CURRICULUM GUIDE FOR

Plant Life Cycle & Soil Properties

(Based on the STC Plant Growth and Development Kit)

Wallingford Public Schools
Third Grade
Science

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your students. These notes are not meant to be an overview of the unit, but as background information for you that go beyond the content of this particular unit. These notes should not be replicated for your students; however, you may share some of the content when appropriate for the developmental level of your students.

CD-ROM is included in the Science Kit " Plant Life Cycle – Teacher Resources"

- Plant Videos (Quick Time)
- Plant Life Cycles (Power Point)
- Plant Life Cycles Power Point Narrative (Word)

For an additional copy of this CD please contact the Science Resource Teacher

UNIT SUMMARY

In this unit, Plant Life Cycle & Soil Properties, students will focus their study on the life cycle of flowering plants and the properties of different types of soils. The unit begins with an exploration of a lima bean and the plant embryo inside of it, concentrating students' attention on the beginning of the plant's life cycle. Students will then participate in planting *Brassica* seeds (Wisconsin Fast Plants) to observe the remaining stages in the plant's life cycle (including sprout, leaf and bud growth, growth spurt, pollination, development of seed pods, and seed production). Particular focus will be applied to observing and recording changes in the plant structure in students' science journals. It is important to note that, because of time constraints, specific time frames have been provided for lesson planning and execution. During "lulls" in the plant part of the unit, lessons regarding soil properties will be introduced.

Several themes are emphasized in this unit. They are (1) plants have a distinct life cycle, (2) other living things depend on plants, (3) fertilization through pollination is essential for plant reproduction, and (4) soils have different properties that are important for plant growth.

STAGE 1- STANDARDS/GOALS

What should students understand, know, and be able to do? Stage one identifies the desired results of the unit including the related state science content standards and expected performances, enduring understandings, essential questions, knowledge and skills.

Enduring Understandings *Insights earned from exploring generalizations via the essential questions (Students will understand THAT…) K-12 enduring understandings are those understandings that should be developed over time, they are not expected to be mastered over one unit or one year.*	**Essential Questions** *Inquiry used to explore generalizations*
<u>*Overarching Enduring Understandings:*</u> • Science is the method of observation and investigation used to understand our world. (K-12) • Inquiry is the integration of process skills, the application of scientific content, and critical thinking to solve problems. (K-12) • Matter (Soil) can be described and classified for understanding. (K-12) • The environment is a complex assemblage of interacting and evolving chemical, physical, and biological processes. (K-12) <u>*Unit Specific Enduring Understandings:*</u> • Soils have different properties and compositions that make them useful in	• How is inquiry used to investigate the answers to questions we pose? • What are the properties by which soils are sorted? • How is inquiry used to investigate the amount of water different soils can retain? • What properties of soil are important for plant growth?

different ways. • Flowering plants have a life cycle that involves changes in growth and structure that ensures production of new plants. • Other living things depend on plant reproduction to supply the food they need. • Fertilization through pollination is essential for flowering plant reproduction and continuation of the life cycle.	• What are the conditions necessary for flowering plants to grow? • How does the plant change over the course of its life? • How do flowering plants produce seeds and new plants? • How are plants connected with other living things?

Knowledge and Skills

What students are expected to know and be able to do

The knowledge and skills in this section have been extracted from Wallingford's K-5 Science Scope and Sequence.

Knowledge

K1. Summarize the conditions necessary for plant growth.
K2. Identify the distinct stages in the life cycle of a flowering plant from the germination of a seed to the production of new seeds.
K3. Conclude that flowering plants must be pollinated in order to produce new seeds.
K4. Recognize the interdependence between the pollinator and the plant.
K5. Explain why it is advantageous for a plant to produce more than one seed.
K6. Identify the properties of different types of soil.
K7. Recognize how soil supports the growth of many plants.
K8. Relate the properties of different soil types to their ability to retain water.

Skills

The student will be able to…

S1. Generate investigable and noninvestigable questions.
S2. Observe objects (soils, leaves, seeds, etc.) and describe commonalities and differences among them.
S3. Classify, based on observations of properties, the different types of soil.
S4. Predict:
- Future plant growth based upon measurements of previous growth.
- The amount of water different soils might hold.
- The effect of pollination on the plant's life cycle.
- The effects of different types of soil on seed germination.
- The effects of other conditions (light, temperature, etc.) on plant growth

S5. Design an investigation to help answer an investigable question
S6. Conduct simple investigations
S7. Collect and record data utilizing simple equipment and measuring tools. (measure and record the daily growth of plants)
S8. Organize results in an appropriate manner, using
- Graphic organizers
- Charts and graphs.
- Illustrations or diagrams.
- Simple reports.

S9. Communicate results or information in an appropriate manner, using

- Presentations
- Visuals
- Simple reports

Content Standard(s) *Generalizations about what students should know and be able to do.*	
CSDE Content Standards (CSDE Science Framework 2004)	**CSDE Primary Expected Performances** (CSDE Science Framework 2004**)**
Structure and Function-How are organisms structured to ensure efficiency and survival? **2.2-Plants change their form as part of their life cycles.** • The life cycles of flowering plants include seed germination, growth, flowering, pollination and seed dispersal. *The Changing Earth-How do materials cycle through the Earth's systems?* **2.3-Earth materials have varied physical properties which make them useful in different ways.** • Soils can be described by their color, texture, and capacity to retain water. • Soils support the growth of many kinds of plants, including those in our food supply.	A 19. Describe the life cycles of flowering plants as they grow from seeds, proceed through maturation and produce new seeds. A 20. Explore and describe the effects of light and water on seed germination and plant growth. A 21. Sort different soils by properties such as particle size, color and composition. A 22. Relate the properties of different soil types to their ability to retain water and support the growth of certain plants.
Scientific Inquiry	B INQ.1 Make observations and ask questions about objects, organisms and the environment. B INQ.3 Design and conduct simple investigations. B INQ.4 Employ simple equipment and measuring tools to gather data and extend the senses.
Scientific Literacy	B INQ.5 Use data to construct reasonable explanations. B INQ.6 Analyze, critique and communicate investigations using words, graphs and drawings.

STAGE 2 – DETERMINE ACCEPTABLE EVIDENCE

How will we know if students have achieved the desired results and met the content standards? How will we know that students really understand? Stage two identifies the acceptable evidence that students have acquired the understandings, knowledge, and skills identified in stage one.

Performance Task(s) *Authentic application in new context to evaluate student achievement of desired results designed according to GRASPS. (Goal, Role, Audience, Setting Performance, Standards)*	**Other Evidence** *Other methods to evaluate student achievement of desired results.*
• The Wallingford Tree and Garden Nursery is having a contest. The person who takes one seed, plants it, cares for it, and produces the greatest number of seeds will win $100! To win the money you must explain to the nursery owners how you cared for your seed. Your explanation must include illustrations and at least five steps in your process that would lead your seed to result in the most seeds at the end. Good luck! **Note: Students should be prepared to address this activity because of their participation in plant growth observations, keeping a plant growth journal, study of the plant life cycle, pollination of their Brassica plants, and knowledge of the conditions necessary for plant growth.* *Answers should include: availability of light, water, and soil, pollination, and any other steps they did in the process of growing their plants (thinning, harvesting seeds, etc.)* See below for sample rubric.	• Plant growth journal • Sequence illustrations of the plant's life cycle • Simple graph demonstrating plant growth • Illustrate and label plant parts • Develop investigable and non-investigable questions • Inquiry-based exploration of different soil types • Vocabulary assessment • Writing prompt – You discover a plant in your yard that you know had flowers, but has never developed seed pods, while those around it have. Explain what might have happened. *Note: The answer is that for whatever reason, this plant's flowers were not pollinated and therefore no seeds were produced. Please note to students that light, water, and soil were held consistent for these plants. • Post-unit assessments • See Appendixes 7-10 for some sample assessments

2*	Includes 5 or more steps in process of caring for plants. Completed a labeled illustration. Included specific details and appropriate vocabulary.
1	Included 3 to 4 steps in the process of caring for plants Partially labeled and illustrated Included SOME specific detail and appropriate vocabulary
0	Included 0 to 2 steps in the process of caring for plants. No illustrations included. Included general details and few appropriate vocabulary terms.

STAGE 3 – LESSON ACTIVITIES

What will need to be taught and coached, and how should it best be taught, in light of the performance goals in stage one? How will we make learning both engaging and effective, given the goals (stage 1) and needed evidence (stage 2)? Stage 3 helps teachers plan learning experiences that align with stage one and enables students to be successful in stage two. Lesson activities are suggested, however, teachers are encouraged to customize these activities, maintaining alignment with stages one and two.

The suggested lesson activities are not sequenced in any particular order. Teachers may select which lesson activities will best meet the needs of their students and the unit objectives. Each lesson activity is coded with the corresponding knowledge (K) and/or skill (S) objectives that are found in stage one.

***Note: Exploration of soil has been placed at the end of the unit due to the strict time demands of planting, observing, pollinating, and harvesting seeds of the Brassica plant. Soil activities have been planned to take place when less time is necessary to be devoted to plant care. (Weeks 5-7)**
****However, please note that time specifications are estimated and may vary. Flexibility in lesson planning is necessary, especially with regard to thinning and pollination.**

Week 1

ELICIT PRIOR KNOWLEDGE OF PLANTS

Present students with an actual, live plant and/or a picture of a flowering plant. Ask students to tell what they know about the plant, if they can name any plant parts, what the plant needs to grow, and any additional information they can provide.
A KWL chart could be done for this section, if preferred.
Another option is a Brain Drain – students write for 10 minutes listing all of the facts they think they know about plants, then take 5 minutes to write questions they have. Students can then share their facts and questions with the class.

