems someone who lives near a river might have. She also asks what are some of the changes people make to rivers and streams. The students' ideas include dams, levies and channels. She proposes that they plan a stream table investigation to find out how these changes affect rivers.

The first part of their challenge is to plan their investigation. They use the Stream-Table Plan sheet to do this. They also refer to the Stream-Table Ideas sheet for a subject for their investigation. The plan should include a materials list and a drawing of how they plan to set up their stream table. After the teacher approves the plan, the groups begin their investigations.

Student: Then it should go down there.

Student: Look.

Narrator: This group is investigating how a mountain affects the path a stream takes. This group is investigating the effect a dam has on a stream. This group is trying two waters sources at different locations in the stream table.

Student: Going this way.

Student: It's going this way.

Student: Three. Three streams.

Narrator: The channel really changes the behavior of the water. The dam also creates some changes.

Student: At least it's going slower.

Narrator: The mountain makes an interesting obstacle for the water. Each group confers to organize their results for a presentation to the rest of the class. They will need to report what they were trying to find out, how the investigation was designed, what happened and what conclusions they can draw. They should also include what they might do differently if they did this again. They can use all of their notes from their journals. Each group will have three minutes for their presentation. Here are some excerpts from their reports.

Student: We had a mountain. Then when we put the water on, it went both -- two separate ways.

Student: We did the houses along the channel. And it made three little streams. And it went through one of the houses and made another one on the side.

Student: We didn't use the cubes and we did the same project instead of doing a different project from the other -- from the other groups.

Teacher: Did you get a different result?

Student: Yes. Instead of letting it flow by itself, we had to make a little dam so it would flow.

Student: What we did is we took the cubes and put them in a line and then we poured the water and then it blocked it and then it was different because yesterday it went faster. But because of the blocks, it slowed it down.

Student: We made a mountain. And the results were it was different from yesterday because the water was going around the mountain. Like the mountain was a little dam. And it wasn't -- and the water wasn't even damaging the mountain.

Narrator: Plan to dry or store the earth materials for the next class and to clean the stream tables. Allow the materials to sit out in the stream tables until they are completely dry, then break up the earth materials and rebag it in plastic bags.

This is a good time to add extra powdered clay and sand to each bag, if necessary. How will you know it's necessary? Well, you might notice that there isn't as much material in the bag as you started with. Or when the last run-through happened, there wasn't much clay in the water in the basin. Or your students will say something to you.

At the end of this part, students should realize that models can be used to show what happens when humans try to change a river and humans can make changes to river channels that affect how the water flows. This brings us to the end of Investigation 3. Be sure to select several of the Interdisciplinary Extensions at the end of the folio for your students to do and have them do the math problem of the week before you move on.

<Investigation 4, Part 1>
Narrator: In this investigation, students use foam pieces to build a model of a mountain and then use the foam pieces to draw a topographic map. Here are the materials you'll need for this part: From the kit you'll need the foam mountain sets which consist of six foam pieces and one dowel in each set. You need to provide pencils, a permanent marking pen with a fine point and aluminum foil, which is actually optional.

Duplicate Student Sheet No. 15, Mountain Map. Make one copy of Assessment Chart For Investigation 4. If you're the first teacher to use this kit, you need to prepare the foam mountains by writing the elevations on each of the foam pieces in all of the foam mountain sets. To do this, it's very important to match each piece with the teacher sheet called Foam Mountain Topographic Map to make sure each piece is correctly oriented and right side up. Use a permanent marking pen to label each piece with its corresponding elevation. Put the label on the top surface at the edge so that when the mountain is assembled the elevation can be read.

Practice drawing a mountain map like this. First take the mountain apart. Then poke a pencil point through the hole in the layer in the top making sure that the side with the elevation label is up. Place the point of the pencil in the center circle on the mountain map. Then line up the foam piece so that the notch is on the black solid line between the circle and the letter B. Hold the foam piece securely and carefully trace around the outside edge of the foam.

