

Wolf Ridge Environmental Learning Center  
6282 Cranberry Rd, Finland, MN 55603 • 800-523-2733 (MN, WI) • 218-353-7414



# PAPER MAKING

## EVENING ACTIVITY



*A student making recycled paper*

# PAPER MAKING

## WOLF RIDGE CLASSES:

### Animals:

Animal Signs  
Beavers  
Birds  
Small Mammals  
Snowshoe Hare  
White-tailed Deer  
Wildlife Management

### Plants:

Forest Ecology  
Plant Study  
Trees and Keys  
Wetlands Ecology

### Aquatics:

Lake Study  
Stream Study  
Fisheries Management  
Frozen Lake Study

### Earth Science:

Acid Rain  
Geology  
Weather

### Human Culture and History:

Living Lightly  
Nature's Timing  
Ojibwa Heritage  
Ojibwa Snowshoe  
Seeds of Change  
Voyageur Life

### Personal Growth:

Adventure Ropes Course  
Rock Climbing

### Group Building:

Basic Survival  
F.I.R.S.T. Games

### Outdoor Recreation:

Beginning Orienteering  
Competitive Orienteering  
Canoeing  
Cross Country Skiing  
Superior Snowshoe  
Superior View Hike

### Evening Activities:

Astronomy  
Block Printing  
Creative Expressions  
Creature from Wolf Lake  
Dream Catchers  
Lake Superior Game  
Night Hike  
Owl Pellets  
Paper Making  
Star Lab  
Woodland Art  
Volleyball

### Naturalist Presentations:

Bats  
Fur Trade  
History of the North Shore  
Logging Camp Life  
Raptors  
Wolves

## **Class Description: An Evening Activity**

Students will learn about the history of paper making and discover the ecological and economic benefits of using recycled paper. Students will go through the process of making four sheets of recycled paper. Artistic creativity is encouraged. After drying overnight the paper will be ready for use the next day.

Total time: 1.5 hours

Audience: 4-20 students, 4th grade through adult

Activity: easy

Travel: none

Total uphill travel: none



## **About Wolf Ridge**

Wolf Ridge is an accredited residential environmental education school for persons of all ages. We offers immersion programs which involve direct observation and participation in outdoor experiences. Wolf Ridge programs focus on environmental sciences, human culture and history, personal growth, team building and outdoor recreation.

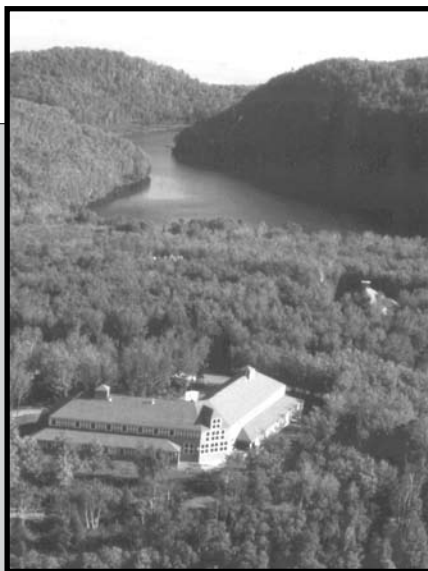
### ***Our Mission***

To develop a citizenry that has the knowledge, skills, motivation and commitment to act together for a quality environment.

### ***What We Do***

We meet our mission by:

- Fostering awareness, curiosity and sensitivity to the natural world.
- Providing lifelong learning experiences in nature.
- Developing social understanding, respect and cooperation.
- Modeling values, behaviors and technologies, which lead to a sustainable lifestyle.
- Promoting the concepts of conservation and stewardship.



