Heath School Area
Geology and Civil Engineering Walking Tour
Teacher's Guide

Materials:

1 Compass
Student Maps
Students Tables and Note Sheets (made in class before the tour)
Clipboards/something hard to take notes on
Pencils/Pens
Index Cards (premade)

Instructions:

Each of the 16 stops on this walking tour has at least one index card to go along with it (there may be multiple index cards per stop). There are *concept* index cards that do not have stops assigned to them. The teacher should place them into the tour at his/her own discretion (we suggest either reading them before the tour starts or along streets where there are not many stops).

Before the tour begins, the teacher should distribute maps and index cards to students (students should already have their tables that they made in a previous class.

Students should follow the tour on their map and read their index card, when they arrive at the appropriate stop. After the card is read, the teacher may lead a small discussion about what was just read, and in some places perform a demonstration. Students should take notes at each stop on their maps and tables.

There should be at least on compass that is taken on the trip. During the tour, the students should pass the compass around, and during a free moment, they should locate north and plot it on their maps (this information will be used when they are divided into groups to make their big maps).

Stops and Their Index Cards:

1. Floor in main lobby and front hallway of the school

Floor
Look carefully at the floor in the main lobby/hallway. This type of rock is called slate. Slate is a very common building material, and is readily found in the Appalachian Mountains. Slate is formed in flat layers. Why do you think the layers in the hall are not completely flat? Why might a builder use slate for a floor?

Slate is a metamorphic rock formed by low grade metamorphism of mudstone that has been highly compressed deep underground. Slate is generally found at the base of very old mountain chains such as the Appalachians. It is varied in color with dark grey, purple or greenish grey being the most common colors. When wet, it often appears black. Historically, it has been used as a roofing material because it is both waterproof and breaks easily in layers. This also makes it useful for paths. It is less often used as a flooring material because constant walking can cause breaks. Note that the floor here at Heath has been heavily sealed.

2. Begin at the main entrance to school

Low Walls in front of School

The low stone walls around the entrance are made of blocks of granite.

How do you think granite forms?
Why do you think the walls are made of multiple pieces as opposed to one big block?
Why do you think an engineer would choose granite for this wall?

Granite is an igneous rock. Granite forms when molten rock intrudes into the earth's crust and cools. Sometimes granite is coarse grained and you can see all the minerals in it; sometimes it is fine grained. Coarse grained granite occurs when the cooling is slow, and fine grained granite occurs when cooling occurs quickly. This is because slow cooling allows minerals to have time to rearrange and group together, where as if the rock is cooled quickly the minerals don't have time to rearrange; they become solidified in place without time for rearrangement (for example if the students were given 1 minute to line up alphabetically, at the end of 1 minute they probably wouldn't be very organized, but if they had 10 minutes, they could probably organize).

The walls are made of multiple pieces because this stone was quarried and transported.

Granite is more resistant to weathering than limestone or sandstone, so it makes a sturdier building material.

3. Look at the walls of the school itself around the entrance.

Walls of School at Main Entrance

Observe the walls of the school around the main entrance.

What type of building material do you think was used?
Do you think this is natural rock facing or some sort of man-made material?
What is your evidence one way or another?
Why do you think an engineer or designer would decide to use this building material?

The walls of the school are faced with a type of concrete that has small rocks embedded in it. By simply looking at the face, it may be difficult to distinguish the concrete from a *conglomerate*, a type of sedimentary rock with fine and coarse particles mixed. But close inspection reveals that the small rocks are only present in the front – look at the side of the facing near a door frame and you'll see that deeper into the material it's just the concrete itself.

The facing is placed on a building mainly to cover and protect the walls underneath, and the choice of material is often about the appearance. Concrete is a relatively inexpensive building material that can easily be shaped into smooth flat blocks or tiles. The drawback to using concrete is that it probably weathers more quickly than natural stone facing.

Consider the cost to the builders if they had decided to create real stone facing – the stone would need to be quarried, cut and polished. Would the appearance be that much more beautiful? Would it be worth the cost, particularly for a school building which is built with public money?

4. Large boulders in playground area.

Large Boulders in Playground Area

Look carefully at the two boulders near the playground. These are both igneous rocks (probably granite).

Given that this area does not have a lot of igneous rocks, how do you think these boulders got here?

Given that there is no source of igneous rocks in this area, the rocks must have formed far away. It's possible that rocks of this size could have been moved by glaciers – as glaciers melted, refroze, and moved, enormous amounts of material were transported quite far.