- *Refer to essential questions on pages 4-5*

Possible Literature Connection: *The Carrot Seed* or *Tops and Bottoms*
Time: 35 minutes (if combining with seed examination plan for more time)
Knowledge and Skills: S1, S2

SCIENCE JOURNAL

STC Plant Growth and Development page xi – xiii.
Model the use of the journal and desired format. This lesson can be combined with the previous lesson, or with the subsequent one, providing a place for students to record their observations, questions, predictions, etc.
See appendix for "What Belongs in a Science Notebook?"
Time: 30 minutes
Knowledge and Skills: S7, S8, S9

SEED EXAMINIATION (This lesson can be combined with eliciting prior knowledge.)
STC Plant Growth and Development Lesson 2: What is Inside a Seed?
Soak and inspect the interior of a bean seed to observe the plant embryo and its parts.
**Note: Beans must be soaked overnight in order to be used for this lesson, but do not soak for more than 24 hours, as they will begin to spoil and smell.*
Suggestions: Students can compare and contrast the dried seed with the soaked seed. They can also diagram the soaked seed. Dried seeds and soaked seeds can be presented, but without immediately revealing that they are the same thing. Students observe both, drawing conclusions and predicting what they are.

- *What is inside a seed?*

Possible Literature Connection: *The Life Cycle of the Bean; From Seed to Plant*
Time: 40 minutes
Knowledge and Skills: S2, K2

Week 2

**Note: For best results, seeds should be planted on Monday or Tuesday. Activity requires and hour of preparation, and could possibly extend over two days.*

PLANT THE SEED
STC Plant Growth and Development Lesson 3: Planting the Seeds.
Students collect necessary supplies and plant their seeds. Activity must be carefully organized in order for plants to successfully grow. The potting soil must be moist in order for the wicking system to work properly. Planter quads should be filled to the top with soil, pressed gently and more added if necessary. If plants become dry as they grow, water gently from the top with a dropper, *especially before a weekend*. Keep the light as close to the plants as possible to keep them from becoming tall and spindly.
*Note: It may be necessary to water seeds/plants from the top over the first 3 days in order to assure proper hydration, or until the wicking system is working.
Record in Science Notebook what occurred on this day and any predictions regarding when they will notice changes in the seed. Recording a materials list is also a good idea to aid students in becoming familiar with proper vocabulary.

- *What are the conditions necessary for flowering plants to grow?*

Time: one to two class periods
Knowledge and Skills: K1, K2, K7, S4, S6

THINNING AND TRANSPLANTING
STC Plant Growth and Development Lesson 4: Thinning and Transplanting.
Students will use forceps to thin and transplant the sprouts to a class container.
**Note: Extra plants that have been removed and replanted in class container will NOT get pollinated during lesson 11. THIS IS YOUR CONTROL GROUP to help demonstrate the effects of pollination.*
Teacher should plant his/her own control group as well to assure consistent growth, as transplanting can be traumatic on the plants and effect their growth.

- *What are the conditions necessary for flowering plants to grow?*

Time: 45 minutes
Knowledge and Skills: K1, K2, K7, S2, S4, S6

OBSERVING, RECORDING, AND GRAPHING PLANT GROWTH
STC Plant Growth and Development Lesson 5: How Does Your Plant Grow?
Students will use place value blocks and graph paper to measure and graph plant growth for at least 4 days. Procedure for observing and recording can be carried over/continued through the growth spurt (Roughly Days 9-13).

- *How does the plant change over the course of its life?*

Time: 40 minutes
Knowledge and Skills: K1, K2, K7, S4, S6, S7, S8

Week 3

OBSERVE LEAVES AND FLOWER BUDS
STC Plant Growth and Development Lesson 6: Observing: Leaves and Flower Buds
Students will observe the first leaves and buds on their Brassica plants, recording their observations in words and pictures in journals. Students will review the life cycle of a plant through this stage of development, using STC Life Cycle Cards, science journal, or shared reading experience from a book found in the science literature kit.
Life Cycle Cards can be revealed to correspond with each stage of the Brassica's life cycle, rather than revealing them all at this point.

- *How does the plant change over the course of its life?*

Time: 30 minutes
Knowledge and Skills: K1, K2, S2, S4, S6, S8, S9

PERIODICALLY OBSERVE PLANT GROWTH SPURT
Ideally done at beginning, middle, and end of week.
STC Plant Growth and Development Lesson 7: Observing the Growth Spurt
Over the course of 5 days students will measure, record, and graph their plants' growth in journal. In addition, they will predict how much their plant will grow from day to day. *
Do not forget to use the wooden plant stakes and clear rings to hold the plant straight to make it easier for students to measure.

- *How does the plant change over the course of its life?*

Time: as needed
Knowledge and Skills: K1, K2, S2, S4, S6, S8, S9
**Note: Can be done any time during the day, or in conjunction with another lesson.*

GETTING A HANDLE ON YOUR BEE
STC Plant Growth and Development Lesson 9: Getting a Handle on Your Bee
Students observe dried bees under a hand lens and make tool to use in next lesson for pollination.
Note: Wooden skewers work much better for this activity than the toothpicks suggested in the STC guide. Also, the cups used for the base should be at least 8 oz. and preferably made of Styrofoam in order to be more stable.

- *How do flowering plants produce seeds and new plants?*
- *How are plants connected with other living things?*

Time: 45 minutes
Knowledge and Skills: K3, K4, S2, S4, S7, S9

**Note: Late in the week, if flowers appear, begin Lessons 10 and 11.*

LOOKING AT FLOWERS

STC Plant Growth and Development Lesson 10: Looking at Flowers
Students observe details of flower's anatomy and identify major parts. You may want students to include observations and drawings in journal.
Teacher may use an overhead of the flower with labeled parts to aid students in recognizing and labeling their own drawings of their flowers.

- *How does the plant change over the course of its life?*
- *How do flowering plants produce seeds and new plants?*

Possible Literature Connection: *From Seed to Plant*
Time: 35 minutes
Knowledge and Skills: K2, K3, K4, S2, S6, S8, S9

CROSS POLLINATION OF FLOWERS

STC Plant Growth and Development Lesson 11: Pollinating Flowers
Over the course of 6 days students will use their bee sticks to cross-pollinate the flowers.
*****DO NOT POLLINATE CLASS CONTROL GROUP*****

- *How do flowering plants produce seeds and new plants?*
- *How are plants connected with other living things?*

Time: daily
Knowledge and Skills: K2, K3, K4, K5, S2 , S4, S6, S7, S8, S9

Week 4

Continue work with Lessons 10 and 11 as appropriate, and pinch off unopened buds.

OBSERVE FERTILIZED PODS

STC Plant Growth and Development Lesson 12: Observing Pods
Students observe the development of fertilized pods and the resultant changes in the plant as it progresses through its life cycle and record information in journals. Students should continue to measure and record their observations. Be aware that plants with growing pods will begin to lose their petals and their leaves will begin to wilt. *They are not dying*.
**Note: Work with this lesson will continue into weeks 5 and 6.*

- *How does the plant change over the course of its life?*

Time: as needed
Knowledge and Skills: K2, K3, K4, K5, S2, S6, S7, S8, S9

Week 5

Continue work from Lesson 12.

POLLINATED V. NON-POLLINATED

Develop activity to compare and contrast the pollinated and non-pollinated plants – height, presence of flowers, leaves, and bean pods. (This activity can be continued into Week 6.)

*Suggested Activities: Venn diagram, T chart, graph, and table.

- *How do flowering plants produce seeds and new plants?*
- *How are plants connected with other living things?*

Time: 30 minutes

Knowledge and Skills: K2, K3, K4, K5, S2, S6, S7, S8, S9

*Note: For next lesson, ask students to bring in a bag of soil from home.

ELICIT PRIOR KNOWLEDGE ABOUT SOIL

(For additional resources see Hands-On Minds-On Science, Plants Lesson: I Call this Home p. 33)

Students will observe and record what they notice about the similarities and differences among their soil samples. A KWL chart could be done for this section, if preferred. Encourage students to classify samples based on its properties. Make sure color, texture, capacity to retain water, particle size, color, and composition are a part of the activity.

- *What are the properties by which soils are sorted?*
- *What properties of soil are important for plant growth?*

Time: 45 minutes

Knowledge and Skills: K6, S2, S3, S6, S7, S8, S9

SOIL AND SEED GROWTH (optional inquiry investigation)

Using different types of soil to grow a seed and note the results. Which properties of soil effect seed germination/plant growth?

AIMS Primarily Plants page 43: Which Soil Works Best?

- *What do plants need to grow?*
- *How is inquiry used to investigate the answers to questions we pose?*

Time: approximately 3 weeks to allow plants to grow

Knowledge and Skills: K6, K7, K8, S1, S2, S3, S4, S5, S6, S7, S8, S9

Week 6

Continue work from Lesson 12.

INTERPRETING GRAPHS

STC Plant Growth and Development Lesson 15: Interpreting Graphs

Possible Teaching Suggestions: Can be integrated with Math Strand 19, pair share of graphs, museum walk, include observation and analysis of graphs from magazines, newspaper, etc.

- *How does the plant change over the course of its life?*

Possible Literature Connection: *Tiger Math*

Time: 35 minutes

Knowledge and Skills: S8, S9

CLASSIFYING AND SORTING DIFFERENT TYPES OF SOIL

STC Land and Water Lesson 5: Examining Earth Materials (See Appendix 11)

Students observe and compare four soil components. They will record and discuss the properties of each soil component. Information regarding each soil can be recorded on a Word web (See Appendix 4), one for each type of soil. These should be kept for use during the next lesson.