*Wolf Ridge Campus*

*Photo by Jim Brandenburg*



## **Wolf Ridge**

Environmental Learning Center

6282 Cranberry Road

Finland, MN 55603-9700

800-523-2733 (MN,WI)

218-353-7414

Fax: 218-353-7762

[www.wolf-ridge.org](http://www.wolf-ridge.org)

*Wolf Ridge is an equal opportunity educator and employer.*

# PAPER MAKING



## OUTLINE:

### I. Set-up (10 min.)

### II. Introduction (10 min.)

- A. Greeting / Grabber
- B. Learn names
- C. Behavior guidelines
- D. Assess learner level

### III. History of Paper (15 min.)

### IV. Paper as a Resource (15 min.)

### V. Students Make Paper (45 min.)

### VI. Clean-up (5 min.)

### VII. Conclusion (5 min.)

- A. Review
- B. Stewardship Action

### VIII. Appendices

- A. Equipment
- B. References
- C. Safety Management
- D. Glossary
- E. Pre-Post Activities



## CONCEPTS:

- Humans have a great ability to alter natural systems, and a responsibility to consider the effects of our actions.
- Awareness, knowledge and appreciation lead to understanding of our impact.
- Waste and pollution are by-products of human society.
- Economic and political considerations have an influence on human actions.
- Using renewable resources is more sustainable than using non-renewable resources.



## OUTCOMES:

Upon completion of the Paper Making activity students will be able to:

1. List materials that can make paper.
2. Define renewable and non-renewable resources.
3. Describe two ways that our use of paper affects the environment.
4. Show how consumer demand influences the paper industry.
5. Make recycled paper using a simple process.



## MN GRADUATION STANDARDS:

Wolf Ridge has aligned the Center's entire curriculum to Minnesota Department of Education Academic Standards. The Center maintains a curriculum standards matrix for the following subject areas:

- Science
- History and Social Studies
- Language Arts
- Mathematics
- Arts

The Matrices are organized by grade level and subject area, listing Strand, Sub-Strand, Standards, and Benchmarks. Every class addressing a benchmark is also noted. As the primary student audience at Wolf Ridge is from 4th-12th grade, the matrices address these grade levels. Teachers may request that their students focus upon a specific benchmark while attending Wolf Ridge.

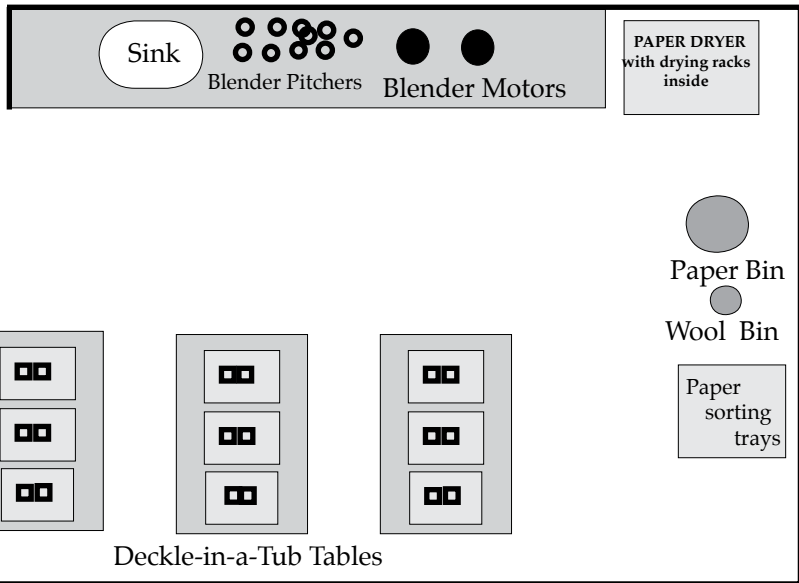
Copies of our matrices are available on the Wolf Ridge web site at [www.wolf-ridge.org](http://www.wolf-ridge.org), found under the "Education" menu. If you cannot access the matrices via the website, request a printed copy by calling 218-353-7414 or e-mailing us at "mail@wolf-ridge.org".

Revised March 2009

## I. Set-up (10 min.)

Paper making is a fun and easy activity . The more organized you are in setting up the equipment, the smoother the process will be. Equipment is located in rooms #4 and #9 of the Education Building.

1. Set up scrap paper bin, wool fiber bin and yellow paper sorting trays on the floor.
2. Place blenders and pitchers next to the sink, ready to be filled with paper and water.
3. Set up 3 deckle tables and 9 deckle tubs.
4. Place a felt couch and roller in each deckle tub.
5. Drying racks are located inside the paper dryer located in each room.



