DOCUMENT RESUME

ED 099 236 SE 018 449

TITLE [Resources Unit, Edmonds School District.]
INSTITUTION Edmonds School District 15, Lynnwood, Wash.
PUB DATE [74]
NOTE 75p.

EDRS PRICE MF-$0.75 HC-$4.20 PLUS POSTAGE
DESCRIPTORS Conservation Education; Depleted Resources; Ecology; Educational Programs; Energy; *Environmental Education; *Instructional Materials; Interdisciplinary Approach; *Learning Activities; *Natural Resources; Outdoor Education; Pollution; Recycling; Science Education; *Secondary Grades; Soil Science

ABSTRACT

This interdisciplinary program, developed for secondary students, contains 13 natural resource activities that can either be used directly in, or as a supplement to, curriculum in Science, Photography, Mathematics, Social Studies and English. The topics to be investigated include: raindrop impact, resource control, recycling, the world model, elements, water retention, charting the use of electricity, nuclear power plants, soil fertilizer and pH. Each learning activity includes: subject area and grade level for which it can be used, level VI objectives, time schedule for prelab and performance of the activity, background information for the teacher and a listing of materials needed. A listing of suggested films is included. (BT)

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RESOURCES

LEVEL VI OBJECTIVES

The student will know how the force of falling rain affects different soil types, e.g., clay, loam, sand, and glacial till.

The student will know that conserving the use of electricity and water in the home is a way of conserving total petroleum and water resources.

The student will know that a tax on automobiles would be one possible means of financing the reclaiming of our nation's resources.

The student will know several effects of population growth on agricultural production, non-renewable resources, industrial output, and pollution generation.

The student will be able to write a hypothetical solution to one world population problem.

The student will know the elements that are included in certain types of soil.

The student will know that different types of soil retain different amounts of water.

The student will know the physical differences between soil types such as texture, adhesion, and composition.

The student will be able to compute energy consumption of electricity in the home in terms of the amount of oil needed to create that amount of energy.

The student will be able to predict the future world availability of the following natural resources: aluminum, coal, copper, iron, lead, natural gas, nickel, petroleum, silver and tin.

The student will know the legal procedures involved in obtaining a permit from a county zoning board in order to build a nuclear power plant.

The student will know how certain types of fertilizers affect the growth of grass seeds.

The student will know how alkalinity and acidity affect plant growth.

R-1 **SUBJECT**

Science

LEVEL (7 - 12)

EST. TIME (45 min.)

RAINDROP IMPACT

LABORATORY INVESTIGATION

The force of raindrops has an effect on soil structure.

LEVEL VI OBJECTIVE

The student will know how the force of falling rain affects different soil types, e.g., clay, loam, sand, and glacial till.

Water falling from any height has an effect on the object it hits. The student often is unaware of this actuality when we are talking about the ecosystem that exists between the land, and the water that is constantly trying to wear it away.

In this exercise, the size of the drops, their velocity, and their rate of fall can be varied to provide a variety of conditions. The student, therefore, can approximate those conditions that one finds in that gentle drizzle "the Washington mist" to the real "Gully Washer" thunder-shower one experiences in the Southwest and Midwest. Soil erosion has been a prime consideration of conservation groups for many years, but our emphasis has been on the affect on farm soils. Today we have to consider the effect on residential housing tracts that have been denuded of their cover as well as that on the large mountain areas that have been laid bare by block forest cutting.

The student could set up as many variables as time and equipment permit.

MATERIALS

Soil Samples
Chemistry Buret
Support Rod
Ruler
Shoe Box of similar container

RESOURCES

EARTH SCIENCE: A Laboratory Approach, Investigating The Earth. Marean, John A. et al. Addison-Wesley, 1970.

A STUDY OF SOIL SCIENCE, 2nd Edition. Dr. Henry D. Foth LaMotte Chemical Products Co. Chestertown, Maryland 1970

LAMOTTE SOIL HANDBOOK: LaMotte Chemical Products Co. Chestertown Maryland 1972

PRE-ACTIVITY

Have the students gather soil samples from around the community. Try to get a diversity of types which at least include one clay, sand, loam and glacial till.

1. Do raindrops actually affect the soil structure?
2. Why does desert soil have a high runoff rate?
3. Can soil texture slow down soil loss?

POST-ACTIVITY

COMPARE & DISCUSS

1. What would stream flow be like immediately after a heavy rainfall in an area in each of the soil sample types?
2. What type would probably be most productive biologically? Why?
3. What could a farmer do to the other soil types to bring about the conditions found in the good soil?

ACTIVITY

TASK: RAINDROP IMPACT

1. Each group will place a soil sample in a shoe box or comparable container.
2. Smooth the surface as smooth as possible.
3. Place the shoe box 3 feet below chemistry buret that contains water.
4. Carefully release the water a drop at a time. Move the box each time so that a fresh target is presented unless the cumulative effect of raindrops is to be measured.
5. Look for crater formation.
6. Measure the depth of the crater if possible and the splash zone (area that is affected by the raindrop).
7. Observe how the soil sample effects the raindrop. Does the drop bounce? Is it cushioned?

IMPACT OF RAINDROPS

Soil Type	Crater Depth	Splash Zone	Impact Appearance
1.			
2.			
3.			
4.			
5.			
6.			