You want to make sure you use pencil to do this. Pen will leave marks on the foam. Repeat this procedure for all six pieces of foam. The order doesn't matter. After you've traced all six pieces of foam, you'll need to label each line with the appropriate elevation.

Begin this part by recalling the maps the students made of the schoolyard in Investigation 1.

Teacher: Okay. Class, remember the other day when we made the models of the schoolyards? I want you to think about the maps that you made when you made the model of our school. We'll be making a different kind of model today. And these are the pieces of equipment you'll be using: Each group is going to get a set of foam pieces. In the set are pieces of different sizes. They are all the same thickness, though you can see that the sizes range from very large down to a fairly small piece.

You can tell the tops from the bottoms because the tops have numbers on them and bottoms are left blank. Also in your kit you'll get a piece of dowel. And this dowel will be used to connect these pieces together. When you're putting the pieces into the foam, you always want to put the dowel in from the bottom and push up. And you are going to start with the number that is the smallest and then go to the number that is the next smallest and so on until all of your pieces are put onto the dowel.

Then you need to look for a little notch. As you can see, there's a notch in the side of each foam piece. Your job is to line up the notches so they are all lined up all the way up the dowel.

Student: The lowest number from the biggest.

Student: I'm the starter.

Student: She's the starter. She's supposed to do it.

Student: So -- wait, you're putting that one on top.

Student: First we have to check for the notch for all of them.

Student: 13,500. 12,000.

Teacher: Okay. You've built a model. Who can tell me what the model is of?
Alex?

Student: A mountain.

Teacher: It is a mountain. Look at the model of your mountain. And I would like you to think of some ways that the model mountain is different from a real mountain.

Student: It's smaller and blue. And mountains are not blue.

Student: It doesn't really look like a mountain. A mountain doesn't have numbers.

Student: It doesn't have a stick sticking out.

Student: It doesn't come in plates.

Teacher: Okay. A real mountain doesn't come in plates like that, layers. Think about the shape of your model. Is there any other way that you can think that this model is different from a real mountain? Look at the shape and think about how this is different from what you would really see if you went out and looked at the mountains.
Michael?

Student: Mountains don't have layers like this going up. They are usually just like rocky but going straight up instead of like little gaps like stairs.

Teacher: Okay. In your model mountain I want to identify some features on the mountain. This bottom part here would be what we would consider the base of the mountain. That's the flat area you start at when you climb up the mountain. When you get to the very top of the mountain, the word we use for the top of the mountain is a peak, p-e-a-k, meaning the top of the mountain.

The distance between the bottom of the mountain and top of the mountain we call elevation. When you're driving along, you might see road signs that tell you the elevation of our town is a certain number of feet. Elevation refers to how high it is up.

So these are elevation marks you see located along each of the foam pieces. And these indicate the number of feet above sea level. If you think about the ocean as being flat and that's 0 feet, we measure everything above it in elevation above sea level. So if we are located at 200 feet above sea level, it means we're 200 feet above where the ocean would be.

All right. I would like you to look at your models right now. And take a look at the numbers as we go up each layer of the model. You may have to rotate it so people have a chance to see. What I would like for you to figure out is what is the distance -- what is the difference between each consecutive piece of foam? How many feet of change is represented from one layer to the next? How many feet of change is represented in each layer of foam?
Brian?

Student: 500.

Teacher: 500 what?

Student: Feet.

Teacher: 500 feet. Now what I would like you to do is take your foam model. And you may have to take turns doing this. But I want you to take your finger and trace along the path along the bottom layer. Pretend you're going for a walk along this mountain all the way around. And I want to think about how high above sea level you would be if you took a walk around the mountain. If you were to walk all the way around --

Narrator: The teacher explains if you travel all the way around the mountain on top of this layer, you will always be at 11,000 feet above sea level. She asks the students to take finger walks on different layers on the foam mountains and identify their elevations.

Teacher: Now we can use a model like this of a mountain to create a special kind of map. And that special kind of map shows elevation just like we have here in tour model. And that type of map is called a topographic map. Each of you has been given a piece of paper that looks like this. You're going to be using this to make a map of the mountain model that you already built.