- *How do we classify objects?*
- *What properties of soils can we use to classify them?*

Time: 45 minutes

Knowledge and Skills: K6, S2, S3, S8, S9

See Soil Properties Word Web (See Appendix 4)

INVESTIGATING DIFFERENT SOILS' ABILITY TO RETAIN WATER

***INQUIRY INVESTIGATION (SEE PAGE 20 FOR INQUIRY TEMPLATE)**

- *How is inquiry used to investigate the amount of water different soils can retain?*

Time: approx. 3 hours

Knowledge and Skills: K6, K7, K8, S1, S2, S3, S4, S5, S6, S7, S8, S9

Week 7

HARVEST AND THRESH SEEDS

STC Plant Growth and Development Lesson 16: Harvesting and Threshing the Seeds

Prior to harvesting, students should predict number of seeds produced. Then students harvest and thresh the seeds and count them. They will compare the number of seeds with the original number of seeds planted and record finding in their journal.

*Note: Each flower, if properly pollinated, should produce 5-10 seeds. Pods will form at different times on different plants, requiring the possibility of spending multiple class periods on harvesting of the seeds. To accelerate the drying of the pods, remove pods that are fully formed.

- *How does the plant change over the course of its life?*
- *How do flowering plants produce seeds and new plants?*

Time: 45 minutes

Knowledge and Skills: K2, K3, K5, S2, S4, S6, S7, S8, S9

Continue with - INVESTIGATING DIFFERENT SOILS' ABILITY TO RETAIN WATER

***INQUIRY INVESTIGATION (SEE PAGE 20 FOR INQUIRY TEMPLATE)**

- *How is inquiry used to investigate the amount of water different soils can retain?*

Time: approx. 3 hours

Knowledge and Skills: K6, K7, K8, S1, S2, S3, S4, S5, S6, S7, S8, S9

See Appendix 7-10 for sample assessments

LITERATURE RESOURCES

These literature resources have been purchased to supplement the kit and are housed in each elementary school library.

Guided Reading Sets (6 copies in each school)

The Magic School Bus , Joanne Cole
How A Seed Grows, Helene J. Jordan
From Seed to Plant, Gail Gibbons
Acorn to Oak Tree, Oliver S. Owen
Bee, Karen Hartley &Chris Macro

Read Aloud (1 copy per school)

Life Cycle of a Bean, Angela Royston
Anno's Magic Seeds, Mitsumasa Anno
Janice Van Cleave's Plants, Janice Van Cleave
This is the Sunflower, Lola M. Schaefer

Big Books (1 copy per school)

The Reason for a Flower, Ruth Heller

Related Materials that May Be Found in Your Library

Miss Rumphius, Barbara Cooney
The Butterfly Seeds, Mary Watson
The Story of Rosy Dock, Jeannie Baker
The Lotus Seed, Sherry Garland
The Big Tree, Bruce Hiscock

Heineman Library Set that includes titles Flowers, Leaves, Roots, Seeds, Plant ABC, Plant Math (ISBN 158810520-2)
Bee 1-575720661-0

Additional Teacher Resources That Are Suggested

Materials List

Plant Life Cycle and Soil Properties – Grade 3

Revised December 2004
(Based on the STC Plant Growth and Development Kit)

1	STC *Plant Growth and Development* Teachers Guide
15	Student Activity Books
30	Trays - cardboard
2 pks	Lima beans
1	Toothpicks
30	Spoons
15	Droppers
30	Paper cups
60	1 oz. plastic cups
1 pks	Dried honey bees
6	20 oz. tall styrofoam cups
30	Forceps
30	Hand lenses
2pks	Wisconsin Fast Plant seeds
1 pk	Pellet form fertilizer
2	Potting soil – gallon bags
160	Wooden stakes or bamboo skewers
2 pks	Plant rings
30	Planter labels
30	Planter quads
4	Water tanks
1 set	Overhead transparencies of: Pg 57 – bee anatomy Pg 128-136 Enlarged life cycle (unlabeled) cards

1	Teacher Resource – AIMS – *Primarily Plants*
1 bag	Sand – 1 gallon bag
120	Wicks
4	Felt squares w/copper sulfate
1	Lighting system
1bag	500 centimeter cubes
1bag	Gravel – 1 gallon bag
1bag	Clay soil – 1 gallon bag
10	Graduated cylinders 50ml
30	9 oz cups large mouth
30	9 oz cups w/3 holes on bottom
2 rolls	Paper towels
4	Ladles for dispensing soil
2-4	White buckets for holding water (if no sink)
8	Plastic café trays
8	Tripod stands
8	Wax pencils – for marking cups
25	Student journals – with lines, 48+ pages
50	50mm round coffee filter papers
8	Timers
CD-Rom	Plant Life Cycles- teacher resources

Teacher Background Notes

These science content background notes were created for teacher use only. We anticipate that these notes provide you, the teacher, with some useful background as you facilitate inquiry activities for your students. These notes are not meant to be an overview of the unit, but as background information for you that go beyond the content of this particular unit. These notes should not be replicated for your students; however, you may share some of the content when appropriate for the developmental level of your students.

These notes have be prepared by Dr. Allan Smits, Professor and Chair
Department of Biological Sciences, Quinnipiac University

For additional support resources consult the included CD-ROM

1. **What are the conditions necessary for flowering plants to grow?**
    a. Water
        i. Water is the media which supports all life. All chemical reactions within animals and plants occur in water. You might say that water is the universal media in which life takes place.
        ii. Water is necessary to move nutrients from roots to leaves and from leaves to roots (happens in specials vessels within the stem).
        iii. When water fills the spaces in the roots, stems and leaves, it gives the plant structure (contrast wilted to a watered plant). The pressure of the water inside the plant gives the plant its structure to stand erect and extend its leaves and flowers.

    b. Sunlight
        i. Sunlight provides the energy for plant growth through the process of photosynthesis.
        ii. Light energy (photons of light) is captured by the plant and used to make organic molecules (sugars) from inorganic molecules (water, carbon dioxide, soil chemicals).
        iii. The green color of plants is due to the presence of chlorophyll, the pigment molecule that traps light in the leaves and stems.
        iv. Except for some unique organisms that live near deep ocean hydro-thermal vents (chemosynthetic organisms), plants are the only organisms that can make living matter from energy.

    c. Soil
        i. One obvious condition that soil provides plants is the support media for growth. While not all plants need soil (hydroponics is an example), most plants need the support of the soil around the roots in order to grow

vertically (root types vary according to the height of plants). Particle size of the soil clearly has an effect on the degree of support.

ii. Soil also provides the plant with access to water. Water molecules occupy the spaces between the soil particles. Therefore, the type of soil (number and type of particles) will determine how much water is held there, and for how long. Compare sand (large and non-dissolvable particles) and clay (very fine and suspended particles).

iii. In the process of moving water into the roots and into the plant, soil also may provide the plant with essential nutrients. These include many different chemicals, but nitrogen and phosphorous are extremely important as they are the building blocks for plant structure (proteins) and reproduction (DNA).

2. What is the life cycle of a plant?

a. See Life cycle Cards in Appendix E of Teacher's Guide; See descriptions of each stage in Figure 6-1 in Teacher's Guide; See narrative for each Powerpoint slide in Word file called "Plant Life Cycle".
b. See Powerpoint slides of plant life cycles, plant parts with labels (Slides 1-7)
c. Examples of roots, stems and leaves (Slides 8-11)
d. Differences between angiosperms and gymnosperms (Slides 2 & 3; Pine Life Cycle Video)
e. Fast Plant Time Lapse Video

3. How do flowering plants produce seeds and new plants?

a. Examples of pollination that ensures fertilization of egg (Slide 12; Bee Pollination Video)
b. Parts of the plant that produce sperm and eggs (Slides 13 and 14)
c. The process whereby sperm arrive at egg and fertilize egg (Slide 15; Plant Fertilization Video)
d. Production of seeds (Seed Development Video)
e. What are some different types of seeds, and how are they presented (dry, pod, fruits, etc) (Slides 16, 17, 18); Fruit Development Video)
f. Examples of seed dispersal (Slides 19 and 20)
g. Reasons for multiple seed production per plant

4. How are plants connected with other living things?

a. Provide food (convert energy from sun into nutrients)
b. Provide oxygen, remove carbon dioxide
c. Anchor the soil, prevent erosion
d. Provide aesthetic beauty
e. Sources of medicine (Slide 21 in Powerpoint)
f. Interdependence: Pollination
    i. What is interdependence (give examples of symbiotic relationships)

ii. What are the advantages to plants and to bees?
iii. Why is cross-pollination important for plants?

5. What are the properties by which soils are sorted (described)?

1. **Soil is a very important natural resource.** Within the context of plants, soil provides the structure and nutrients required for most plants to germinate and grow.
2. **Soil is made of many different kinds of matter.** Most soil is made of weathered rocks. This means the rock has been broken down. Some pieces may be large, others may be as fine as dust. Soil also contains matter that was once living. The remains of dead plants and animals become part of many types of soil.

3. **A soil profile is used to show the two layers of soil**.

Topsoil contains the decayed remains of plants and animals. This makes the soil good for growing plants. The color of topsoil is general darker than the subsoil.

Subsoil is below the topsoil. Compare the color "Light brown, yellow, red" with the dark color of topsoil.) Look at materials found in each soil. Leaves and twigs are found in topsoil; rocks, sand, and clay are found in subsoil.

Bedrock is the layer of soil under the subsoil. It contains large pieces of rock.

4. **Soils can be classified into several types, based upon their properties**. These properties are texture, particle size, color, and their ability to retail water. There is much variation in the names of these types, depending upon your source of information. Some consider “gravel” a soil type. I have not included it here.