R-2

SUBJECT: Social Studies, Photography, English, Science

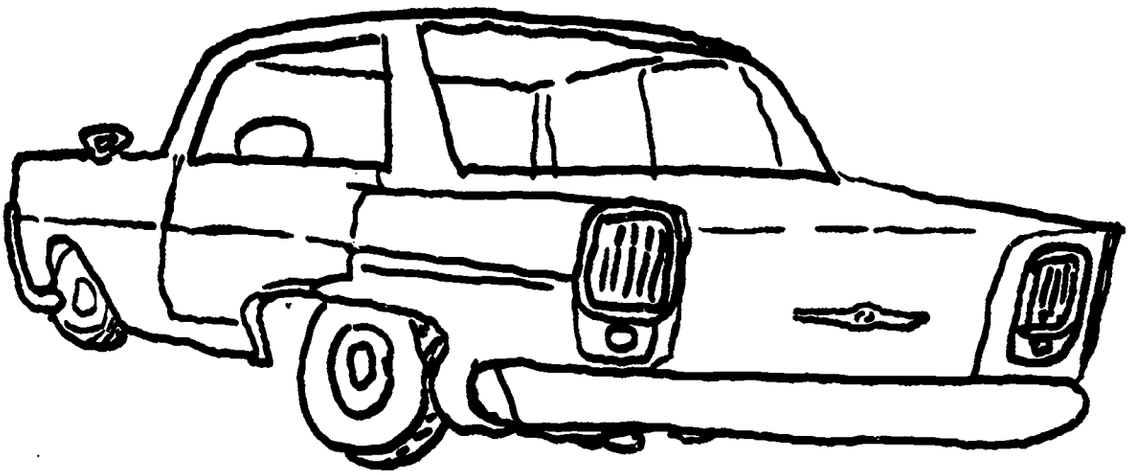
LEVEL: 10--12

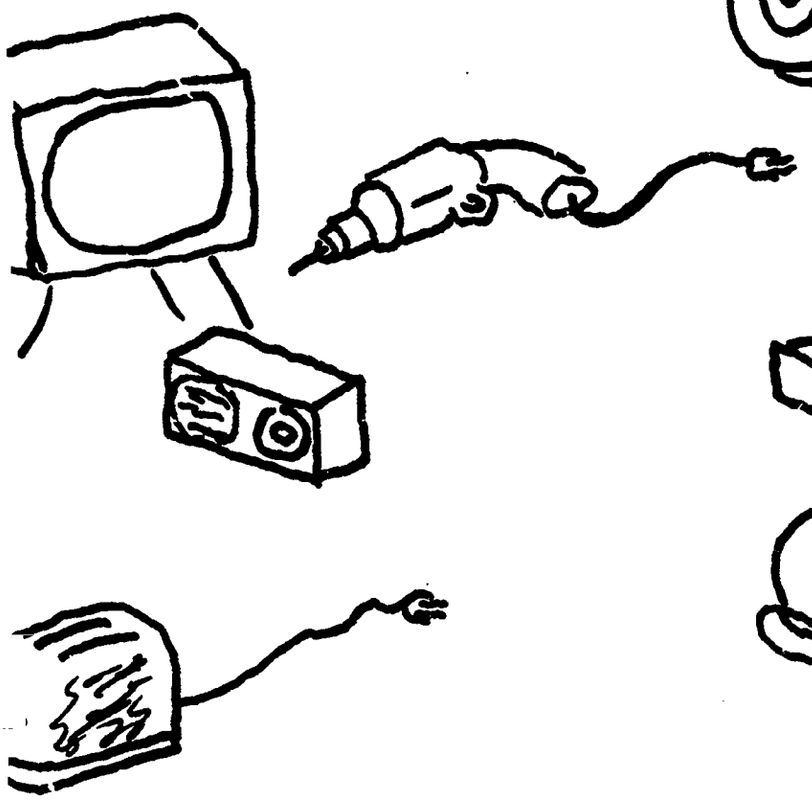
ESTIMATED TIME: 2 weeks

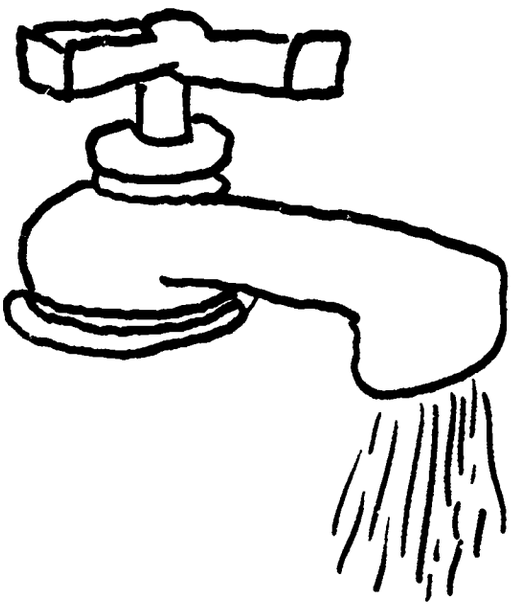
Controlling our resources.

PHOTO ESSAY

Means of controlling our resources can be photographically recorded.







LEVEL VI OBJECTIVE

The student will know that conserving the use of electricity and water in the home is a way of conserving total petroleum and water resources.