The way you're going to do this is you're going to take the mountain apart. And you'll notice there's a hole here. That's going to be lined up with the dot on the paper here. What you're going to do is line up the dot and then make sure that the notch is lined up with the black line on the right. You can see the way I've done this having the dot and the hole lined up and the notch and the black line lined up.

Then what you're going to do is carefully trace around the outside of this piece. And when you're done with this piece, you pass it to your neighbor and you take another piece. And you'll repeat the same process. Line up the dot, line up the notch and trace. You'll continue this for all six pieces of your mountain. When you're done, of course you'll have six outlined shapes of different sizes on your map.

Narrator: The teacher explains the importance of labeling each elevation on both sides of the horizontal line on the map and shows the students where the elevation is labeled on the foam pieces.

Teacher: Yes. You have once over on this side and one over on this side.

Narrator: When the students have finished their topographic maps, their teacher asks them to reassemble their foam mountains.

Teacher: Now that you have finished rebuilding your mountains, I would like for you to make a comparison between the maps you've made and the mountain on your desk. Take a glance and see if you can see some similarities and differences between the two.

Student: The paper one is two dimensional and then the mountain is three dimensional. And this one is drawn and then this one is made.

Teacher: All right. What I would like for you to do is with your finger identify the highest place on the map that you've drawn. Put your finger on the place that represents the peak of the mountain, your finger on the place that represents the highest point. Now I would like you to put your finger on the place that indicates the base of the mountain. Remember the base is the bottom of the mountain, the lowest elevation of the mountain. Pick one of the places on your map. Good.

On the mountain that you made we talked about the difference between each level of the foam. Who remembers what the difference was between one level to the next in terms of elevation? Angelica?

Student: That there's 500 feet difference.

Teacher: Good.

Narrator: The teacher asks the students to fold their mountain maps along the A-B line so the bottom half of the sheet is visible. They need to check to see that the contour line labels are visible on the bottom half. The teacher asks the students which is the steeper side of the mountain.

Teacher: You'll see that the slope -- like my finger is showing -- is very steep. It would be very difficult for you to walk over a mountain that was this steep. On this side the slope is much more gentle. You can see that it does not go nearly so sharp as this side. This side goes much steeper. This side is a more gentle slope.

Narrator: The teacher asks the students to point to the steep side of the mountain on the map. This is more difficult. The teacher asks the students to compare the lines on the steep side to the lines on the other side and tell her what they notice about them.

Teacher: Jessica?

Student: That the lines are much closer together on the steep side than they are on the not so steep side.

Teacher: Yes, they are.

Narrator: The teacher reminds the students that the contour interval is the same whether the contour lines are close together or far apart. Contour lines that are close together represent a steep slope. She has the students notice that on the more gently sloped side of the mountain the lines are farther apart.

In this part, students learn that on a topographic map, contour lines show the shape and elevation of the land and close-together contour lines mean the slope is steep. Plan to check the Science Stories folio for some ideas for extending the investigations through reading and plan for time for your students to read the stories.

<Investigation 4, Part 2>
Narrator: In this part students use their topographic maps to produce two dimensional profiles or cross sections of their foam mountains. Here is what you'll need for this part: From the kit you'll need the foam mountain sets and the poster of Mt. Shasta. You will need to provide completed mountain maps from Part 1, pencils and an overhead transparency of the student sheet called Contours And Intervals. Duplicate Student Sheet No. 16, Profile, and Student Sheet No. 17, Contours And Intervals. Have Assessment Chart For Investigation 4 available.

Practice drawing a profile map. Fold the mountain map along Line A-B. Make sure the contour lines on the mountain map are labeled with the elevations. Write the contour line elevations at the left side of the profile sheet starting with 11,000 at the bottom. Line up the A-B line on the mountain map with the bottom line on the profile sheet. Find the two places where the 11,000 foot contour line crosses the horizontal 11,000 foot line on the profile. Use a pencil to put a mark at both intersections on the profile line.