Sand

1. Sandy soils contain mostly sand.
2. Most sand is small pieces of quartz. They have a course texture.
3. The particle is the largest of all soils. Thus, flowing water tends to move easily through sandy soils. Sandy soils do not hold water very well.
4. The color of sand is typically light colored (broken down quartz glass), but can be darker in color, dependent on the source of the quartz.

Clay

1. Clay soil is mostly clay and is made mostly of small pieces of mineral other than quartz.
2. Clay soils have the smallest particles of all soils. When dry, the clay soils have very smooth texture.
3. Because of their fine particle size, clay soils hold water very well. Also, because of the diverse minerals that make up clay, water tends to be electrically attracted to and held by the clay particles.

4. Clay soils can be a variety of colors, but are typically darker brown and reddish in color.

Loam (Humus)

1. Loam is made of gravel, sand, clay and a lot of humus.
2. The texture is intermediate between sand and clay because of its composition. Loam has the highest amount of organic matter (humus).
3. The ability of loam to retain water is also intermediate between sand and clay.
4. Color of loam is highly variable, depending on the amount of sand, clay and humus.

Internet Sites related to Soils

The following two sites are excellent sources of review on soils and soil types. The first is very comprehensive and relates well to plant growth and gardening. Use the topic links in the upper right of the page to navigate to the relevant topics.

The second site is an animated site for kids (Detective LePlant), but also contains some excellent background information, especially on how soils provide the conditions necessary for plant growth.

http://greennature.com/article431.html

http://www.urbanext.uiuc.edu/gpe/index.html

DIFFERENT SOIL'S ABILITY TO RETAIN WATER INQUIRY INVESTIGATION

This guide is a tool for helping you plan an inquiry activity. The prime factor is that your students get the opportunity to practice choosing their own question and planning and carrying out an investigation to find out what they can learn from investigating that question.

Approx. Time: 3 hours

Related State Content Standard(s):	Related State Expected Performance(s):
The Changing Earth – How do Materials cycle through the Earth's systems? **2.3-Earth materials have varied physical properties which make them useful in different ways.** • Soils can be described by their color, texture, and capacity to retain water.	A 22. Relate the properties of different soil types to their ability to retain water and support the growth of certain plants.
Related Enduring Understanding(s):	**Related Essential Question(s):**
• Inquiry is the integration of process skills, the application of scientific content, and critical thinking to solve problems. • Matter (soil) can be described and classified for understanding. • Soils have different properties and compositions that make them useful in different ways. • Soil samples from our earth are often mixtures of different types of soil components (sand, humus, clay, gravel).	• How is inquiry used to investigate the answers to questions we pose? • What are the properties by which soils are sorted? • How is inquiry used to investigate the amount of water different soils retain?
What simple **content objectives**/goals do you want to accomplish with this investigation? (see district curriculum documents)	What simple **process skills** do you want to improve with this investigation?
Students will: • Relate the properties (color, texture, particle size, composition) of different soil types to their ability to retain water. • Generate investigable and non-	• Predicting • Observing • Collecting data, organizing it, and communicating results

investigable questions. • Design an investigation to help answer an investigable question. • Predict the amount of water different soils might hold.	

What phase of this investigation will you provide the most modeling/templates/mini-lessons/scaffolding for better skill development?

Phase 2 – planning an investigation and collecting observations and data

Materials/Resources:

- Potting soil – 1 gallon bag
- Gravel – 1 gallon bag
- Sand – 1 gallon bag
- Clay – 1 gallon bag
- Assorted soil samples from student yards
- Tri-pod stands - 10
- Plastic cups with holes in bottom – 30
- Plastic cups for collecting water run-off - 30
- Filter paper – circular to fit in the bottom of the cups - 50
- 50 mL graduated cylinders – 10
- Plastic café trays – 8
- Paper towels
- White plastic buckets to hold water if there is no sink in classroom. – 8
- Wax pencils - 8
- Timers – 8
- Poster paper for group presentations – 1/group
- Sentence strips for inquiry questions – 30
- Student journals – 30
- Markers, crayons, pencils
- Student planning and sharing templates (See Appendix 1-6)

What kinds of investigations do you anticipate students designing?

Sample student investigation questions:

- What type of soil, (sand, gravel, clay, dirt from my backyard, etc.) retains the most water?
- How much water will half a cup of potting soil retain before it begins to drip? (Sand? Gravel? Dirt from my yard? Etc.)
- Does the particle size of soil (composition/texture) effect how much water is retained?
- If I compact (pack) the soil, will it retain more water? How much?

- How much water will be retained if I mix half gravel and half soil?
- Was it clay? (not investigable with hands on materials – help coach this student to turn this question into an investigable question such as “How much water can half a cup of clay hold unit it starts to drip?”)
- Does wet clay vs. dry clay retain different amounts of water?
- Does initial wetness of soil effect retention?
- How does soil composition effect retention?

PHASE 1 – Observing and Questioning

INQUIRY STARTERS

- What is the launching activity or **inquiry starter** for the investigation?
- What will be your **inquiry starter prompt**? How will you "invite" your audience to work with the materials?
- What **materials** will you use for the inquiry starters?
- How will you **elicit and collect or display student's questions**? Will they share questions orally? In writing?
- **Choosing investigation questions**: How will you help your students determine which questions they can choose from to investigate? How will you or the students form investigation groups?

Time	Task	Hints
5 min.	Teacher review of previous activity classifying and sorting different types of soil according to color, particle size, and texture.	
15 min.	Teacher demonstrates the capacity of two soil types to retain water (inquiry starter). 1. Place a damp filter paper on the bottom of two cups with holes on the bottom. 2. Teacher should model drawing a fill line on each cup w/holes using the wax pencil, explaining the need for the fill line. 3. Fill one cup up to predetermined fill line with gravel and fill the other cup with the same amount of potting soil. 4. Place each cup on a tripod with a cup underneath to capture the run off water. 5. Model how to measure 50 mL of water into each of two graduated cylinders. 6. Have student predict what will happen when you pour 50 mL of	• Students should make predictions about what they expect to happen when the water is poured into the soil in their **science journal**. These can be listed on chart paper for later reference, if desired. • Students should be encouraged to record their observations and measurements made by the teacher during this demonstration. A diagram of the set up and procedure the teacher modeled with be helpful to them later when they design their own experiment. • **Assessment note:** This is an opportunity for the teacher to formatively assess the ability of your students to write detailed observations and questions. • Teacher should model this as he/she would expect the students to conduct their experiments. Water

	water into each cup. 7. Discuss with students the need to keep the run-off time constant. Model for students the use of the timer, allowing a set amount of time for the water to drain. (2 minutes is recommended.) 8. One at a time, carefully pour 50 mL of water into each cup. 9. Observe (rate of run-off, color of run-off, changes in soil, etc.) 10. Model how to measure the amount of run-off for each sample by pouring the water back into the graduated cylinders.	and soil containers should be same as students'. Focus should be on keeping everything constant (measuring water, soil, time, etc.)
10 min.	Students make observations and use them to generate questions about what they saw and their knowledge of soil properties. • Create a T-chart on the board with "I notice" and "I wonder". Chart the student's observations (I notice). These will naturally lead to questions (I wonder). • At this time teacher should introduce students to the additional materials that will be available for students' investigations. (clay and sand) This will generate additional questions. • During the initial investigation, it is not recommended that students investigate using their soil samples from home. Pure soil samples will obtain results that better help students understand the properties of soil. Given the time, students may do an additional investigation using their soil samples from home. • Teacher may choose the most appropriate questions for investigation based on the content	• Example: I noticed that the soil retained more water. I wonder - how much water the soil from my yard will retain since it is a mixture of rocks and sand? • Refer to Appendix 1 "Observation Starters" for "I notice/I wonder" starters. • Teacher should direct students back to soil properties, and introduce new property – capacity to retain water. • **Guided Lesson/Thinking Tool:** Try to help students rephrase their questions into investigable questions that can be investigated in the "here and now" with the materials that we have available. "What is clay?" is a great question, but not investigable with our materials. • See page 2 of this inquiry investigation for some of the sample questions that students may generate

	objectives of this lesson.	

Student Samples -	I notice…. I wonder…
• The gravel retained more water than I thought it would • I was surprised that the clay retained as much water as it did • The water was spilling, some didn't spill in the cup • The clay was dry – reddish – I expected it to be more wet looking • The run-off water in the cup looked dirty	• How much water can ½ cup of clay retain before it begins to drip? • Why does clay retain more water than gravel? • What type of soil retains the most water? • How does color effect retention?

	Teacher can create groups for planning and investigating, (groups of 3-4 are recommended). • Things to consider: How will you help your students determine which questions they can choose from to investigate? How will you or students form investigation groups?	• The teacher may want to form groups based on student interest in a particular question. • The teacher may want to encourage groups to investigate questions that relate to the properties of soils. • Assigning group roles such as materials manager, recorder, timer, etc. may be helpful. • ***Note: This is the suggested end to Day 1 of the lesson.***

PHASE 2 – Planning and Investigating

INVESTIGATION

- What **additional materials** will you introduce? How will you introduce additional materials participants can use to study the phenomena?
- How will you manage/organize materials, set up and clean up?
- How will you support the groups in **planning** their investigation? Will you provide criteria or planning sheets?
- How will you facilitate during the investigation?