## II. Introduction (10 min.)

### A. Greeting/Grabber

Greet the students as they enter and let them look and wonder about all the equipment set around the room. While they are sitting at the tables, pass around the paper sample book for them to examine.

### B. Learn Students' Names

Take a few minutes to learn the names of your students and welcome them individually to the class. Repeat their names and strive to use them in every communication.

### C. Set Behavior Guidelines

Discuss clearly and specifically which behaviors you expect from your students during the next one and a half hours. Explain the need for respect; for you, for each other, for the equipment.

## D. Overview of the Class and Concepts

Students will sit tight for the first 20 minutes while aspects of the paper making process are discussed. After a brief demonstration, students will be given 45 minutes to make up to 4 post card sized sheets of paper. The concepts focused upon deal with our use of resources and how we affect the environment by our actions.

## E. Assess Learner Level

During the introduction find out what the students already know about paper and paper making.

1. "Has anyone here made paper before?" (Share experiences.)
2. "How many of you recycle paper?" (40% of the garbage (solid waste) in Minnesota is paper and paper products )(10).
3. "Who knows what paper is made from?" (Modern paper is made from wood fibers of trees. In Minnesota, aspen is most common species harvested for paper and paper products. Stationery and art paper has a certain linen or cotton content, which adds durability, but also cost and resources.)
4. What was used for writing before paper? (clay, skins, cliffs, bone, reeds, bark, rags, etc.)

### CONCEPT:

*Awareness, knowledge and appreciation lead to an understanding of our impact.*

## III. History of Paper (15 min.)

Throughout human's early history many different surfaces were used to record ideas and exchange messages. Ask the students to make a list of primitive (pre-paper) writing surfaces. The list may include cliffs, cave walls, bones and tusks, leaves, bark, cloth, clay, animal skins, etc.

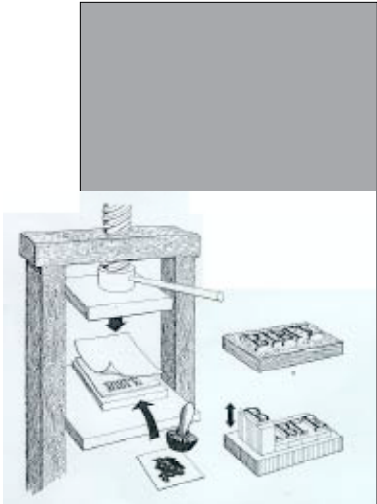
**4000 years ago** the Egyptians discovered a more efficient writing surface than animal skins. Papyrus, a type of reed, was woven into a mat and then pounded into a hard thin sheet.

**2000 years ago** paper as we know it today was invented by the Chinese. They mixed up bark, hemp and rags with water, mashed it into a pulp, pressed out the liquid and hung the thin mat to dry in the sun. This mostly wooden mixture launched a revolution in communication. One Chinese emperor had a library of 50,000 books--at a time when most of the great leaders in Europe couldn't even write their names.

**1000 years ago** the conquering Moors brought the Chinese technique for making paper to Europe. The idea of including wood was lost along the way, and paper was made using a mixture of rags and cloth, one sheet at a time, until the early 1800's.

**150 years ago** a machine was made for grinding wood into fibers and several chemical pulping processes were invented that made tree fiber papermaking an economical, mass-produced operation.





**Today** the vast bulk of modern paper is now made mostly from trees.....wood fiber from trees. Wood is made of billions of small cellulose fibers, bound together by a glue-like substance called lignin. The sap, resins, lignin and other matter in the tree have to be separated from the cellulose fibers in one of two ways: ground wood pulping or chemical pulping. Ground wood pulping is accomplished by high speed mechanical grinding and rubbing of wood chips between stones or blades. This process makes lower quality papers like newspapers. Chemical pulping produces higher quality papers. The wood chips are fed into giant tanks called digesters. Chemicals are added and the whole mass is steamed to produce pulp and eventually into paper.

In other parts of the world, some paper is made from non-wood sources; from rice and barley straw in China, from sugar cane waste ("bagasse") in Mexico and India, from bamboo in Vietnam, from hemp in Brazil, and from the kenaf plant in Australia.