Slide the folded mountain map to the line labeled 11,500 and mark where the contour line intersects its corresponding line in both places. Continue until all the points are marked like this. You'll notice that the elevation at 14,000 feet has been added over here. That's because the peak of Mt. Shasta is about 14,162 feet, which would be right about there. Now connect these points as smoothly as possible.

You can demonstrate this process to your students with transparencies of a completed mountain map and a profile. Cut the transparency of the mountain map in half and use the bottom half with the labeled contour lines for a demonstration on an overhead projector. Begin this part by showing your students the Mt. Shasta poster.

Teacher: The other day you made models of a mountain and you made a topographic map based on that model. I would like to show you today a picture of the actual mountain that those models are based on. And that is Mt. Shasta.

Narrator: The teacher explains that Mt. Shasta is a mountain in northern California. She points out that this is the side view we usually get of a mountain. She explains that the foam mountains are actually models of Mt. Shasta. The teacher introduces today's challenge, to make a profile of

Mt. Shasta using the mountain maps. She continues with a demonstration of how to do it.

Teacher: -- your mountain map to make a profile of the mountain. Now, as you know, a profile is sort of a sideways look at the shape of something. For example, this is the profile of your face. All right. The first thing that you are going to do is you're going to label the elevations where it says Contour Line Number. For example, we started out with 11,000 feet. The next interval we had was 11,500.

Narrator: When the students have labeled their profiles, the teacher continues.

Teacher: You're going to take your mountain map and you're going to lay it down against the profile map. Now, watch carefully what you're going to do. This is the contour line representing 11,000 feet. We're going to make a mark that indicates where the 11,000 feet crosses and put a dot in to represent the peak. Once you've done that step, you're ready to connect your dots. And all you need to do is connect the dots of the contour line and you'll see a profile of Mt. Shasta.

Narrator: When the students compare the profile with the side view of the foam mountain and with the poster, they realize that the profile gives a picture of what the slopes of the mountain look like. The teacher reviews with the students that the top of the mountain is called the peak. The bottom of the mountain is called the base. They can identify the steeper side of the mountain on the topographic map because the contour lines are closer together. The contour interval is 500 feet.

By the end of this part, students should understand that a profile gives you a side view of a landform such as a mountain. This is a good time for students to add ideas and questions to the Project Folder.

<Investigation 4, Part 3>
Narrator: In Part 3, students apply what they've learned to interpret a topographic map of the Foss Creek area, an imaginary place. Here is what you'll need for this part: From the kit you get the rulers. You need to supply a transparency of the Foss Creek Map. Duplicate Student Sheet 18 called Foss Creek Map, Student Sheet No. 16 called Profile and Student Sheet No. 19 called Response Sheet - Build A Mountain.
You should also make a transparency of the Student Sheet No. 18, the Foss Creek Map. Have Assessment Chart For Investigation 4 and teacher answer sheet called Foss Creek Map available.

Begin this part by distributing copies of the Foss Creek Map and rulers to your students. The teacher explains to the students that this map is of an imaginary place called Foss Creek. The elevations on this map are in meters. She explains the meaning of bench mark, intermittent stream and perennial stream. The students study the map and answer the questions at the top.

Teacher: Okay. To solve Problem 4, what I would like you to do is trace with your finger the Rocky River. As you can see, Rocky River is not starting exactly on a contour line but it's very close to this contour line right here. And that contour line represents 120 meters. So the Rocky River is very close to 120 meters here. As you can see, it crosses the 100 meter contour line. It crosses the 80 meter contour line. It crosses the 60 meter contour line. And it crosses the 40 meter contour line.

Now, think about this: Do you think the Rocky River is going from 120 meters to 100 meters to 80 meters to 60 meters to 40 meters or do you think the Rocky River is starting at 40 meters and going up to 60 meters, 80 meters, 100 meters and 120 meters? Alex?

Student: From 120 down to 40 meters.

Teacher: Why?