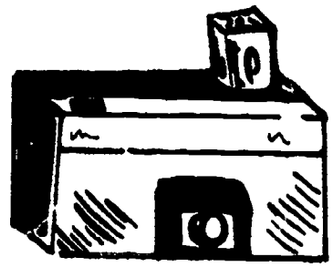
TEACHER INFORMATION:
Prepare a list of probable areas to photograph.
Example: Poor usage of electricity in the home, using cars for transportation instead of mass transit or car pools, leaving water running when not using it, and many other areas.

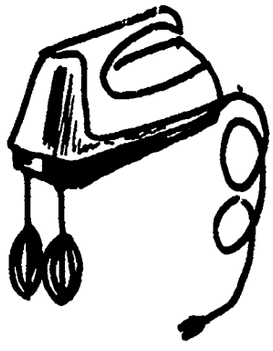
The teacher should have a photo essay prepared as a working model for the students. This may be done by having before and after photo sequences or by using a photo of poor utilization versus conservative usage of energy resources. A 3"x 5"card may be placed next to each photo explaining why or why not this photo exemplifies conservation of energy resources. Allow enough time for the assignment to cover photographing and developing of the film (approximately two weeks). Some questions which could provide student interest in the project may be: "What are various types of energy resources?" "How might we control the use of these resources?"

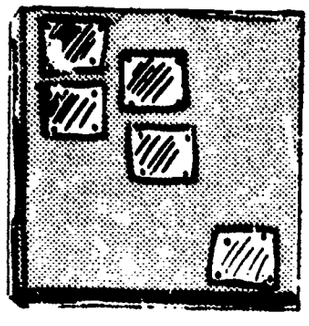
MATERIALS NEEDED:
Camera, Film, Bulletin Board or Tag Board Sheets onto which the photos may be mounted; Model of a Photo Essay; pens, marking pens and/or pencils; means of transportation

PRE-ACTIVITY:
Hand out list of areas to photograph. Plan the sequence and photo format to be used. Collect equipment needed and decide whether a Bulletin Board or slide show is to be used. Students should list sequence of their photographs in order to plan out their visiting these areas.

ACTIVITY:
Visit areas taking pictures of resource waste and then photograph ways of conserving these same resources. Try to get photos of usage of the following energy resources: electric, water, minerals, and gas. Send in film to be developed.







POST-ACTIVITY:
Upon receiving developed prints of the photographs, write up a description of each photograph on a 3x5 card. Place these descriptions next to each photo explaining why or why not each photo exemplifies conservation and control of energy resources. Place these on a bulletin board or tag board display.

Classroom discussion should follow, evaluating the methods of controlling resources as represented by the photo essays.

Discuss other solutions to some of the improper usage of resources. Identify those resources which are non-renewable. Example: Petroleum, coal, uranium, etc.