**In the future** paper will be made using more alternative sources of fiber and also using more recycled paper fibers. Currently paper pulp is made (on average) from 30% recycled fibers, and that will grow to be almost 50% by the year 2010. (13)

Plastic has become a common alternative to paper, especially for bags and cartons. Made from oil, plastic is a nonrenewable resource, but if the bags and cartons are used again and again, they have the potential to be an environmentally responsible product.

*Assessment (Outcome 1): List primitive and modern alternatives to tree based paper products.*

**CONCEPT:**

*Economic and political considerations have an influence on human actions.*

### IV. Paper as a Resource (15 min.)

Start this discussion with the question: "How much paper do you use?" Hold up the "One Pound" example ream of paper and let the students guess. Then floor them with the answer.....600 lbs (average)!

Americans use over 67 million tons of paper, or an average of 600 pounds per person (1). Our use has doubled since 1965 (4) and may double again by the year 2010. (13) An estimated 4 billion trees are cut worldwide for paper each year. (13)

Wood and paper can be considered natural resources, or raw materials supplied by the earth. Have students list some examples of resources. As you write their answers, put them in two columns for renewable and non-renewable resources. Answers may include:

**CONCEPT:**

*Using renewable resources is more sustainable than using non-renewable resources.*

#### Renewable Resources

- sun
- wind
- water
- trees & plants
- animals.

#### Non-renewable Resources

- oil
- gold
- iron
- aluminum
- coal

The definition of a renewable resource is, "a raw material or energy form that can naturally replenish itself (12). Conversely, a non-renewable resource is one that once taken from the earth, will not be replenished naturally.

Paper is used, often times just once, then landfilled or burned as waste paper. Until recently, very little has been recycled back into paper or other products. Times are changing. Our paper use has gone up "tree"mendously, and so has the cost of disposing of our waste paper. We recognize the coming possibilities of damaging our forests by harvesting too many trees too quickly. Although trees are considered a renewable resource, forest ecosystems take time to respond to disturbance and regain wood fiber content and their biodiversity. Some forests take over 200 years to "renew", Minnesota's aspen forests take approximately 50 years.

*Assessment (Outcome 2): Define and give examples of renewable and nonrenewable resources.*

It takes 17 trees to make one ton of virgin paper. Because of current recycling efforts and people's acceptance of recycled paper it is estimated that over 200 million trees are saved each year (4). Because it takes less energy to make paper from paper, 64% less energy is used to make recycled paper rather than virgin wood pulp, (5) there is less air pollution (74%), less water used (58%) and less water polluted (35%)(9). Harvesting waste paper in cities creates five times as many jobs as does harvesting the raw material from forests. (8)

When weighing the "friendliness" of paper to the environment, there are 3 considerations; recycled fiber content, paper color and method of whitening, and ink and dyes .

- Recycled Fiber Content

If a paper product says the word "recycled" on it that usually means that it contains leftover paper from the paper mill and printing operations. This makes good sense for the paper and printing companies to do this but it doesn't contain paper that has been used by us consumers. We should be looking for the word "post-consumer" on a paper product. Post-consumer means that the paper has been used by a person already and instead of being thrown away it has been collected, sorted, and re-made into another paper product. 100% post consumer means no new trees were cut to make the product. Paper cannot be recycled forever, only up to 12 times (11). Each time paper is recycled the fibers become shorter and weaker so high grade papers will still need some virgin tree fiber to give strength, but think of the benefits of using post consumer recycled fiber whenever possible!

- Paper Color and Method of Whitening

Bleaching paper with chlorine makes beautiful white paper but also releases cancer causing dioxins into the environment. The more natural and duller grays and browns, require much less whitening chemicals. Hydrogen peroxide and sodium hydrosulphite are safer bleaching agents than chlorine bleach compounds.

- Dyes and Inks

Neon and bright colored papers use strong dyes that need to be bleached during recycling. Avoid these dyes and you use fewer whitening agents. Many inks are now made using vegetable dyes and are safer than synthetic or metallic inks.