Student: Because a river can't go up.

Teacher: A river doesn't travel uphill. Good answer.
Question No. 6 asks you to draw a trail that's not very steep that you would use to walk from the dry lake to Lawrence Peak. Who can share an answer?

Student: This way because the closer the lines, the steeper it is. So I picked this way because the farther the lines, the easier to get up.

Teacher: Great explanation.

Narrator: Ask the students to draw a profile of Foss Creek. Review the process with them, if necessary. Then have them compare the profile they make of Foss Creek with the one they did for the foam mountain.

At the end of this part, students should understand that symbols and patterns represent landforms and structures on a map and a bench mark is a place where a surveyor has measured the elevation and location. This brings us to the end of Investigation 4. Be sure to select several of the Interdisciplinary Extensions for your students and have them do the math problem of the week before moving on.

<Investigation 5, Part 1>
Narrator: In this investigation, students work with USGS topographic maps and learn how to read their symbols. Here is what you'll need for Part 1: From the kit you'll need the foam mountain sets and the large topographic maps called Mt. Shasta California. You will need to supply the completed mountain maps from Investigation 4. Duplicate Student Sheet No. 20 called Topographic Map Symbols. Make one copy of Assessment Chart For Investigation 5. The maps and photos included in the kit are permanent equipment. You may want to have them laminated and ask students to be very careful with them.

When you look at the Mt. Shasta USGS topographic map, you'll notice there's a peak called Shastina. Shastina's peak is missing from the foam mountain. It could not easily be attached to the foam mountain so it was not included. Go over the steps in this part to become familiar with the features of the topographic map so you can show them to your students.

Here are some to look for. The brown directional arrow described in Step 2, the contour interval, the scale, road symbols and the location of this quadrangle in the state of California. Show the students the topographic map of Mt. Shasta and tell them this is an example of a map created by the U.S. Geological Survey.

Teacher: What you have in front of you now is called a topographic map.

Narrator: The students will notice it has many more details than the maps they have been using. One of the details the teacher points out is that Mt. Shasta is so tall that glaciers can be found on its peak. The teacher points out the brown arrow and explains on topographic maps north is always at the top of the map. She identifies which way is east, west and south.

The teacher asks the students what colors they see on the map and what they think the colors represent. The teacher then confirms that blue represents water features such as lakes, streams and rivers, brown represents land features such as contour lines and sand areas and lava, green represents areas covered by plants such as woods, scrub and swamps, black is used for elevations and for structures made by people such as roads, buildings, stands and campgrounds and red represents important roads and survey information such as freeways, county lines and park boundaries.

Students get a copy of the student sheet called Topographic Map Symbols. They try to locate as many of the symbols as they can on the map. They should be able to find crossed shovels for a quarry or gravel pit, dashed lines for 4 wheel drive roads, double dashed lines for unimproved roads, small blue circles with squiggly lines for springs, crosses and triangles with adjacent numbers for elevations and solid black squares for buildings.

Teacher: Okay. Who can remember what a contour interval is? We talked about that a couple of days ago.

Student: It's an elevation change between two contour lines.

Teacher: Good answer. I would like for you to look on this map and find out what the contour interval is. In other words, what is the distance, the change in elevation, between two lines?

Student: 40 feet, you guys.

Teacher: If you look at your map, you can see that there are dark brown lines occurring every five contour lines. These are called index contours. And the index contours are used to mark a place. Every time we have a 40 and a 40 and a 40 and a 40, they have an index contour.

Narrator: The students find the peak of Mt. Shasta on the maps and see the height is labeled at 14,162 feet. The teacher explains that the exact elevation has been measured by a surveyor. A metal disk called a bench mark is located here on Mt. Shasta. The spot on the map is also called a bench mark.

Teacher: At the bottom of your map you'll see a symbol for radio facilities.

Narrator: Next the teacher asks the students to find the radio facilities at the bottom center of the map.

Teacher: What I would like for you to do in your groups is figure out what the elevation of the radio facility is. You can use the index contours and the other contour lines to figure it out.

