



Soil Engineers: Animals Above Ground



STEM CONNECTIONS

Science: Ecosystem Dynamics

Engineering: Developing Possible Solutions



DURATION

60 Minutes

OBJECTIVE

Engineer beaver dams and swallow nests using natural materials.

SCHEDULE

- Dirt Camp Storyline Introduction (5 minutes)
- Build a Beaver Dam Engineering Challenge (25 minutes)
- Build a Swallow Nest Engineering Challenge (20 minutes)
- Wrap-Up and Cleanup (10 minutes)

ALIGNED STANDARDS

Next Generation Science Standards (NGSS):

K-2-ETS1-1: Engineering Design

K-2-ETS1-2: Engineering Design

K-2-ETS1-3: Engineering Design

1-LS1-1: Structure and Function

2-PS1-2: Analyzing Properties of Matter

3-LS4-4: Ecosystem Dynamics

21ST CENTURY SKILLS

- Information, Media, and Technology Literacy
- Leadership and Responsibility

HABITS OF MIND

- Creating, Imagining, and Innovating



MATERIALS

- **Dirt Journal pages** (1 per student):
 - **Dirtflection** (optional)
- **Dirt Camp Daily Slides** (optional but recommended)
- **Paper Plates** (2 per group)
- **Pitchers of Water** (1 per group)
- **Plastic Tablecloths** (1 per group)
- **Popsicle Sticks** (1 per student)
- **Resealable Plastic Bags** (1 per group)
- **Spoons** (1 per student)
- **Vegetation & Sticks** (gathered by campers)
- **16 Fl Oz Deli Containers** (2 per group)
- **Dirt Boxes** (1 per group plus 1 extra)
- **Pea Gravel**



DIRT MANAGEMENT

Use the included measuring cup to prepare materials ahead of time.

For the Build a Beaver Dam Engineering Challenge, each group needs:

- **1 Deli Container filled with ¼ cup pea gravel**
- **1 empty Deli Container**

DAILY PREP

1. Cover the tables or floor with the provided plastic tablecloths.
2. Fill Deli Containers as described in the Dirt Management section above.
3. Ask your campers to collect beaver dam building supplies such as small sticks or dry grass. They can also use extra popsicle sticks if natural materials are not available. Any leftover vegetation from previous days can also be used for this activity.

4. Test the videos below before introducing them to your learners to make sure your site's systems aren't running any interference with the hosting platform. These links are also found in the Daily Slides.

How Do Beavers Build Dams? - Nature on PBS
<https://www.youtube.com/watch?v=82DiWd7KGt0>

Cliff Swallow Nests - Cornell Lab of Ornithology
<https://youtu.be/tQ0IP8kSwcA>

Dirt Camp Day 07 - PCS Edventures
<https://edventures.com/dirt-camp-tutorials>

KEY TERMS

Beaver Dam: Beavers use sticks and other materials to build dams that block the flow of moving water.



Beaver Lodge: A beaver lodge is a hut-like structure that beavers build out of vegetation in the deep pool that forms behind the dam. This helps protect beavers from predators, and keeps the beavers and their offspring warm and dry. A beaver lodge is another name for a beaver home. Lodges have openings that are underwater, but the living area is above water.



Swallows: Swallows are a type of bird that catch and feed on insects while in flight. There are many different kinds of swallows. Most swallows build their nest out of mud. The mud is rolled into small balls and stacked in layers.

BACKGROUND INFORMATION

In Day 7 of Dirt Camp, campers learn how two animals, beavers and swallows, use dirt to engineer dams and nests.

Beavers are nature's top engineers. They can transform forests into wetlands and can't help but jump into action when they hear running water. They continuously search for trees to chomp down — which they can do rather quickly. Using their sharp incisor teeth, beavers can fell a large tree in minutes and drag it into the water. Beavers fashion dams out of logs, branches, mud, stones and anything else they can find. Beavers build dams across streams, creeks and narrow rivers. The largest dam is estimated to be 850 meters across!

Why do beavers build dams? Beavers build their dams to slow down running water, creating a pond of deep, quiet water. In the middle of the new pond, beavers build their home, called a lodge. This lodge provides the beavers with protection from predators like coyotes and humans. The lodges also keep the beavers warm and dry during the winter months with underwater entryways that they swim in and out of. The underwater entryways are where beavers raise their babies and teach them how to build their own dams and lodges. Beavers work tirelessly to build and maintain their structures.

The work of a beaver never seems to be done. Whether it's building a dam or a lodge, beavers seem to always be on the move. There are repairs and upgrades to be made, trees to be cut and food to be stored. The pond raises the water table and attracts a wide variety of wildlife, often increasing the biodiversity in the area. The pond also traps soil and pollutants that have been eroded. The areas around the pond become very fertile and are highly prized by farmers.