Time	Task	Hints
15 min.	Teacher will review the materials available for the groups to use to investigate their questions, quickly going over the proper use of each	

	(particularly the graduated cylinder and tripod stand).	
25 min.	Class can brainstorm the elements of an effective plan while the teacher records on chart paper. Items discussed may include: o Question o Directions – numbered/sequenced steps o Revise plans when changes are made o List of materials w/ quantities o Jobs – if assigned o Must be reproducible (someone else should be able to duplicate the investigation and get same results o Labeled diagrams or drawings o Prediction / hypothesis o Type of results you will collect and how they might be This can remain as a guide for students to refer to as they plan, or can be utilized to formulate a rubric. Teacher directs each group to develop a plan to use to investigate their question. This should be recorded by each group to share with the class in words or pictures.	• This can be done with minimal teacher input; in order for students to develop their own plans (mistakes are expected). • **Assessment Note:** This is an opportunity to formatively assess student planning. • Teachers may choose to use the "Investigation Plan Template" (appendix 2). This template can be taped into students' journals for future reference. • Teacher may choose to model a plan using a question that students are not investigating.
3 min./group (15-20 min. total)	Students will then share their plans with the class (pair share, museum walk, chart paper, jigsaw, etc.), possibly modeling specific steps, using the materials.	• Teacher should be adding key elements of an effective plan to the original list recorded on chart paper.
15 min.	Students should revisit their plans at this time, making the necessary revisions.	• Teacher should reinforce the fact that most/all of the important plan elements were included in students' shared plans. • ***Note: This is the suggested end to Day 2.***

40 min. *include time for cleanup*	Using their investigation plans and materials, students can conduct their investigations. Students will record their observations during the investigation in their student journals. Teacher will facilitate with reminders to record observations and measurements. Removing students from their materials for a few minutes will help them concentrate on recording observations and noting revisions they made to their plan. If students finish their investigation early they can continue to investigate a related question or start preparing for their presentation/sharing with the larger group. Plan on ample time for clean-up procedures.	• Materials can be distributed to each group by the teacher, or a designated student may gather them for his/her group. Plastic café trays may be helpful to manage the materials. • Note: For best results, filter paper must be wetted before conducting the experiment. • Teacher should circulate, questioning and guiding groups. • Remind students that a good plan may still need to be revised once you begin your investigation. • Remind groups that if they get stuck, they can: o Walk around the room to see what other groups are doing o Ask another group for advice o Ask the teacher for advice • Remind students to provide **enough time** for the water to drip out of their soil, in order to obtain accurate results. (all samples in a group should be tested under the same time constraints) • **Guided Lesson/Thinking Tools**: Teacher may need to provide a mini-lesson on data collection and organization of this data. Some groups may need a template/chart to help with data collection. See Appendix 3 for sample data chart. • **Guided Lesson/Thinking Tool:** Writing Detailed Observations. The teacher will model writing detailed observations for the students through a "think aloud". In attachments, see student suggested "Observation Starters", (Appendix 1) • ***Note: This is the suggested end to Day 3 of the lesson.***

Open Ended Questions and Comments to Help Guide Students During the Investigation

What do you know about…?	Tell me about it.
What will you need?	What's your plan for that?
What will you add?	What does this remind you of?
I wonder what will happen when…?	Tell me more about…
Why is that happening?	How are you going to use…?
Show me how that…	How will you use this today?
How do you know that?	What does it need?
What do you see, notice, hear about…?	What else can you do about…?
What does this do?	What will happen if…?
Where have you seen…?	How can we change that?
What's happening with this?	What happened when you did that?
What would you say about…?	What is different about that?
How can we find out about…?	What will you do to change that?
What other way can you try?	Show me…
What else can you do about…?	I'm noticing that…, how did that happen?
What can you use this for?	

PHASE 3 – Interpreting Results and Communicating

SHARING RESULTS AND PROCESSING FOR MEANING

- How will investigation groups present what they have learned from their investigations? (visual, oral presentation, combination, etc.) How will you decide the order of the presentations? (by similar questions, content goals, random, etc.)
- How will the facilitator synthesize the knowledge and findings of the participants for the group?

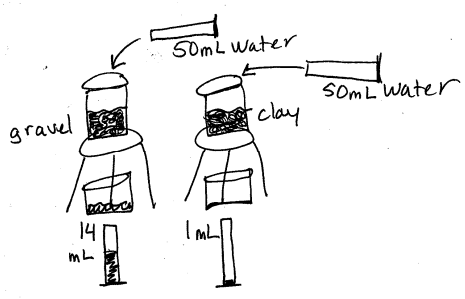
Time	Task	Hints
30 min. 3 min./group	Prepare to share results. Things to consider: How will students visually share their results? (overheads, chart paper, poster, etc.) Teacher will allow an allotted time for each group to share their results (approx 3 minutes).	• **Guided Lesson/Thinking Tool:** Discuss with students what would be in an "effective presentation" (question, hypothesis/prediction, overview of procedure, results, and conclusion). • Teachers may find it helpful to take notes as students present; documenting which groups had evidence of each big idea.

		• Teachers may choose to use the template, called "Preparing to Share Results," to prepare for sharing (Appendix 5) • Information can be added to the **Word Web** (see Appendix 4) for each soil, recording what they observed about each, adding 'water retention' property information. • Consider charting "findings/ conclusions" after each group presentation. This will be helpful later during the synthesis.

Sample Student Visual for Presentation:

Question: Which soil holds more water, clay or gravel?

Plan:



Hypothesis: We predicted that the clay would hold more water, because it is thicker.

Results (data):

Clay – 1 mL of water drained out

Gravel – 14 mL of water drained out

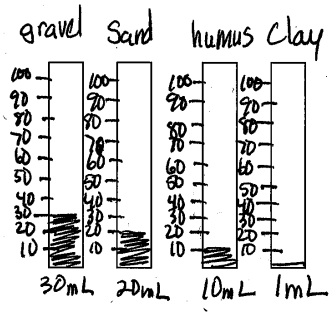
Conclusion: More water drained out of the gravel because there are larger particles and more spaces between the particles. More water is retained by the clay than the gravel.

By Kate and Brian

Sam, Caroline, and Tom

Which soil can hold the most water in two minutes?
Cups, some with holes, red marker, ring stand, graduated cylinder, water, clay, sand, humus, gravel, filter paper
We put in 50 mL of water

WATER THAT CAME OUT OF THE SOIL.



Clay retained the most water and gravel retained the least amount of water because there are smaller particles in the clay and more places for the water to 'hold on' to the clay.
We found we had to revise our plan because it didn't work the first time.

15 min. 10 min.	Synthesis – What have we learned about the properties of soil during these investigations? Use specific examples from the class to support new learning/findings. Provide a copy (or have students copy them into their journal) of the "Big Ideas/Summary of Investigation Findings" (See Appendix 6) to tape/staple into their journal.	• Use these big ideas to question students to guide them toward the higher level big ideas (last 3 bullets).

Sample – Big Ideas/Summary of Investigation Findings:

- Soils have different properties (color, texture, composition, particle size).
- Particle size is the property that affects water retention.
- The greater the run-off through the soil, the less water that is retained by the soil.
- Soils with large particles retain the least amount of water.
- Water is retained on the surface of soil particles.
- The greater the number of particles, the more surface there is to retain the water. Therefore, soils with smaller particles retain more water.
- As scientists, we need to plan, test, and observe to better understand the properties of soil and the world around us.

10 min. for writing	Follow up activity after synthesis. Students will be prompted to write in	• What did they learn from revising their plans?

5 min. for sharing	their science journals about why the **investigation plan** was important. Students will then Pair Share their journal entries with a student who was not in their investigation group.	• What did they notice about their plans as they investigated? • Was sequence important? • Did they develop/consider new questions during their investigation? • Did their partners notice the same things?
10 min.	Whole class discussion regarding student journal entries and Pair Share discussions.	• You might ask, "How was this different than how you have done science before?" • **Assessment Note**: Teacher will collect the student science notebooks for summative assessment. • **Assessment Note**: Students will revisit their soil samples from home. They will identify the predominant particle size compared to the pure soil samples, and predict the degree of water retention. Given sufficient time, students may want to test the water retention of their soil samples from home.

Observation Starters

Appendix 1

Think of the five senses

- What kind of information does your five senses tell you? Size, shape, color, lines, texture, smell, weight, patterns, sound, behavior
- I observed…….
- I noticed…….

Connect it with what you know.

- It reminds me of _____ because _____.

Observe and record cause and effect

- When I _____, it _____.

Note any changes

- It changed after _____, and now it _____.

Be curious and full of wonder.

- I am curious about _____.
- I wonder what would happen if _____.

Source: Seattle's K-5 Inquiry Based Science Program, Betsy Rupp Fulwiller, March 2002

Investigation Plan Template

Appendix 2

Team member names:_____
_____

Our **question** is:_____
_____

Our **hypothesis/prediction** is:_____
_____

Materials we will use:_____
_____
_____

PLAN
First, we will_____
_____
_____
_____
Then we will_____
_____
_____
_____
Next we will_____
_____
_____
_____
Finally we will_____
_____
_____
_____

What **changes/revisions** did you make to your original plan?
_____
_____
_____

SAMPLE Data Chart

Appendix 3

Where Does the Water Go?