*Assessment (Outcome 3): Describe the environmental pros and cons of various paper products displayed by the instructor.*

**CONCEPT:**

*Humans have a great ability to alter natural systems, and a responsibility to consider the effects of our actions.*

**CONCEPT:**

*Waste and pollution are by-products of human society.*



As more people recycle their waste paper, it becomes economically practical to use it as a resource. Purchasing post-consumer recycled paper is becoming more and more acceptable and common as we learn about its advantages. Industry has responded dramatically to market and consumer pressures and is now using ever increasing amounts of recycled fiber. Duluth, Minnesota houses one of the newest post consumer recycled paper mills in the country. More will follow. StoraEnso Company in Duluth collects 120,000 tons of office paper from the Upper Midwest each day and sends the cleaned, de-inked, and safely whitened pulp to various mills in MN. Paper used by the federal government must include 30% post consumer recycled content.

*Assessment (Outcome 4): Describe the economic and political power you have in the paper market.*



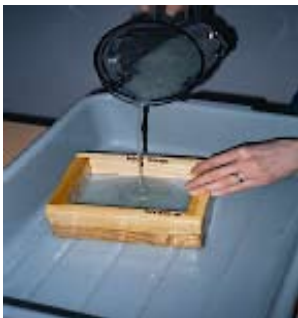
## V. Students Make Paper (45 min.)

Students should be able to make up to 4 sheets of paper which can later be used for notes or postcards. The instructor will manage the safety aspect of the blenders, supervise draining of water from the deckle tubs into the sink, and keep general chaos in check. Walk through the paper making process, explaining techniques as you go, and pointing out instruction/picture cards at each station.



### Station 1: Paper Bin

- Select paper from the paper bins.
- Collect a small (thumb-sized) wad of wool fibers. These fibers give strength to the paper.
- Rip up into tiny pieces and sort into piles on your yellow Paper Sorting Tray.



### Station 2: Sink and Blenders

- Fill blender with ripped up paper to the yellow paper line.
- Fill blender with water to the blue water line.
- Hold the cover tightly on the blender pitcher, as you blend to desired consistency (10-30 seconds).
- Tiny pieces of different colors can be blended in a second step.



### Station 3: Deckles

- Place a closed deckle into a dry deckle tub. (When water level gets over an inch deep in the tub then pour some off into the sink.)
- Pour the paper slurry evenly into the deckle. Jiggle the deckle or use your fingers to spread and arrange the slurry.
- Let the slurry drain for a minute.
- Open the deckle and lay a felt (couch) gently on top of your paper and press out the water. Wring out the couch and repeat.
- Use a roller on top of the couch to roll out the last bit of water.
- Gently peel away the couch from the paper. Lay paper face down on your drying tray (letter A-Y). Re-use the couch.



## Station 4: Drying

- Lay your paper face down on your drying tray leaving room for 3 more sheets.
- When you are done making paper, slide your drying tray into the proper slots in the paper dryer. (Rack "A" goes into slot "A".)
- When the class is done, place the wet couches on an empty drying tray and put into the paper dryer.
- Set the timer on the paper dryer for 12 hours and close the door.
- The next morning remove the dried paper from the dryer, making sure students can find their own papers.

*Assessment (Outcome 5): Show samples of your finished recycled paper.*



## VI. Clean-up (5 min.)

Have students help with the following clean-up:

Scrub the deckle screens with the brush to clean out the little screen holes.

Rinse the blender pitchers and deckles.

Dump and rinse the deckle tubs.

**Clean and rinse deckles:**

- Thoroughly scrub both sides of the deckle screens with the brush. This cleans out the little screen holes.
- Rinse and drain the deckles and tubs.
- Wring out towels and hang up to dry.
  - Dry tables.
  - Dry wet couches on extra drying racks.
- Pick up bits of paper and cotton. Use the carpet sweeper to sweep after big pieces have been picked up.
- Put all the equipment neatly away.



## VII. Conclusion (5 min.)

### A. Review

We have looked at how paper is made, how much we use (600 lbs / person / year), and the advantages of buying post consumer recycled paper. We have gone through a simplified process of paper making using post consumer recycled paper and wool fibers.