Below the dam, the water is slowed, preventing further erosion. During times of high rainfalls, the dams help decrease flooding. In times of drought, dams are beneficial as they slowly release water downstream. Dams are often removed when they are viewed as problematic. Sometimes, dams create flooding upstream, which can be bad if buildings or roads are nearby. As the pond fills up, the soil becomes saturated with water, drowning a lot of plants. Homeowners may also view beavers as problematic because they chew the bark off of trees for food and cut trees down for their dams.

...But is this really a problem?

Once found in every waterway across most of the United States and Canada, beaver populations were greatly reduced due to the fur trade. In recent years, however, they've made a comeback. Scientists, ecologists and even farmers are learning just how important beavers are to the ecosystem. As the role of beaver dams becomes more understood, some farmers are actually requesting beavers not to be removed from their property but instead to be reintroduced. For farmers stuck on the waiting list, ecologists are even engineering earthen "beaver dam analogs" inspired by the work of nature's top engineers.

Another soil engineer helpful to ecosystems is the swallow. Swallows can be found in the same habitat as beavers. These slender birds are built for high-flying aeronautics. Gliding through the air, they swoop, turn and roll in chase of flying insects. With weak feet, swallows don't perch like many other birds but instead catch and eat their meals on the fly.



There are different kinds of swallows, but they all use dirt to build their nests. Building nests using mud is not uncommon in the bird world. Robins, for example, use their beaks to collect sticks and other vegetation to create a cup-shaped nest. Mud is then added to reinforce the nest. Swallows, however, have a unique engineering strategy: they use their beaks to roll muddy sand, silt and clay into balls. Vegetation is added to the mud ball as it is rolled. The swallows then fly the balls back to the nesting area, which usually consists of some type of overhang such as a roof or cliff. They start by building a platform to stand on, and then build the nest layer by layer. Small holes are filled in with extra mud. A completed nest may contain 1000 mud pellets!

Each kind of swallow has its own building style and location preference. Some swallows build a nest that looks like a cup. Others build a nest that looks like a small cave. Some swallows, such as the Barn Swallow, nest in isolation from other swallows. But other types of swallows, such as the Cliff or Tree Swallow, nest in colonies, offering protection from predators and free babysitting services. Whatever their nesting habits, both the male and female work together to make the perfect nest to raise their babies, even adding a cozy lining of feathers and vegetation.

STEP-BY-STEP DIRECTIONS FOR INSTRUCTORS



Whole Group

DIRT CAMP STORYLINE INTRODUCTION

Welcome learners to Day 7! Continue with the storyline to get your campers thinking about the relationships between animals and humans:



You were hoping to sleep in this morning, but the swallows had a different idea. A few weeks ago, you noticed the swallows building a nest above your window. Visiting small puddles, the swallows would use their beaks to roll up a ball of mud and fly back to your window. In the corner, the swallows built their nest, one mud ball at a time. At first, it was one pair of swallows but then another came and another and by the end of the week, there was a colony of swallows with at least five nests!

Even before the sun began to rise, the swallows began chirping, announcing their presence and greeting the morning. The baby swallows were hungry and chirped loudly for food. The parents took turns bringing back a breakfast of flying insects they caught while swooping, gliding and rolling through the air. This continued until the chicks were full, but by this time you had given up on sleeping.

Reluctantly, you get out of bed and grab your own breakfast, minus the flying insects. You head outside to begin your day, walking the property, making repairs and checking on your fields. There is a small stream that crisscrosses your farm. Along the edges, you discover trees that have been gnawed down. No doubt the work of beavers. You walk upstream and discover that the stream has been dammed. Logs, sticks and vegetation are woven together and packed with mud, creating a dam that spans the width of the stream.

The swallows aren't the only early-risers. The dam has backed up the stream, creating a deep pond. The edges of the stream overflow the banks and bring many animals to the edge. Deer graze on the lush grass and squirrels search for seeds in the now water-logged soil. Muskrats swim playfully in the pond, diving underwater and then popping back up in the distance.

The deep pond created behind the dam creates a sanctuary for these busy beavers. Safely tucked inside their lodge, the beaver family begins to emerge. First, one beaver pops its head above water, then another. Suddenly you hear a loud THUMP and see a splash of water. One of the beavers spots you and warns the others of danger. Or, maybe it's just saying good morning. Either way, you keep walking. You know how beneficial beavers are to the land and are thankful they chose your property to build a dam on.