Student: Over here they look the same. So we should find the line that they are both on.

Student: They are both on it. So 92 plus 40 would be -- 92-40.

Narrator: After the students identify the elevation of the radio facility, ask them to find the elevation for the peak near North Gate, which is 7,915 feet, the elevation of Shastina, which is 12,330 feet and the elevation of Brewer Creek's headwaters, which is 10,080 feet. The students also identify ice fields and glaciers. They look for vegetation and find it below 8,800 feet in elevation. They identify the roads, trails and radio facility as evidence of human activity on the mountain. The students place the base of their foam models on the 11,000 foot contour line on the map and see the fit.

Teacher: Good job. Okay. I would like --

Narrator: Now the students attempt to find the Casaval Ridge on the map and model. After the students look for other valleys and ridges on the topographic map that match up with the foam mountain, the teacher describes the route to a mystery location. The teacher starts the hike at a small glacier located between 10,800 and 11,200 feet of elevation. She hikes southwest to the closest waterfall, which is located at 10,400 feet. She follows this contour west until she reaches the small lake. The teacher asks what the name of that lake is.

After they solve the mystery, the teacher challenges each group to come up with a set of clues for a route to a mystery spot on the map to present to the rest of the class. You'll find the rules in the Teacher Guide. Review the Content/Inquiry chart and help students make connections between content on the chart and the investigation they just did. Be sure to check the Science Stories folio for ideas for extending the investigation through reading.

<Investigation 5, Part 2>

Narrator: In Part 2, students compare an aerial photograph of Mt. Shasta to the topographic map and foam mountain. Here is what you'll need for this part: From the kit you'll get the topographic maps of Mt. Shasta, large photographs called Mt. Shasta that are about the same scale as the Mt. Shasta topographic maps and which you'll use first and small photographs of Mt. Shasta, which you'll use later. From the measurement kit you'll need hand lenses. Duplicate Student Sheet No. 21 called Mt. Shasta Questions and Student Sheet No. 22 called Response Sheet - Bird's-Eye view. Have Assessment Chart For Investigation 5 available.

You can get copies of topographic maps for your local area from the US Geological Survey. Have your local latitude and longitude ready when you call, write or check their web site for more information. You can find more information in the resource list in this Teacher Guide.

Begin this session by showing students a copy of the large aerial photograph of Mt. Shasta. The teacher explains that before computers and other technology were available, surveyors would use the aerial photographs as a base for ground surveys. They would make measurements of specific points in an area and record their measurements on the aerial photographs.
Cartographers would use these measurements to draw the topographic maps.

Today aerial photographs are digitized and used for a base for topographic maps created on computers. The students use Shastina, the peak of Mt. Shasta, Wintun Glacier, North Gate and other landmarks to line up the topographic map, the photograph and the foam model. The teacher demonstrates how students can use the topographic map to identify features on the photograph.

Teacher: You'll want to know what is this. One way you can find it out is by looking underneath and finding out what is that there. There are some names that go with some of the things that might interest you.

Student: Let's figure out what that is.

Student: Oh, that's a creek.

Student: Cool.

Student: Oh, yeah. You can see it because see.

Student: Yeah, you can see it.

Student: And then here's a creek right here, too.

Narrator: The students use a small Mt. Shasta photo to answer the questions on the Mt. Shasta Questions Student Sheet. It's a good idea to review vocabulary at this point.

In this part, the students learn that aerial photographs are used by surveyors to record measurements and cartographers use aerial photos as a base for topographic maps. Your students probably have lots of questions and ideas right now that you could add to the Project Folder. Encourage them to write the ideas down on paper and put them in the folder.

<Investigation 5, Part 3>
Narrator: In Part 3, students look at aerial photographs of Death Valley and the Grand Canyon and compare them to their corresponding topographic maps. Here is what you'll need for this part: From the kit you'll need the small Grand Canyon photographs and the bright angel topographic maps, which include part of the Grand Canyon, the small Death Valley photographs and the Furnace Creek topographic map, which includes part of Death Valley. You'll also need the poster of the Grand Canyon.