### B. Stewardship Actions

*Assessment (Outcome 4): Involve students in a discussion about how using paper products wisely can help alleviate stress on our environment.*

At our current rate of paper recycling we are conserving 200 million trees / year. "How can we increase our recycling rate to save even more trees and reduce the amount of paper going into landfills and incinerators?"

- Use more recycle friendly paper products. Less glossy, less bold and neon colors, soybean based rather than metal based inks.
- Understand the labeling of paper products and buy more 100% post-consumer recycled products.
- Let people know how you feel about the look and functionality of 100% post-consumer recycled paper products.



- Reduce your use of paper and paper products.
- Re-use paper products.
- Recycle. Urge and help others to recycle.
- Write one of your new recycled postcards to StoraEnso expressing your appreciation of their commitment and environmentally friendly technologies. (Address in appendix.)

## VIII. Appendix

### A. Equipment

2 blender motor bases  
Wool fiber bin  
Scrap paper bin  
20 paper sorting trays  
9 deckles  
9 deckle tubs  
9 rollers  
Paper Sample book  
Water, Sink, Tables  
"One Pound" ream of paper prop  
Paper Dryer

### B. Resources

Earth Care , Ukiah, CA 95842-8507, 1-800-347-0070 (Kenaf paper)  
Lee Scott McDonald, Inc. PO Box 264, Charlestown, MA 02129 617-242-2505  
Hamilton Beach Commercial 1-800-572-3331 (bar blenders)  
Faribo Woolen Mills, Faribault, MN (wool lint)  
Fort Howard Corp., Green Bay, WI 54307. (Envision 95% post-consumer toilet paper)  
Badger Paper Mills, Inc. (Envirographic writing paper 50% / 20% post-consumer)  
Wisconsin Tissue, Menasha, WI 54952 1-800-462-7546 (100% post-consumer)

### C. References

- 1) Paper and Paper Manufacture, American Paper Institute, 260 Madison , NY, NY 10016
- (2) StoraEnso, 30 W. Superior St. Duluth, MN 55802, 218-722-9510
- (3) Minnesota Forest Industries, Inc. 208 Phoenix Bldg, Duluth, MN 55802, 218-722-5013.
- (4) The Futurist, Feb 1984.
- (5) National Association of Recycling Industries, 330 Madison Ave., New York, NY 10017.
- (6) Paper By Kids, Arnold E. Grummer, 1980. ISBN: 0-87518-191-0
- (7) Earth Care , Ukiah, CA 95842-8507, 1-800-347-0070
- (8) The Environment, Nov. 1981.
- (9) "A Guide to Recycling", Indiana State Board of Health, 1981.
- (10) Minnesota Pollution Control Agency, 1992.
- (11) "The Truth About Recycled Paper", Minnesota Volunteer, Sept.-Oct.1991.
- (12) Project Learning Tree, American Forest Foundation, 1993.
- (13) "Making Paper Without Trees", World Watch, Sept./Oct 1993.

Web resources:

Minnesota Forest Industries, Inc. [[www.minntrees.org](http://www.minntrees.org)]  
American Forest and Paper Association [[www.afandpa.org](http://www.afandpa.org)]  
Forest Resource Environment Education Network [[www.freenetwork.org](http://www.freenetwork.org)]

## D. Safety Management

Instructor will adhere to all safety practices designated by this lesson plan or updated by Wolf Ridge staff. Instructor will carefully monitor students for safe and responsible use of scissors and pruners. A first aid kit and telephone are available in the kit room. Any safety or risk concerns should be brought to the attention of the Wolf Ridge permanent staff.

## E. Glossary

Post-consumer recycled paper: Paper used and discarded by consumers that has been recycled into another product.

Deckle: The hand mold used to make paper.

Couch: Pronounced "kootch". A piece of felt or similar water absorbing material used to press out the water from newly made paper. The paper adheres to the couch until dry and is then pulled away for reuse.

Pulp: fibrous material prepared from wood, recovered paper, cotton, grasses, etc., by chemical or mechanical processes for use in making paper or cellulose products.

Renewable Natural Resource: A naturally occurring raw material or form of energy which has the capacity to replenish itself through ecological cycles and sound management practices.

Nonrenewable Natural Resource: Raw materials supplied by the earth that cannot be replaced for a long time if ever.