R-3

SUBJECT AREAS: Math and Social Studies

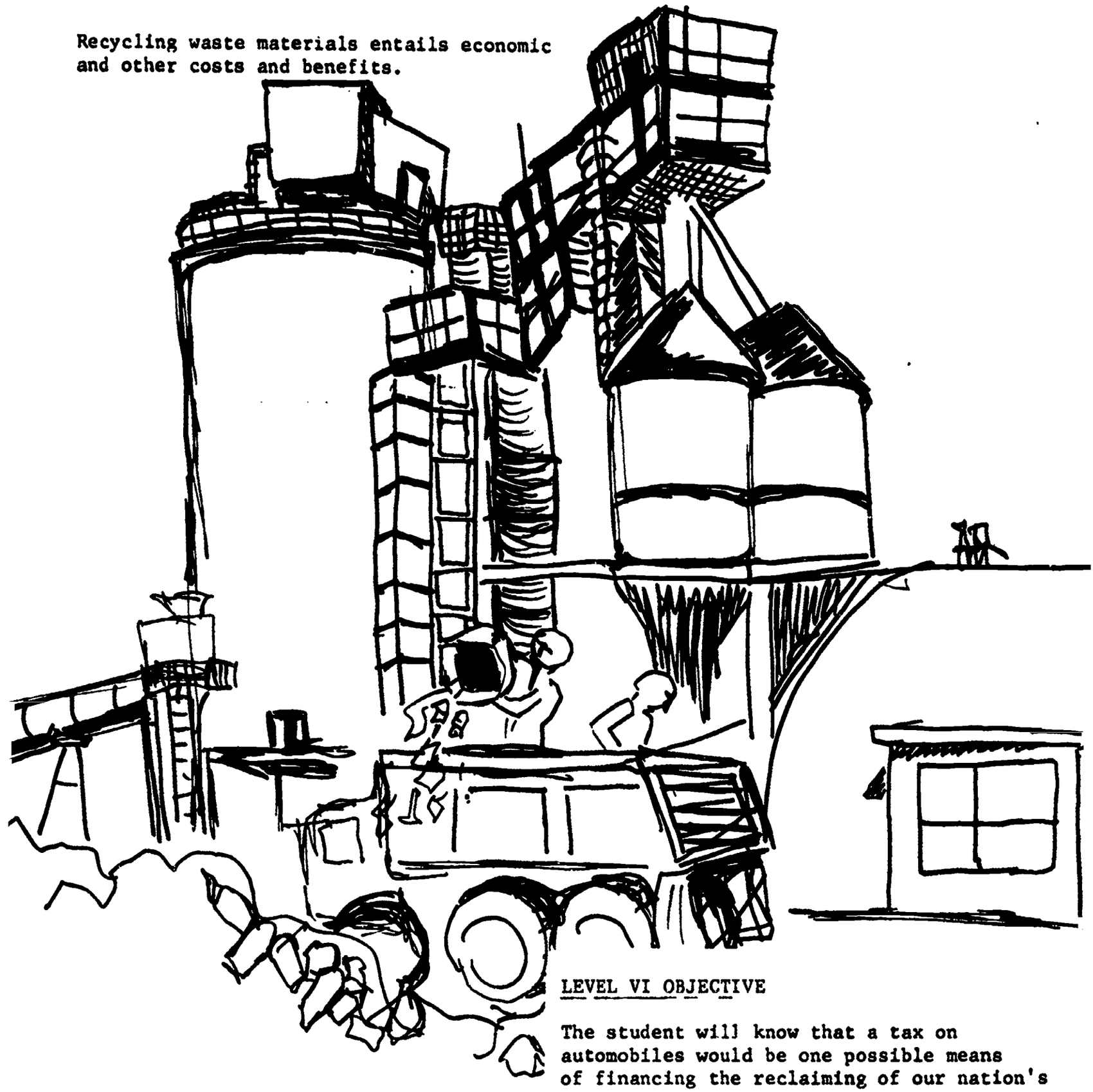
LEVEL: 7 - 12

ESTIMATED TIME: 50 min.

Funding of, and Recycling Process for, the reclaimable waste materials in the United States.

PROBLEM SOLVING

Recycling waste materials entails economic and other costs and benefits.



LEVEL VI OBJECTIVE

The student will know that a tax on automobiles would be one possible means of financing the reclaiming of our nation's resources.

TEACHER BACKGROUND

The figures used in the following sequence of problems are representative of totals published in the 1971 Environmental Quality Index of the National Wildlife Federation and publications of the U. S. Environmental Protection Agency.

It is necessary to caution the students to use the utmost care in checking and re-checking each segment of the total collection of problems, as the information gathered from the solving of one problem will be used in the following problem.

MATERIALS NEEDED

Pencil and Paper

REFERENCES

1971 E. Q. Index

PRE - ACTIVITY

Some opening questions one might use to bring about class interest in the problem might be:

What are some ways of controlling our loss of natural resources in the U. S. today?

How much would you be willing to pay per year to recover reusable resources?

ACTIVITY

Solve the following problems:

1. If the owner of each automobile in the U. S. were to pay a fee of $50, and there are 90,000,000 automobiles in the U. S., how much money would these fees provide to build recycling plants?

   _____

2. If each of these plants were to cost $4,000,000, how many could be built?

3. If each plant could handle the garbage output of 200,000 people, and there were 200,000,000 people in the U. S., how many plants would it take to handle the total output?

4. If a recycling plant processes 500 tons of garbage per day, what would the annual tonnage be, based on a 365-day year?

   _____

5. From the annual tonnage of recycled garbage, a plant recovers:

15,600	tons of ferrous metal worth	$173,200
16,120	tons of glass worth	$188,900
5,460	tons of paper fiber worth	$70,434
780	tons of aluminum worth	$138,000
5,460	tons of sand worth	$5,500
260	tons other metals worth	$45,800

   218 million pounds of steam (convert to tons.)

   The plant's profit is $100,000. Figure the following:

   A. Cost to run the plant_____

   B. Total tonnage reclaimed_____

   C. Tatal tonnage that is waste_____

POST ACTIVITY

Based on your prediction and the solutions you found for the problems, what conclusions might be drawn concerning the feasibility of using this means to fund a recycling effort in the United States?

R-4 **SUBJECTS**

Science, Social Studies

LEVEL (10 - 12)

EST. TIME (45-90 minutes)

THE WORLD MODEL

INVESTIGATIVE

The earth is finite, and resources available for human use are limited. If man is concerned with long-term survival on earth (i. e. hundreds or thousands of years) he will have to achieve a dynamic balance within the earth's limits and natural laws. A world model has been formulated, using the tools of systems analysis and computer technology; this model is being used to define the limits of human population and technological growth.

LEVEL VI OBJECTIVE

The student will know several effects of population growth on agricultural production, non-renewable resources, industrial output, and pollution generation.

The student will be able to write a hypothetical solution to one world population problem.

The Limits to Growth is the nontechnical report of an international team of researchers commissioned by the Club of Rome and working at Massachusetts Institute of Technology under the direction of Dr. Dennis L. Meadows. Their study, begun in 1970, examined the implications of continued worldwide growth on a planet of finite size and containing limited exploitable resources. The basic conclusion of the study is that the world ecosystem apparently cannot support present rates of economic and population growth much beyond the year 2100, and probably not that long, even with advanced technology and increasingly sophisticated mineral discovery and extraction techniques.

Five major, interacting factors were considered to be potential limiting factors for human activity on earth: Population increase, agricultural production, non-renewable resource depletion, industrial output, and pollution generation. Data on these five factors was fed into a complex global world computer model, employing multiple factor interaction and feedback loops. The behavior of the global model was then tested under several sets of assumptions to determine alternatives for mankind's future.