After setting the scene, get campers thinking about a farmer's relationship with animals like beavers and swallows. Are they helpful to farmers and people overall or are they a problem? Should people reconsider their relationship with animals and the land?

Based on what you have learned in Dirt Camp so far, are beaver dams good or bad? Why?

Why are they good or bad for the soil?

To lead into the upcoming engineering challenge, share some fun facts about beavers with your campers. Then, show the following clip about how beavers build their dams.

How Do Beavers Build Dams? - Nature on PBS
<https://www.youtube.com/watch?v=82DiWd7KGt0>



Small Groups

BUILD A BEAVER DAM ENGINEERING CHALLENGE

For this activity, campers must use their engineering skills to build beaver dams! Start by introducing the challenge to the group:

Weathering is constantly occurring. Water and erosion create river channels, which are perfect for beavers because they need running water to build their dams.

Today, imagine your Dirt Box is part of a river channel. Your challenge is to build a beaver dam across the river. Remember what you saw the beavers do in the video and use rocks, sticks and vegetation to build your dam. Seal any spaces with mud like the beavers do.

To get started, carefully empty your Dirt Box into the big plastic bag to keep most of your soil dry for the next activity.

If your campers need some ideas to get started, check out the step-by-step instructions at the end of this lesson. Encourage each group to work together as a colony of beavers, taking turns being leaders and builders.


Give your campers about ten minutes to work on their dams then ask each group to test their design by gently pouring water at one end of the Dirt Box to act as the beginning of the river. Watch the water move toward the dam. Does your dam successfully block the flow of water?

Then, ask campers to reflect on their beaver dam building experience.


- What happened? Was your dam successful? Why or why not?
- Did your dam stop most of the water? Was there a small pool (pond) behind the dam? (Some water will still go through the dam, and that is okay. Remind campers that beaver dams do not completely stop the flow of water and that behind the dam, a small pool should form.)

BEAVER DAM STEP-BY-STEP DIRECTIONS


<p>Group Materials:</p> <ul style="list-style-type: none"> • 1 Dirt Box • 1 Empty Deli Container • 1 Deli Container filled with 1/4 cup pea gravel • 1 Pitcher of Water • 1 Resealable Bag (to store soil in during the challenge) • Any lava rocks already in the Dirt Box • Sticks and Vegetation Gathered 	<p>Individual Materials:</p> <ul style="list-style-type: none"> • Popsicle Sticks (1 per person) • Spoons (1 per person)
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1
Make a bundle of sticks. Pretend they are legs. Wrap grass or other vegetation around the sticks.



2
Place the bundle of sticks and grass across an empty Dirt Box. Add rocks to keep the dam in place across the river channel.



3
Add any last vegetation to make the dam strong and to fill any gaps.



4
Make a sticky mud mixture in a Deli Container to plug holes in the dam like a beaver does.

- Let's think about ways we can improve our beaver dams. Beavers are constantly working on their dams, keep working as a team to perfect yours.

Spend ten more minutes improving the beaver dams. Then, ask everyone to gather around each one and watch what happens when water is poured into the river. Encourage each group to briefly describe their engineering design.

To transition groups to the next engineering challenge, dump testing water into an extra Dirt Box. Set aside the wet vegetation and Deli Container of mud until the end of class. Before starting the engineering challenge, pour the dirt from the plastic bag back into the Dirt Boxes.



Group Discussion

BUILD A SWALLOW NEST ENGINEERING CHALLENGE

For this activity, campers use their spoons and hands to build swallow nests.

Orient campers to how swallows engineer their nests with the following video clip. This type of swallow is called a Barn Swallow. Ask your learners what they notice about the swallows' building techniques. How can we copy their ways of building? Share information about swallow nests with your learners before viewing the video below.

Cliff Swallow Nests - Cornell Lab of Ornithology
<https://youtu.be/tQ0IP8kSwcA>



Small Groups

Now that you've seen how the swallows do it, it's your turn to build swallow nests. Each group can build two nests, each on its own paper plate. Review the step-by-step instructions at the end of this lesson or watch the video tutorial at <https://edventures.com/dirt-camp-tutorials> to prepare your campers to start building!

Tips:

- The paper plates serve as mounts for the nests, so make sure learners understand that they are building the nests on their sides. When the nests dry, they can hang vertically as they would in nature.
- Place the paper plates next to the Dirt Box and a Deli Container with water. Start by building the nest in a V-shape with mud balls. Then start filling in the bottom of the nest or "platform" like swallows do. Make sure the nest is built out from the V-shape in a rounded manner and is kept moist throughout the building process to avoid cracking or collapse. Learners may need to periodically dip their hands in water to do so. The finished nest should look like half of a cone shape.