If you plan to have your students draw the optional landforms map, you'll need these materials: From the kit the small Mt. Shasta photographs, the Mt. Shasta topographic maps, overlay grids and the overhead transparency pens. From the measurement kit you'll need hand lenses. You'll need to provide colored pencils, paper clips, and extra overhead transparency markers, if you have them available.
Duplicate Student Sheet No. 23 called Death Valley Questions, Student Sheet 24 called Grand Canyon Questions and Student Sheet No. 5 called the Map Grid. Have Assessment Chart For Investigation 5 available.

This part could be used as an assessment. The students can work alone or in pairs. Plan to have time to discuss the sheets with them and consult the assessment folio for the scoring guide.

Familiarize yourself with the locations on the topographic maps and the photographs.

In Part 3, students work with two topographic maps and two aerial photographs. These photos and maps were chosen because they include features similar to the ones students saw on their stream table investigations. For example, on the Furnace Creek map and photograph, they can see a nice example of an alluvial fan. On the Grand Canyon map and photograph, they can see the Grand Canyon.

There are two copies of each of these maps and two copies of their corresponding photographs. This will allow you to set up four map stations. A map station consists of one map and its photograph and the hand lens.

Begin the session by telling the students that you have more topographic maps and aerial photographs for them to study.

Student: I think that's probably the Grand Canyon.

Narrator: After the teacher distributes the student sheets, she reviews vocabulary that will help the students do this part. In pairs or in groups of four, the students visit each station.

Student: The M shaped ditch; the M shaped ditch.

Student: Okay. We'll put . . .

Student: Highways.

Teacher: So what do we see that might have come from humans?

Student: Right here. This looks like a path.

Teacher: Yeah. A trail. Park service, training center, gravel pit.

Student: Oh, gravel pit.

Teacher: Sewage disposal.

Narrator: As an optional activity, the students may use the overlay grids and Map Grid sheets to draw a landform map using a process similar to the one they used to make a schoolyard map in Investigation 1. This activity is a good way to bring together many of the concepts students have learned in the Landforms module. To draw the maps, students secure an overlay grid over one of the photographs with paper clips. They then trace and label important features of the land, including mountain peaks, edges of canyons, alluvial fans and channels or streams. When the students have finished their overlay grids, distribute the paper map grids. Review how to transfer the information from their overlay grids to the paper grids.

Through these investigations students have developed map reading and photo interpretation skills with USGS maps and aerial photographs. They should now be able to use these skills to begin interpreting any topographic map or aerial photograph they encounter and to visualize the landforms represented.

<Investigation 5, Part 4>
Narrator: In the last part of this module, students work on their own investigations. As they work through their investigations, you will gain insight into their understanding of these earth science concepts. This is the time to bring out the project ideas folder. As much as possible you want students to use their own ideas and investigate the questions they have come up with during the module. If you don't have enough ideas in the Project Folder for everyone to investigate, you can use the project ideas sheet to help students think about more investigations.

The project plan sheet should be completed by each student or team of students doing a project. This sheet helps you control materials and keep tabs on what the students are working on. You will need to decide whether or not you will be able to supply any additional equipment the students ask for. You will also want to make sure that the projects the students propose are realistic and will be of some benefit to the class.

FOSS suggests students give three-minute presentations following the guidelines on the Presentation Guidelines sheets. They can also make a poster to help them explain their investigation to the class. You should plan on about two weeks for your students to do their projects. You can allow for some time in class or suggest to the students that they do some of the work at home.

The Assessment folio has suggestions for scoring the students' work on the projects. Also in the folio you will find information and masters for two kinds of summative assessments: An end-of-module test given in a variety of formats and suggestions for assembling portfolios.

This is the end of the Landforms module. I hope that you and your students enjoy the hands-on experience you had with landforms and maps in this module and that the insights gained from the investigations encourage your students to appreciate the shapes and forms of the earth's surface even more.