If growth continues to follow trends set from 1900 to the present, the model predicts that the primary limiting factor will be nonrenewable resouce depletion, becoming critical around the year 2000, and very quickly producing an unpleasant chain of events for the earth's inhabitants. Collapse of the industrial and agricultural systems eventually leads to a population crash as death rate catches up with and finally surpasses the birth rate sometime before the year 2100.

Changing sumptions give different world behavior modes. The effects of birth control policies, resourse recycling, finding new resource deposits, pollution control and various combinations of technological solutions alone are not sufficient, nor is birth control alone, or multiplication of exploitable resources alone. A combination of changes in technology, economic and political priorities, and human value systems was necessary to produce a stable world model beyond the year 2100.

Moreover, all these changes were instituted in 1975 to produce the Stabilized World Model. Waiting until the year 2000 to introduce the same changes produced an unstable global condition with eventual population crash, as resources had already been too depleted. Thus, the authors suggest that the world can be saved, provided we act quickly.

The MIT research team is continuing to refine its computer model and the data that go into it. A computer prediction is only as accurate as the data and assumptions on which it is based; in other words: GARBAGE IN, GARBAGE OUT. Probably we should consider The Limits to Growth as only a preliminary report, and watch for future updates. The report has already generated much discussion and controversy. Some economists and social scientists believe that the computer model is based on entirely false assumption-; others believe that important determining factors (particularly social and political factors) have been left out of the model.

(continued)

Regardless of the controversy, The Limits to Growth is a sobering message, and if we wait too long to get the word out, it just may be too late. The nature of exponential population and economic growth and exponential resource depletion is such that when things first start to get uncomfortable, it's already too late to do anything about it.

MATERIALS

"Standard Run" graph

"Stabilized" graph

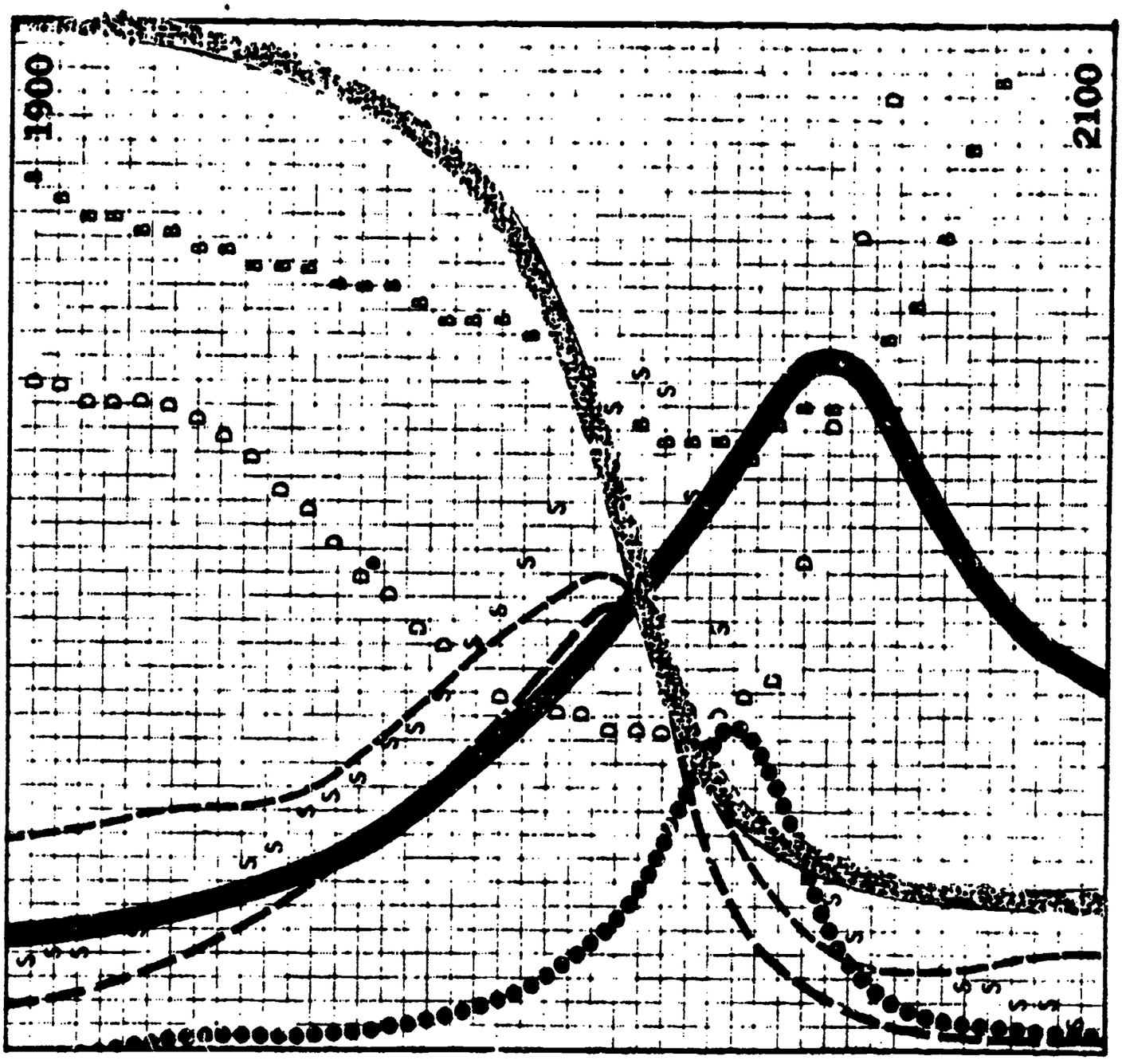
pencil

REFERENCES

THE LIMITS TO GROWTH,
Dennis L. Meadows, et al,
Potomac Associates, Universe
Books, New York, 1972