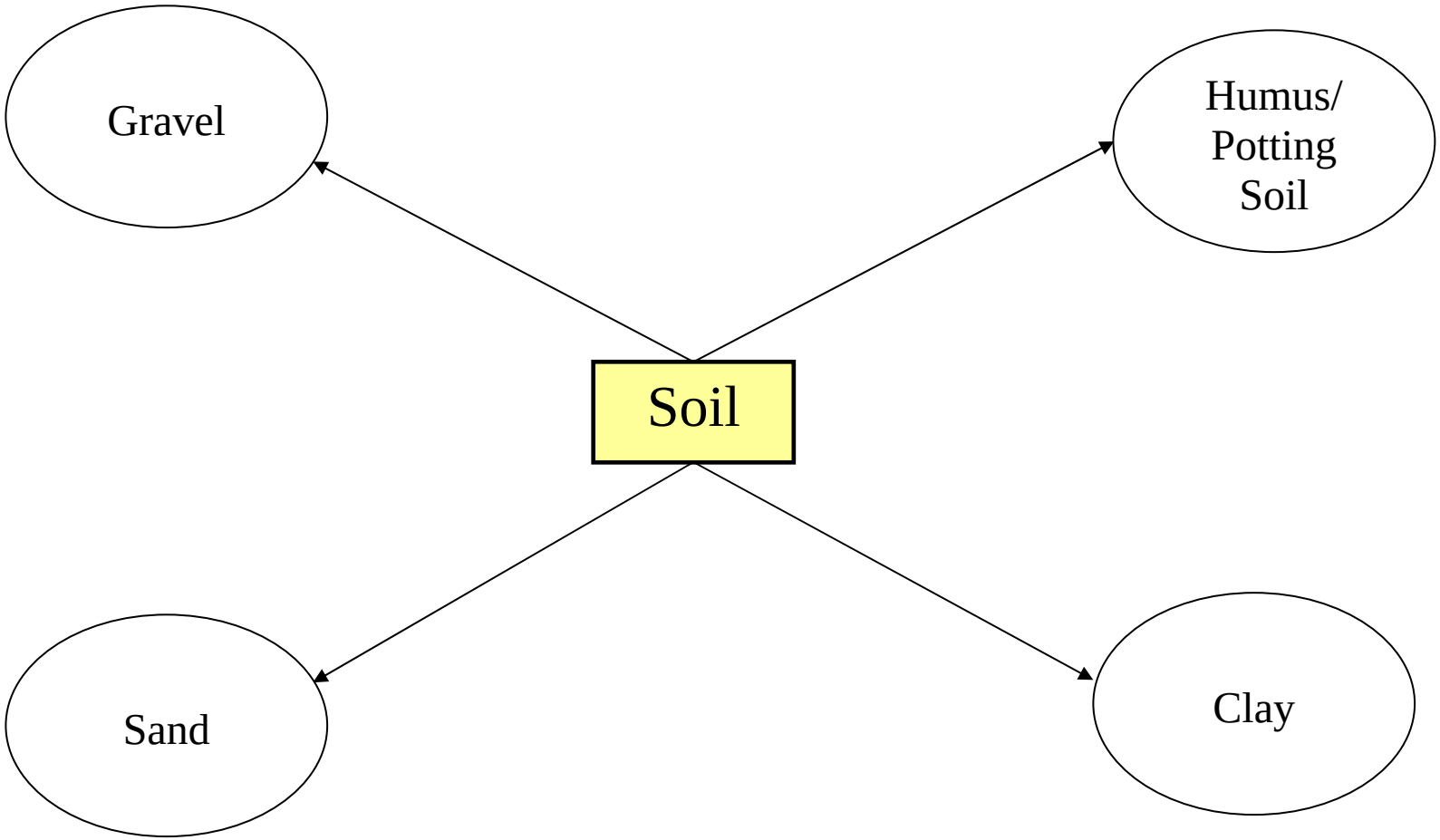
Data Collection Sheet

Soil	***Water Added (in mL)***	***Water Collected (in mL)***	***Observations***
Clay			
Sand			
Gravel			
Humus/ Potting			

Soil			

Soil Properties Word Web

Appendix 4



Preparing To Share Results

Appendix 5

Question: _____

Hypothesis/Prediction: _____

_____

Summary of what you did (plan) _____

_____

_____

_____

_____

We found out that (data or results)_____

_____

Conclusion (WHY?) _____

_____

_____

Space for illustration/diagram of investigation plan and/or results.

Big Ideas/Summary of Investigation Findings

Appendix 6

- Soils have different properties (color, texture, composition, particle size).
- Particle size is the property that affects water retention.
- The greater the run-off through the soil, the less water that is retained by the soil.
- Soils with large particles retain the least amount of water.
- Water is retained on the surface of soil particles.
- The greater the number of particles, the more surface there is to retain the water. Therefore, soils with smaller particles retain more water.
- As scientists, we need to plan, test, and observe to better understand the properties of soil and the world around us.

Sample – Soil Property Quiz

Appendix 7

Susie did an experiment with gravel collected from the Quinnipiac River and the Farm River. She put the same amount of each gravel in a cup with holes and poured 50 mL of water into each. She measured 30 mL of run-off from the Quinnipiac River gravel, and she measured 20 mL of run-off from the Farm River gravel.

1. Which gravel retained the most water? How do you know?

2. Explain why one type of gravel retained more water than the other.

3. List three properties of soil that can be used to describe them.

4. Use a Venn diagram to compare the two soil samples in front of you.

Sample - Plant and Soil Vocabulary – Study Guide

Appendix8

1. **germinate** –What happens when the seed is planted and begins to grow by coming out of its seed coat

2. **seed leaves** –The two leaves that are part of the baby plant inside the seed. They are the first two leaves that you see when the plant sprouts.

3. **true leaves** – All the other leaves that appear on the plant as it grows.

4. **growth spurt** – Early in the plant's life when it grows very quickly straight up, with little change in the leaves or flowers.

5. **pollination** – When pollen is moved from the blossom of one plant to that of another by bees, birds, or wind, causing the plant to be able to produce seeds.

6. **seed pod** – The part of the plant that contains the seeds.

7. **life cycle** – The life of a plant as is changes from seed, to sprout, to plant with flowers, to plant with seed pods, to seeds again.

8. **soil composition** – What the soil is made of: rocks, minerals, twigs, humus, etc.

9. **texture** – The look or the feel of the soil.

10. **particle size** – The size of the small pieces of soil.

11. **retention** – The ability of the soil to hold water that is poured on it.

Sample - Plant and Soil Vocabulary Quiz

Appendix 9

Match each vocabulary word with its definition by writing the definition's letter on the appropriate line.

1. germinate _____	a) The look or the feel of the soil.
2. seed leaves _____	b) The size of the small pieces of soil.
3. true leaves _____	c) All the leaves that appear on the plant as it grows, other than seed leaves.
4. growth spurt _____	d) The life of a plant as is changes from seed, to sprout, to plant with flowers, to plant with seed pods, to seeds again.
5. pollination _____	e) When pollen is moved from the blossom of one plant to that of another by bees, birds, or wind, causing the plant to be able to produce seeds.
6. seed pod _____	f) What happens when the seed is planted and begins to grow by coming out of its seed coat.
7. life cycle _____	g) The ability of the soil to hold water that is poured on it.
8. soil composition _____	h) What the soil is made of: rocks, minerals, twigs, humus, etc.
9. texture _____	i) The two leaves that are part of the baby plant inside the seed. They are the first two leaves that you see when the plant sprouts.
10. particle size _____	j) The part of the plant that contains the seeds.
11. retention _____	k) Early in the plant's life when it grows very quickly straight up, with little change in the leaves or flowers.

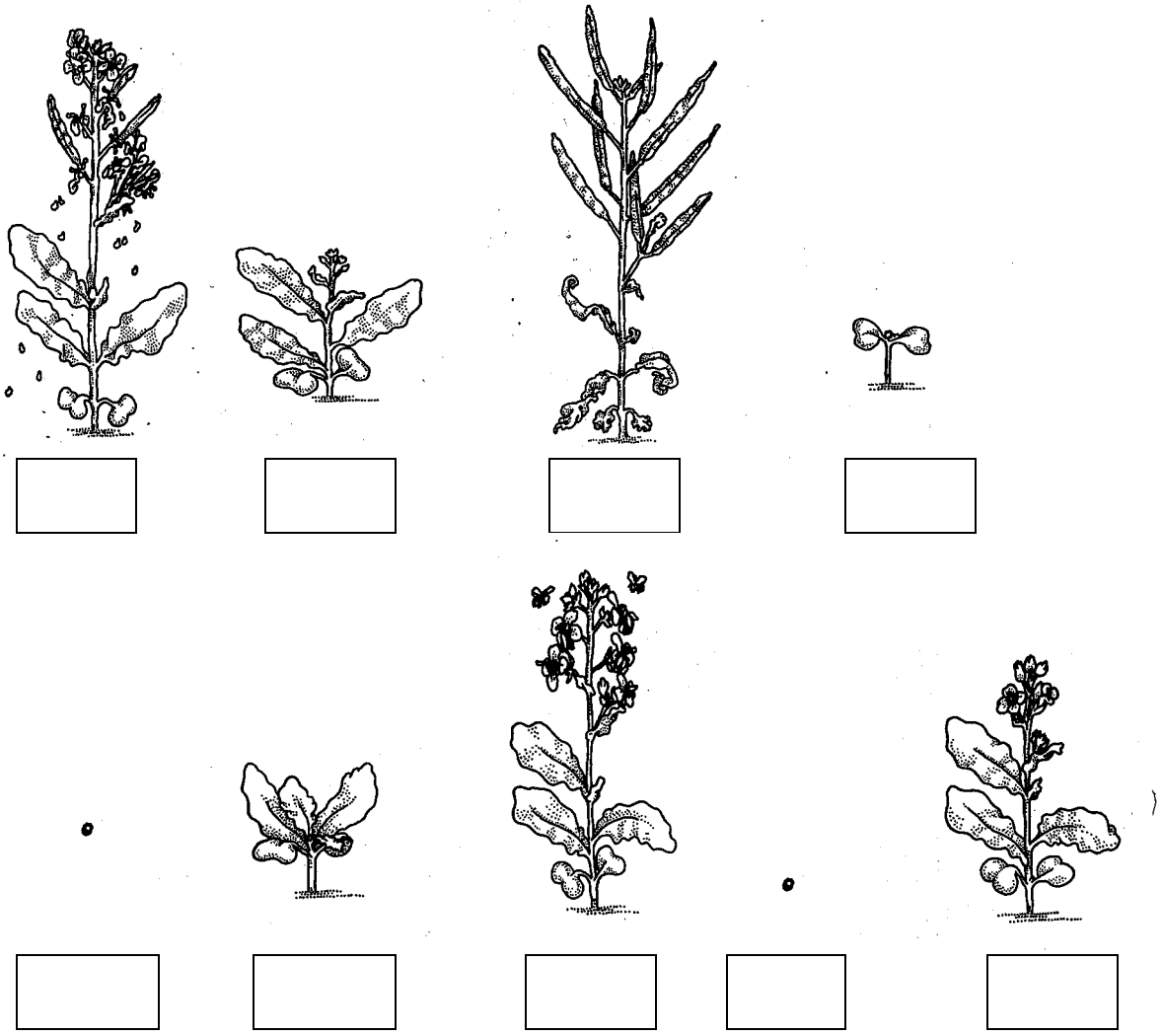
Sample - Plant Life Cycle and Soil Properties Unit Test

Appendix 10

Congratulations! You just won the Brassica Plant of the Year contest in *Water It!* magazine. Your prize will be a three page feature story on how you took care of your Brassica plant and the cover photo. In order for the reporter to write the story, you must complete the following informational activities. Make sure that you follow each direction below and print clearly. This is your chance to show off your green thumb!