If they were transported here by the glaciers, they would have been buried in the ground by thousands of years of erosion and soil. The hill behind the school is what's known as a "drumlin" – a hill of debris left behind by a glacier. If the rock was in the hill, it is what is known as an "erratic" – a rock that doesn't match the features of the rocks in the area.

When the hill was excavated to build the school, perhaps these boulders were uncovered and left as a place to play.

(It's also possible that the rocks were literally trucked in.)

The rock looks like it's probably a type of granite, but it's too hard to tell given the amount of weathering on the rock. We'd need to take a sample of the rock and look inside to be able to tell for sure.

5. Brick wall near the gym.

Brick Wall

Observe the bricks on the wall of the gym.

How many different types of bricks can you observe?
Why do you think some of the purple bricks are bubbly?
How does the cement between the bricks compare to the cement in the front of the school?
Look at the seams between the brick wall and the door – what do you notice? Why is that rubber seam there?

There are several different colors of bricks. Some of them may have been painted, but probably they are made from slightly different materials. The choice of color is entirely for aesthetic reasons. You probably notice that the different bricks weather differently, probably due to the differences in the materials used to make the bricks. Perhaps the purple bricks are reacting more quickly to the effects of water.

The cement between the bricks is much coarser grained than the cement in the front of the school. This may lead to faster erosion of the cement – the larger grains may be more likely to pop out, weakening the cement more quickly. You can see lots of evidence of erosion on this wall.

The rubber seam is there to allow for expansion and contraction of the wall and doorway. Otherwise in the winter a gap may appear as the wall gets colder and shrinks. Rubber is used since it is an elastic material.

6. Drainage in Playground area.

Drainage in Playground Area

Look carefully at slope of the hill.

How effectively do you think water would run down the hill during a rainstorm?
What features have been designed to help keep water from pooling in the playground area?

The hill itself has probably been excavated to keep water from flowing into the school. There is a drainage cover at the lowest point on the asphalt playground. Also drainage pipes are visible in the retaining wall behind the far basketball court.

7. Retaining Wall behind Basketball court

Retaining Wall behind Basketball Court

Look carefully at the Retaining Wall.
What is its purpose?
What evidence of weathering can you observe?

Why are there drainage pipes in the wall? What might happen if they weren't there?

Notice the hole in the concrete wall above the metal post.
What do you think caused that hole?
What function does the hole serve?

The retaining wall's purpose is to keep the hill from eroding into the playground. It must hold back an enormous amount of earth plus water. You can see drainage pipes to allow water to flow through the wall – this

is critical, because the pressure of water-saturated soil could weaken this wall very quickly.

You can see plants growing in between cracks and seams. As the plants grow they can help weaken the wall as well. Also there are numerous cracks in the wall.

Some of the concrete has come off the platform just to the right of the retaining wall, which is further evidence of weathering. You can see a bit of exposed iron which is rusting. The iron is the piece that really holds up the structure – the purpose of the concrete is mainly to protect the iron from rusting and for aesthetics.

It appears as though the hole in the upper wall was created purposely to allow drainage. You can see the way the lines are in the platform that it was designed so that water would run off away from the school. But, from years of settling, the water has begun to pool in that corner. This is clear if you walk up to the platform. The hole allows the water to drain down and not pool on the platform.

8. Looking carefully at the hill that Heath is built into. Walk behind the school to the parking lot. Go over right behind the Kindergarten playground and observe the features of the hill.

The Hill

Do you think the hill was altered in any way, or was the school just put in where there was space in the hill?
What clues are there that there might have been changes made to the hill?

The hill has clearly been changed quite a bit – by looking at the contours of the hill on either side of the school, you can see that the hill used to be a gently sloping hill. It wouldn't make sense for there to be such an abrupt change in the contours of a hill in this area without evidence of serious erosion from a stream or river, which there isn't here.

The hill was excavated to nestle the school into it. The kindergarten playground hill was probably made from fill excavated when the school was built.

9. Start walking down Reservoir Road. Stop at #155 – first house on the right. The next several stops ask the students to look at building materials at houses along the road.

155 Reservoir Road

Look at the effects of decay on the wood structures on the house.
How many different decaying elements can you spot – what are their causes?
Why do you think you see more sagging of the roof in the middle than on the sides?