ACTIVITY

WORLD MODEL: Standard Run

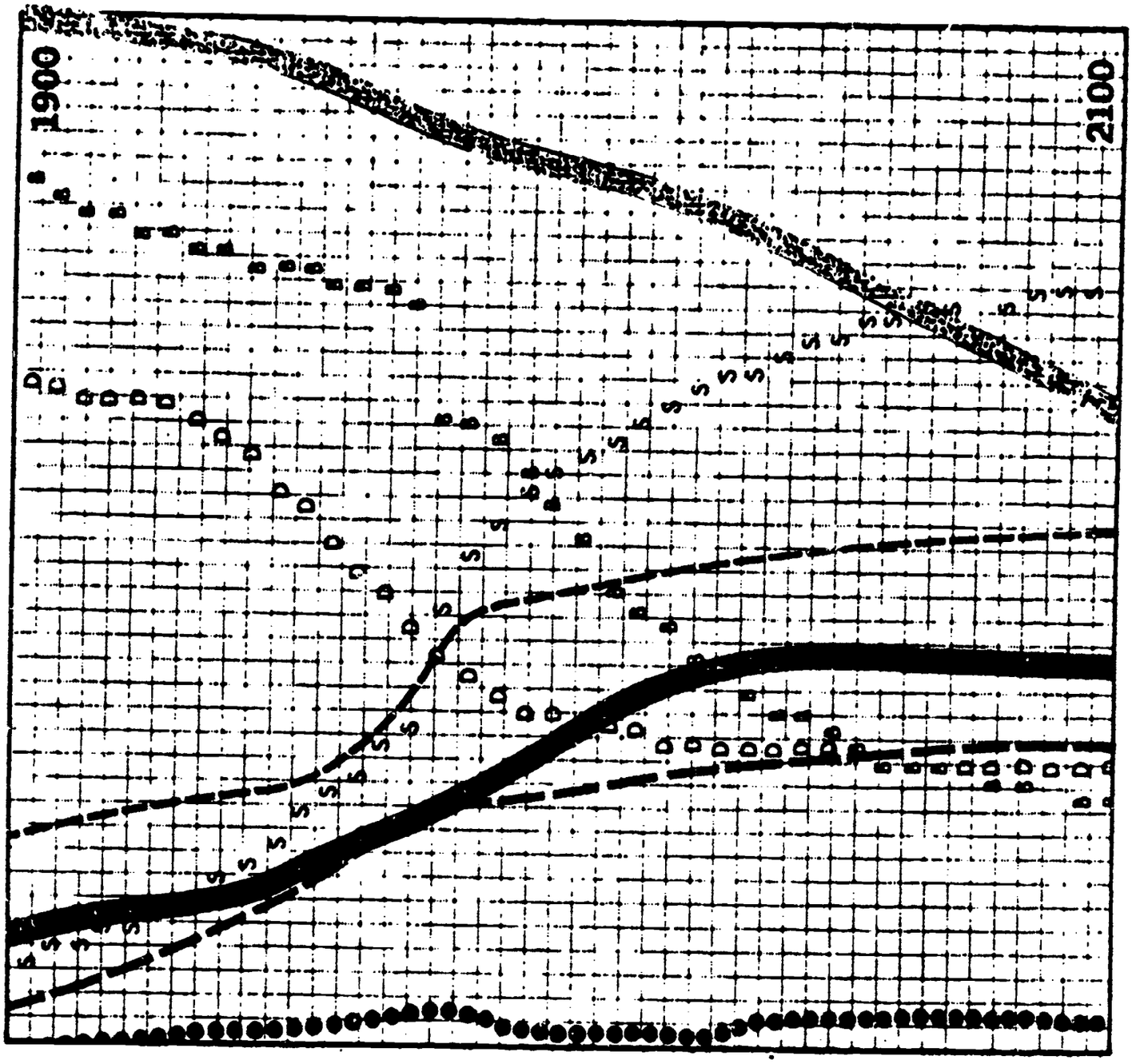


The "standard" world model computer run assumes no major change in the physical, economic, or social relationships that have historically governed the development of the world system. All variables plotted here follow historical values from 1900 to 1970.

KEY:

Population
Industrial output per capita
Food per capita
Pollution
Non-renewable resources
B Crude birth rate
D Crude death rate
S Services per capita

WORLD MODEL: Stabilized



The assumptions for this model will be found on the reverse side.

KEY:

- Population
- Industrial output per capita
- Food per capita
- Pollution
- Non-renewable resources
- B Crude birth rate
- D Crude death rate
- S Services per capita

PRE-ACTIVITY

Duplicate the graphs and have them ready to distribute to the students. For group instruction you may also wish to prepare transparencies to use with the overhead. Check with the library for reference books to provide the students with sources to debate and/or refute the statements in the book.