1. People reading *Water It!* magazine need to know what conditions are necessary for the Brassica plant to grow. Write a response giving at least three conditions that must be present in order or the Brassica plant to grow. Use specific examples from your own experiment to support your answer. Use complete sentences and restate the question in the answer.

2. The people need to know what their plant will look like as it grows. Number the following pictures to show the life cycle of the Brassica plant. Label the pictures in order from the beginning of the Brassica plant's life to the end.



3. The reporter has your measurements that you took of your plant as it grew. OOOPS! It seems that the measurements were mixed up. The reporter needs your help putting them back in order. Read the chart below. Draw a line from the day to the correct measurement.

Day	**Measurements**
Day 1	5 centimeters
Day 9	16 centimeters
Day 8	3 centimeters
Day 3	13 centimeters
Day 2	8 centimeters

4. Use the information from the table to create a bar graph that shows your plants growth over time. Remember to put your information in order from day 1 to day 9. Label each part of your graph and give it a descriptive title.

Title _____

5. You have done a great job filling the reporter in on how you grew your Brassica plant. Now, he needs a final picture of you and your plant for the cover. On a separate piece of paper, draw and label a picture of you and your plant. You want to draw your plant at the end of its life cycle. Think about what it would look like and include as many details as possible. Don't forget to smile!

Word Bank

root	stem	flower
stem	seed pod	true leaves
seed leaves	me	

See page 7 for suggested performance task and rubric and additional assessment ideas.

LESSON 5

Examining Earth Materials

Overview and Objectives

Building on the experiences of Lessons 3 and 4, students now examine more closely the four soil components that make up their stream tables: sand, clay, humus, and gravel. By observing samples of these materials, both dry and wet, students discover the properties of each. As students relate what they know about the properties of each component to how these components behaved in their stream table investigation in Lesson 4, they can draw conclusions about why and how soil is eroded and deposited. Students will apply this knowledge of soil properties in the next lesson as they investigate how each of these soil components holds and releases water.

- Students observe and compare four soil components.
- Students record and discuss the properties of each soil component.
- Students discuss how soil properties affect the ways in which soil is eroded and deposited by water in their stream tables.

Background

Most students at this level have had a wide range of experiences with soil. However, few students may know that soil is actually a complex mixture of weathered rock fragments **(inorganic matter),** living and decayed plant and animal material **(organic matter),** air, and water.

Sand, silt, clay, gravel, and humus are examples of these earth materials. They are all soil components. In this lesson, students explore the characteristics, or **properties,** of four of these soil components in their stream tables—sand, clay, gravel, and humus. Each component has unique characteristics in dry form and reacts in a particular way when added to water.

Students begin the investigation in this lesson by observing the soil components in dry form and drawing conclusions about the following properties:

- **Appearance:** When viewed with the unaided eye, each soil component has a distinctive color, luster, and granularity. Colors include reddish orange, gray, white, and black. Luster ranges from dull to shiny, and granularity from clumpy to grainy.
- **Texture:** Each soil component has a different feel. Soil scientists use texture to help identify the components in a soil. For example, if a soil has a rough feel, it contains sand. If it is slippery and sticky when moist, it may contain clay.

- **Size of particles:** Grains or particles of soil components vary in size. For example, sand particles are much larger than clay particles and are easy to see with the unaided eye or a hand lens. Although silt particles can be seen with a hand lens, one would need a compound microscope to see individual clay particles. When scientists analyze a particular soil sample, they frequently describe its composition by particle size. One set of accepted ranges for the average particle size of the inorganic soil components is as follows:

Soil Component	Particle Size
Gravel	Greater than 2.0 mm
Coarse sand	0.2 mm to 2.0 mm
Fine sand	0.05 mm to 0.2 mm
Silt	0.002 mm to 0.05 mm
Clay	Smaller than 0.002 mm

  Observing particle size is complicated by the tendency of certain soil components, such as clay, to clump together. These clumps must be completely broken up before the true particle size can be seen even under a microscope. In this lesson, students will not be able to observe the size of the clay particles, even with a hand lens. It is important they do not confuse clumps of clay with clay particles.

After observing each soil component in dry form, students discover what happens when they add the component to water. Whether the component settles or remains suspended depends primarily on its particle size, the rate of flow, and to some extent, the component's shape and weight. More specifically:

- **Gravel** is composed of relatively large pieces of various rocks and minerals. Gravel particles are usually rounded from tumbling in rushing water. The heaviest particles, which are not easily pushed by the force of the water in this unit, sink almost immediately.
- **Sand** has a high content of silicate minerals, predominantly quartz. Sand particles tend to become rounded by long periods of movement in water. Sand particles are smaller than gravel and are more easily transported by water.
- **Silt** particles, which are smaller than sand but larger than clay, can consist of almost any mineral. Because silt tends to remain suspended, it is the major component of sediment found in deltas and floodplains. Silt can prove difficult for young students to identify because it can look and feel indistinguishable from clay. It is therefore not included in this unit.
- **Clay** has the smallest particle size of the soil components. The properties of a particular sample of clay depend on its mineral composition. The minerals that can be found in clay include kaolinite, vermiculite, and some of the micas. If a soil contains 35 to 40 percent clay, it is designated "clay soil." Clay particles remain suspended in water for a long time, primarily because of their small size.
- **Humus** is the soft and dark, often black, organic component of soil. Its high volume of air space gives it a loose texture and high water-holding capacity. Because humus contains small sticks and other plant and animal remains, it reacts differently when added to water than do the other soil components. Many of the less-dense materials will float on the water's surface. When the humus becomes waterlogged, much of it will settle.

By relating their observations in this lesson to those made in Lesson 4, students may begin to understand that some soil components will be easily eroded while others may be deposited as soon as the movement of water begins to slow. Do not expect students to fully comprehend this difficult concept at the close of this lesson. This investigation lays the foundation for a better understanding of erosion and deposition in the upper grades.

Materials

For each student

- 1 science notebook
- 1 copy of **Record Sheet 5-A: Examining Earth Materials**

For each group of four

- 1 clear plastic cup, 270 ml (9 oz)
- Sand, 15 ml (½ oz)
- Gravel, 15 ml (½ oz)
- Humus, 15 ml (½ oz)
- Clay, 15 ml (½ oz)
- 1 spoon
- 2 hand lenses
- 1 sheet of white paper, 22 × 28 cm (8½ × 11 in) (can be scrap paper with one clean side)
- 1 section of newspaper
- 1 stream table lid

For the class

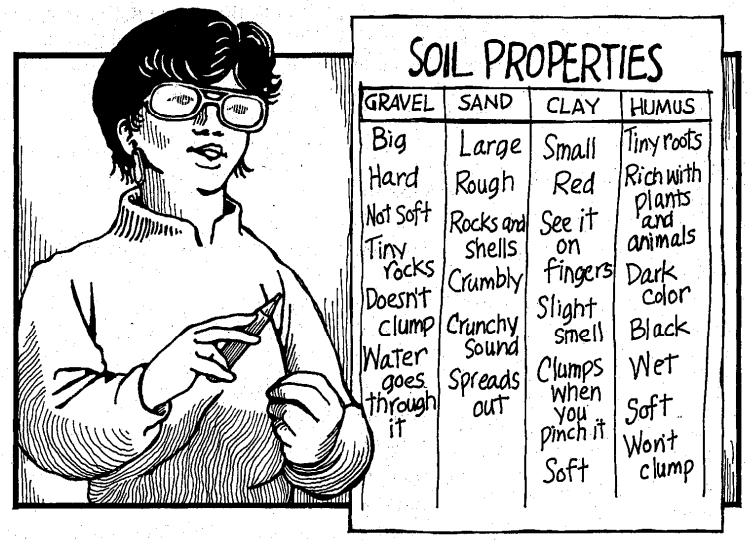
- Brainstorming lists from Lesson 1
- 32 small graduated cups, 30 ml (1 oz)
- 1 sheet of newsprint
- 1 clear, 2-liter soda bottle, containing 2 liters of water
- Index cards
- Assorted colored markers
- Post-it™ notes, 7.6 × 12.7 cm (3 × 5 in)
- Masking tape
- Newspaper
- Rinse buckets
- Cleanup supplies

Preparation

1. Make one copy of **Record Sheet 5-A: Examining Earth Materials** for each student.
2. Title a clean sheet of newsprint "Soil Properties." Label four columns: "Gravel," "Sand," "Clay," and "Humus." (Figure 5-1 shows the table with sample student responses.)
3. Preview the **Student Instructions for Examining Earth Materials** (pgs. 75–76 in this guide and pgs. 27–28 in the Student Activity Book).
4. Fill the 30-ml cups halfway with the four soil components. Each group gets a half cup of each type.