SWALLOW NEST STEP-BY-STEP DIRECTIONS

Group Materials:


- 1 Dirt Box
- 1 Deli Container of Water
- 2 Paper Plates — for making 2 nests

Individual Materials:

- Spoons (1 per person)



1
Pour some water into the Dirt Box to make small mud balls.



2
Make a V-shape on the paper plate with mud. Press and shape the mud securely onto the plate.

- It does work better to use larger mud balls or chunks vs. the typical pellets that swallows use. Campers may use pellet shapes but the activity will take longer and the overall structure must be smoothed out anyway for a successful build.

Allow 15 minutes for campers to build their nests. Afterwards, ask each group to share their design and talk about their engineering techniques.



Whole Group

WRAP-UP AND CLEANUP

- Dump the Deli Containers of wet soil used in the building of the beaver dams back into the Dirt Boxes.
- Throw away the wet vegetation and dirty paper plates.
- Allow the swallow nests to dry overnight.
- Save all other materials for future lessons.

CHECK FOR UNDERSTANDING

- What are some examples of animals that are considered soil engineers? (*Examples include the moles, crayfish, tortoises, beavers and swallows that have been discussed in camp.*)
- How do different animals use soil? (*Animals use soil in a variety of different ways, including as a home, a shelter, a place to find food or as a building material.*)

EXTENSIONS

Beaver Dam and Swallow Nest Extensions

If you have just a little extra time, watch the extra videos below with your campers. They are great resources to show how beavers and swallows use dirt and other natural items to engineer dams and nests.

Beaver Lodge Construction Squad - Attenborough - BBC Earth

<https://youtu.be/iyNA62FrKCE>

How Do Swallows Build Their Mud Pellet Nests? - The Kid Should See This

<https://thekidshouldseethis.com/post/how-do-cliff-swallows-build-their-mud-pellet-nests>

Five Busy Beavers

For additional context, read even a portion of this book to campers. It is short and describes how beavers build their dams. Then ask learners to draw the beavers' dam and lodge.

Five Busy Beavers - The Reel Read Kidz Corner

<https://www.youtube.com/watch?v=1Tz46vzPDwE>

Parachuting Beavers

Here is a great video from the 1950s. Beavers were relocated from a town in Idaho by plane dropped high into the backcountry by parachutes. The beavers were removed because they were viewed as problematic but once the beavers repopulated streams in the backcountry, the health of the ecosystem greatly improved. Write a story about the adventures of Geronimo, one of the beavers that was relocated.

Newly discovered video of parachuting beavers - CBSN
<https://youtu.be/snbTtuDCT6w>

Researching Soil Engineers

There are endless examples of animals that are soil engineers (termites, parrots, dung beetles, wolves, and many more). Research different animals that use soil or dirt to build structures and ask learners to build one of these structures.



BEAVER DAM STEP-BY-STEP DIRECTIONS

Group Materials:

- 1 Dirt Box
- 1 Empty Deli Container
- 1 Deli Container filled with $\frac{1}{4}$ cup pea gravel
- 1 Pitcher of Water
- 1 Resealable Bag (to store soil in during the challenge)
- Any lava rocks already in the Dirt Box
- Sticks and Vegetation Gathered

Individual Materials:

- Popsicle Sticks (1 per person)
- Spoons (1 per person)



1
Make a bundle of sticks. Pretend they are logs. Wrap grass or other vegetation around the sticks.



2
Place the bundle of sticks and grass across an empty Dirt Box. Add rocks to keep the dam in place across the river channel.



3
Add any last vegetation to make the dam strong and to fill any gaps.



4
Make a sticky mud mixture in a Deli Container to plug holes in the dam like a beaver does.



5
Add any last sticks or vegetation before testing your design with water.



6
Test your beaver dam with water like in a real river. Does your design keep the water out? Does a pond form? If it leaks, try a new design!

SWALLOW NEST STEP-BY-STEP DIRECTIONS

Group Materials:

- 1 Dirt Box
- 1 Deli Container of Water
- 2 Paper Plates — for making 2 nests

Individual Materials:

- Spoons (1 per person)



1
Pour some water into the Dirt Box to make small mud balls.



2
Make a V-shape on the paper plate with mud. Press and shape the mud securely onto the plate.



3

Fill in the V-shape starting at the bottom. This is the platform that the swallow makes first.



4

Keep the mud moist so you can keep forming it into a rounded shape or cone.



5

Press in the sides of the nest to make sure they are rounded and strong. Smooth out any bumps.



6

Proudly hold your nest vertically. Pretend it's hanging from a barn or the side of a cliff just like a real swallow nest!