1. How long will the resources of the world last at the present rate of use?

2. What is the maximum population that the world can support?

3. What are the fundamental factors that effect the total population?

4. What are the basic alternatives that can be offered to "save" the world?

POST-ACTIVITY

1. Read the whole book Limits to Growth (it's non-technical, straight-forward).

   If you groove on computer language, feedback loops, etc., read the technical reports of the MIT group under Dr. Dennis Meadows, to be printed in technical journals.

2. Watch for reaction in the press to the Meadows' Limits to Growth report. A number of critical reviews of this MIT computer study have already appeared, and there will probably be more.

3. The U.S.G.S. has recently put out a lengthy report on limited resources. This, as well as a report by a British agency seem to support the main thesis of "the Limits." You might try to dig up these reports and look for others, which either support or tend to refute the Limits to Growth.

I. Study the "Standard Run" Graph that Has Been Presented To You.

   A. What, basically, does the graph suggest to you?

   B. What happens to human population? Approximately when is this projected to occur?

   C. What cause - effect relationships are implied by the graph? (i.e., What happens first, second, etc., and how might these occurrences be related?)

   D. Can you suggest an explanation for the time delay between the collapse of industrial productivity and the decline of pollution?

   E. Analyze the birth rate and death rate curves. How do these two factors relate to the population curve? Do the projected trends in birth and death rate seem reasonable to you?

   F. This computer-drawn graph simply attempts to project current trends into the future. Do you feel that the prediction is basically valid?

   If you question the validity of the "Standard Run" prediction, what factors do you think might have been omitted from the computer model, or what weakness in the model might have led to a misleading prediction?

G. Explain the essential message of this graph by defining the caption "Overshoot & Collapse Behavior Mode". What, essentially, is being overshot?

H. What is an exponential (or logarithmic) curve? Which factors on the "Standard Run" graph follow exponential curves? What are the implications of exponential growth (or exponential decrease)?

II. Do you like the "Standard Run" picture of life in the future? If so, you have only to keep things going as they are. If not, how would you like to change the picture?

A. Define your goals/or the world's future and re-draw the graph as you would like to see it. Label your graph "MY UTOPIA".

B. Assume that the Standard Run graph gives a valid prediction for business as usual; also assume that the resource depletion problem is a reality.

What changes can you suggest that might contribute to the long-term survival of mankind on earth with a reasonably high quality of life. Consider technological, social, life-style, legislative, economic, value system or other types of change.

C. The changes you have suggested might be refined to form your "blueprint for long-term survival." What difficulties can you anticipate in actually making the changes you have suggested? Are any of the suggested changes already being started? How long do you feel we can wait before the other necessary changes are initiated?

D. What things can you as an individual do to put humanity on the path to your "Utopia"? Remember, no contribution is too small!

III. Show the STABILIZED WORLD MODEL Graph, and discuss the changed assumptions behind it. Note that stability could not be obtained in the computer model without making all these changes.

A. How does the STABILIZED WORLD MODEL compare with the "Utopia" you designed?

B. How do the changes recommended by the MIT research team compare with the changes you suggested?

R-5

SUBJECT

Science

LEVEL (7 - 12)

EST. TIME (90 minutes)

SOIL: ELEMENTS

INVESTIGATION

Soil is constituted of a mixture of individual elements and compounds that furnish the basic raw materials for plant growth.

LEVEL VI OBJECTIVE

The student will know the elements that are included in certain types of soil.

Teacher Background:

The most precious substance on this earth is its soil. Without this mantle of dirt life would be at a simple bacterial level. The green mantle with its associated animal life would be non-existent.

Element components of soil can be divided into two groups: those that are required in macroquantities and those that are required in microquantities. Those that are required in macroquantities are carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur, the essential elements of plant growth. Those that are required in microquantities are iron, zinc, copper, chlorine, vanadium, manganese, cobalt, boron, molybdenum, and sodium, the trace elements of plant growth. While the lack of any of the major elements is readily apparent and will probably not even allow the plant to start growing, the lack of one of the trace elements is not obvious at first. The plant may still grow to maturity, although it is weak and sickly. The trace elements are necessary for many of the activities that are going on in the plant. These incompletely understood processes include chlorophyll formation, photosynthesis function, electron transport systems, and enzyme and co-enzyme activities.

The student should become familiar with the mineral components of soil. With further investigation on world agriculture he should be able to make some judgements on why certain areas of the world lend themselves to agriculture and others don't, as well as how to create new areas.

MATERIALS

Soil samples
A soil test kit (LaMotte or comparably equipped kit)
Containers
Trowels or spoons

RESOURCES

EARTH SCIENCE: A Laboratory Approach, Investigating the Earth. Marean, Joan A., et. al. Addison-Wesley. 1970

A STUDY OF SOIL SCIENCE 2nd ed. Dr. Henry D. Foth: LaMotte Chemical Products Co. Chestertown, Maryland 1970

LAMOTTE SOIL HANDBOOK, LaMotte Chemical Products Co., Chestertown, Maryland 1972

PRE-ACTIVITY

Have the students collect soil samples for analysis. Make sure there is a variety for initial tests to get as broad a spectrum of soil types as possible. After the tests have been made to establish the mineral makeup of the soil samples, the students could also analyze the soil samples of their own yards.