Figure 5-1

Sample table of soil properties



5. Set up the distribution center for this lesson like the one pictured in Figure 5-2.
   - Cover the area with newspaper.
   - Place all the materials in a line for easy pickup, with the stream table lids at the beginning of the line. Students can use the lids to carry their materials. Using index cards, label the items and the quantity needed by each group.
   - Students can get their hand lenses and spoons from their storage containers.
   - Fill a soda bottle with 2 liters of water. Set the clear plastic cups next to the bottle of water. Label the water "Get ½ cupful water."
   - Set out the cups of sand, humus, clay, and gravel. Label the soil components "Take one cup."
6. Set up a cleanup and rinse station area as you have in previous lessons.

Procedure

1. Ask students to review what they did in Lessons 3 and 4. Let students know that in this lesson, they will examine more closely the four soil components that make up their stream tables in order to better understand how each component interacts with water.
2. Review with your students the **Student Instructions for Examining Earth Materials** (pgs. 75–76 in this guide and pgs. 27–28 in the Student Activity Book). Ask students if they have any questions. Remind students to assign responsibility for each step to a group member.
3. Distribute one copy of **Record Sheet 5-A: Examining Earth Materials** to each student. Discuss how to complete the record sheet. Encourage students to use adjectives when recording their observations on the record sheet. You may want to brainstorm possible adjectives at this time.

Figure 5-2

Distribution center

4. Guide one student from each group in picking up the materials for this lesson from the distribution center. Hand lenses and the spoon are in the storage containers. Another member can cover the group's work space with newspaper.
5. Allow students time to complete the investigation and record their observations. Remind groups to work together when discussing and recording the properties of each soil component.
6. Have students clean up by following Step 10 on their Student Instruction Sheet.

Management Tip: Do not dispose of the plastic cups and other reusable materials. They will be used throughout the unit.

Final Activities

1. Ask groups to share what they have learned about the properties of each of the four soil components. Record the students' findings on the "Soil Properties" table. Place a check mark next to any duplicate responses to acknowledge all answers.
2. Encourage students to use evidence from today's investigation to support their ideas about how water affects soil in their stream tables. Ask the following questions about each soil component to help students relate soil

properties they studied in this lesson to observations they made during the stream table investigation in Lesson 4:

- Think about your stream table in Lesson 4. How did the water wear away and deposit each soil component in your stream table?
- With what you know about the properties of each soil component, why do you think this happened?

3. Display the brainstorming charts from Lesson 1. Encourage students to use Post-it™ notes to add any new questions or comments they may have about land and water.

Extensions

SCIENCE LANGUAGE ARTS

1. Set up an observation center in your classroom where students can practice describing the properties of objects. Invite them to bring in interesting items from home for their classmates to examine. Encourage students to use adjectives to describe the properties of each object. They can use hand lenses to look closely at the objects.

SCIENCE

2. Ask students to examine a soil sample from their stream tables using the techniques from this lesson. Have them look at the sample through a hand lens. Then have them drop the sample into a cup of water. Can they see each of the soil components in the water?

LANGUAGE ARTS ART

3. Ask students to think about a time when they made something by mixing water with one or more of the soil components studied in this lesson. Examples include building a sand castle, making a clay pot, or baking mud pies. Have the students write a story about this experience.

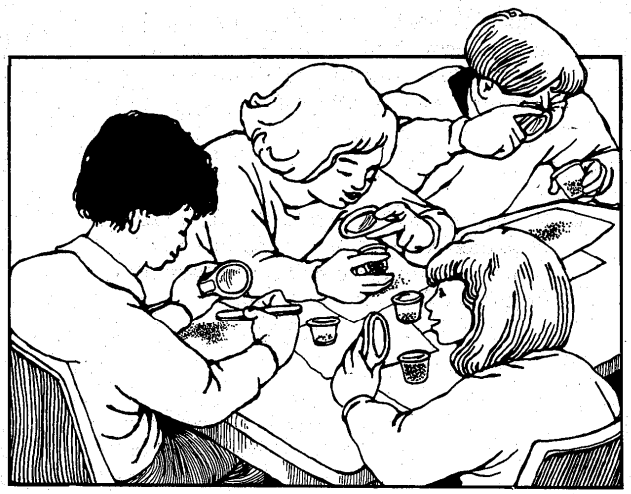
Student Instructions for Examining Earth Materials

Directions: Read all the directions before you begin. You will do each of the following steps four times, once for each of the four soil components, in the order listed on **Record Sheet 5–A: Examining Earth Materials.** Start with gravel. Then test sand, clay, and finally humus. Work as a group. Complete your record sheet as you make observations about each soil component.

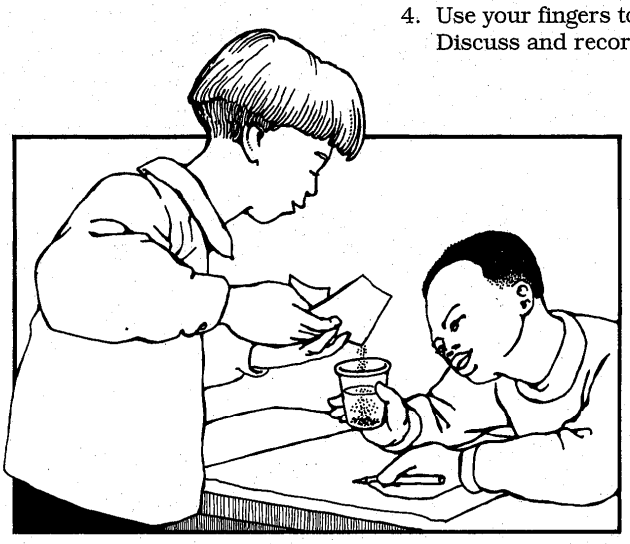
1. Pour the gravel onto the sheet of paper.

2. With your hand lens, look closely at the gravel.

3. What do you notice about the appearance of the gravel? How does it look? Discuss your observations with the group. Record your observations on Record Sheet 5–A.



4. Use your fingers to feel the texture of the gravel. Discuss and record your observations.



5. Gently fold your sheet of paper. Using it like a funnel or chute, drop the gravel into the cup of water. Watch it fall. Discuss and record your observations on your record sheet.

6. Stir the water gently with your spoon. Record your observations.

7. Repeat Steps 1 through 6. This time use sand. Record your observations on your record sheet. Use the same cup of water that you used for the gravel.

8. When you are finished testing sand, test clay, then humus. Use the same cup of water each time. Record your observations on the record sheet each time.

9. When you have tested all four soil components, stir the mixture of soil and water again. Record any additional observations on the record sheet.

10. Clean up by doing the following:

- Pour the soil and water from the cups into the rinse bucket. Rinse the cups.
- Return all materials to their original positions on the distribution table.
- Throw away any soiled newspaper. Sponge down and dry your work space.

Record Sheet 5-A Name(s): _____

Group: _____ Date: _____

Examining Earth Materials

	Gravel	Sand	Clay	Humus
Appearance (how it looks: color, shine, clumping)				
Texture (how it feels)				
What it does when you put it in water				
What it does when you stir the water				
Other observations				

Record Sheet 5-A Name(s): _____

Examining Earth Materials, *continued*

1. Stir the cup of soil and water again. What happens to the soil when the water begins to move?

   _____

   _____

2. What happens to the soil when the water slows down?

   _____

   _____

3. Which soil component drops to the bottom of the cup first? _____

   Why do you think this happens?

   _____

   _____

4. Which soil floats on the water? _____

   Why do you think this happens?

   _____

   _____

In Lesson 7, you will learn more about the way soil is picked up and dropped off in your stream table.

I N S T I T U T E · F O R · I N Q U I R Y
A DESCRIPTION OF INQUIRY

Appendix A

At the *Exploratorium Institute for Inquiry* our work in science education is deeply rooted in the belief that human beings are natural inquirers and that inquiry is at the heart of all learning. The work that we do with educators is designed to give them an opportunity to personally experience the process of learning science through inquiry. Our hope is that this experience will stimulate their thinking about how to create classrooms that are supportive environments for children's inquiry.

Inquiry is an approach to learning that involves a process of exploring the natural or material world, that leads to asking questions and making discoveries in the search for new understandings. Inquiry, as it relates to science education, should mirror as closely as possible the enterprise of doing real science.

The inquiry process is driven by one's own curiosity, wonder, interest or passion to understand an observation or solve a problem.

The process begins when the learner notices something that intrigues, surprises, or stimulates a question—something that is new, or something that may not make sense in relationship to the learner's previous experience or current understanding.

The next step is to take action—through continued observing, raising questions, making predictions, testing hypotheses and creating theories and conceptual models.

The learner must find her or his own pathway through this process. It is rarely a linear progression, but rather more of a back and forth, or cyclical, series of events.

As the process unfolds, more observations and questions emerge, giving occasion for deeper interaction and relationship with the phenomena—and greater potential for further development of understanding.

Along the way, the inquirer collects and records data, makes representations of results and explanations, and draws upon other resources such as books, videos and the expertise or insights of others.

Making meaning from the experience requires reflection, conversations and comparison of findings with others, interpretation of data and observations, and the application of new conceptions to other contexts. All of this serves to help the learner construct new mental frameworks of the world.

Teaching science using the inquiry process requires a fundamental reexamination of the relationship between the teacher and the learner whereby the teacher becomes a facilitator or guide for the learner's own process of discovery and creating understanding of the world.

Map of IFI Inquiry Structure

(3 Phases of Inquiry Diagram)

Appendix B