While wood is a cheap and readily available building material in this area, it is prone to rot. If water gets into the wood, decomposers will eat at the wood and it weakens. You can see many examples of wood that is rotting and warping.

Also, houses settle as a result of shifts in soil, movement of cars and trucks along the street, and movement within the house itself. This movement of the house is not uniform – different parts of the house will settle more than others. Since there is less to support the roof in the middle, you will generally see more settling and sagging in the middle of a house than on the sides.

The main reason people paint the wood or put siding on it is to protect the wood inside from decaying. You may notice that where paint has peeled more you often see more evidence of decay underneath.

10. 161 Reservoir Road

161 Reservoir Road

Look at the different building materials used on this house.
What is there purpose?
What do you think the house is made of (underneath the siding)? What's your evidence? Why does this make sense?

Look at the roof – why do you think this type of roofing was chosen? Why are the roofing tiles laid out the way they are?

This house has several examples of different building materials. Part of the house is sided with brick and part is sided with wood. There are very few houses in this area that are entirely made of brick – most are faced with brick but made with wood. In this part of the country, wood is a very cheap and readily available building material.

There are advantages and disadvantages to every choice of building material. If there was an earthquake, a wood house is much more likely to remain standing than a house made completely from brick. On the other hand, a wood house would be more susceptible to fire.

The roof is a slate roof. Slate is a metamorphic rock that has a very smooth surface. By overlapping the tiles as they slope down, water will easily run off the slate helping to keep the roof sealed from water. It is more common these days for people to use asphalt roofing shingles, which are much cheaper. Slate is considered more durable (and many consider it to be more beautiful) but it is much more expensive.

11. Retaining Wall at 176 Reservoir Road

176 Reservoir Road

Look at the retaining wall at this house. In what ways does the construction help keep the wall standing and allow for drainage?

The wall leans slightly toward the hill, which makes it more difficult for it to tip over onto the sidewalk. Also, there are many gaps between the stones which allow for drainage. This relieves the pressure on the wall.

12. Cracks and roots in sidewalk

Which came first – the sidewalk or the root?

As you are walking down Reservoir Road, pay attention to the cracks in the sidewalk as the sidewalk passes over roots. Which came first – the roots or the sidewalk? How can you tell?

Since sidewalks are laid flat, the tree root was underground when the sidewalk was created. Then, as the tree grew larger, the roots also grew larger, and cracked the sidewalk.

13. Walkway stones

Walkway stones

As you are walking, notice the choice of stones used to create walkways. What do you notice about the stones?

The stones in the walkways are flat. Students might recognize the stones as looking like the slate they saw before. Some may well be slate, others may be mudstones or siltstones. All these rocks can have very flat layers.

14. 226 Reservoir Road

226 Reservoir Road

Spend some time looking carefully at all the different building materials used to create the retaining wall.

Can you spot the large piece of granite? There's also a large rock that look like granite but is called a *gneiss* – this is a type of granite that has been *metamorphosed*, or changed because of intense heat and pressure. What evidence do you have for these changes?

The gneiss has the same minerals as the granite but because of the high heat and pressure as become foliated, or squeezed into layers. The layers are made of the quartz, mica and feldspar from the granite that have recrystalized.

15. Roxbury Conglomerate

As you are walking, find a piece of the Roxbury Conglomerate to point out to the students.

Roxbury Conglomerate

This rock is known as Roxbury conglomerate, a rock formation found all over the Boston area that is about 560 million years old. This piece is likely an old piece of foundation.

What can you guess about the age of the rocks compared to the stuff that holds them together?

The rocks in the conglomerate had to be older than the cementing material. First the rocks were carried by water from where they originated, then deposited as the water slowed down. Once they were deposited, the mud that eventually cemented them settled all around the rocks. Finally, over long time and pressure, they were cemented into the conglomerate you see here.

16. 76 Crafts Road – at the chain link fence

Roxbury Conglomerate examples at 76 Crafts Road

Look at the different examples of the Roxbury Conglomerate here. Which rocks were naturally in this spot, and which rocks were placed here by people? What clues can you use to determine what's natural and what's not?

This is a fascinating place: the builders used the natural outcrop to form a retaining wall for the house above, and then added many boulders as further wall and as steps to get to the house. Look for where the human placed pieces have shifted over the years, as opposed to the outcrops that appear very solidly in place. You can see plants growing in cracks in the outcrop, and holes where small animals such as chipmunks have made homes.