ACTIVITY

TASK: Soil Analysis

What mineral resources are present in my soil sample? One-half pint should be sufficient. Using the soil test kit (LaMotte) run the soil tests according to directions and determine the elements present.

Mineral	Soil Sample #1	Soil Sample #2	Soil Sample #3
N			
P			
K			
Ca			
Mg			
Mn			
S			
Fe			
Al			
NH_3			
NO_2			
Cl			

DISCUSSION

1. What minerals are present and which are lacking in the soil around my house?
2. Where do the minerals come from that are present in the soil?
3. Can soil be reconditioned?

EXTENDED ACTIVITY

Have class offer to analyze soil from the community for a nominal fee.

1. Determine the composition of the fertilizer necessary to bring your soil up to good biological productivity.
2. What factors contribute to the depletion of certain minerals?
3. Only 10% of the land in the world is suited for agriculture. Is this due to a lack of minerals or is it due to other factors? List the factors that would influence land being farmable.
4. Explain why tropical regions are poor for agriculture.
5. Are desert areas worth the monetary investment?

R-6

SUBJECT

Science

LEVEL (7 - 12)

EST. TIME (45 minutes)

SOIL: WATER RETENTION

INVESTIGATION

Soil has many physical characteristics that can be measured. These characteristics interact to influence plant growth in a variety of ways.

LEVEL VI OBJECTIVE

The student will know that different types of soil retain different amounts of water.

 BJECTIVES

TEACHER BACKGROUND

The soil is the foundation for growth of plants. Although the bulk of the plant is made up of water and carbon dioxide, the trace elements and major elements present in the soil provide the key components in the plant functioning.

These elements contribute to the pH of the soil. Their ability to bind together may affect their availability to the plants, and they can influence the vegetation present in an area. The science of Geobotany is based on the fact that a species of plant requires certain minerals, or can tolerate excess amounts of a mineral. A local example is the Salt Tolerant Plant, Saltcornia, which lives in the splash zone adjacent to the salt water. Other plants are indicators for vanadium, manganese or other elements.

The water holding power of soil, which is based on its structural composition, is a key to its characteristic vegetation. Climate and soil work together to form a biome of plants.

MATERIALS

Orange juice cans
(both ends cut out)

Soil Samples
(loam, clay, sand, gravel)

Filter paper
Containers for soil samples
Shallow pan
Support Rod
Balance
400-600 m/breakers
Glass tubes (20 mm diameter)
Crucible gas burner
Crucible tongs

RESOURCES

EARTH SCIENCE: A Laboratory Approach, Investigating the Earth.
Mason, John A. et al.
Addison-Wesley. 1970

A STUDY OF SOIL SCIENCE, 2nd Ed.
Dr. Henry D. Foth
LaMotte Chemical Products Co.
Chestertown, Maryland 1970

LAMOTTE SOIL HANDBOOK
LaMotte Chemical Products Co.
Chestertown, Maryland 1972

TASK #1 (Work In Groups of 2 or 4 people)

Each group will have samples of four or more soil types, including, loam, clay, sand, and glacial till. The samples have been dried.

Weigh out 50 gram samples into the organge juice cans. Place the filter paper over the end of the orange cans, and place the can in a beaker and fill the beaker with water to a depth 1/2 that of soil height. Let the soil soak over night. The next day reweigh the can and record the following:

SOIL TYPE	DRY WEIGHT	WET WEIGHT	% WATER HOLDING CAP
Loam			
Sand			
Clay			
Glacial			
Till			

Now take dry samples of soil, and place them in glass tubes. Tamp the soil down, and set them on end in a shallow pan. Time the rise of water in each tube. This can be noted by the appearance of moisture on the sides and top. Record the rate of capillary movement.

Weigh out another 50 gram sample of soil of each type and place in a crucible. Carefully incinerate this crucible over a gas flame until there is no more smoke given off, or there is no more glow in the crucible. Now reweigh the soil samples. The amount of weight lost is due to humus (organic material). Record these measurements.

TASK - Capillary Movement and Humus Content

SOIL TYPE	RATE OF WATER MOVEMENT	DRY WEIGHT	WEIGHT AFTER INCINERATION	% of HUMUS

PRE-ACTIVITY

Assemble the materials for the students and have them bring in the variety of soils. Also have readings available for them to do further research in.

1. What factors influence the water holding capacity of the soil?

2. How fast can water move through the various types of soils?

3. Does the amount of plant material affect the water holding capacity of the soil greatly?

ACTIVITY

(see following page)

POST-ACTIVITY

Discussion

1. What soil type is probably best for crops?

   Which type would be best for irrigation ditches?

   Which type would be best for a walkway base?

2. If time permits, repeat the water holding experiment with incinerated soil.

   Compare the results with unincinerated soil.

   Are the differences as great between soil types?

   What apparent role does humus play in soil?

3. Looking at the capillary rate chart, which soil type is probably best for desert plants (xerophtes)?

   Which type is most characteristic of the Snohomish River Valley?

4. Is there a direct correlation between water holding capacity and capillary rate?

   Why or why not?

R-7 **SUBJECT**

Science

LEVEL (7 - 12)

EST. TIME (45 Minutes)

SOIL:

TEXTURE, ADHESION, COMPOSITION

INVESTIGATION

Various soil types differ in their physical characteristics.

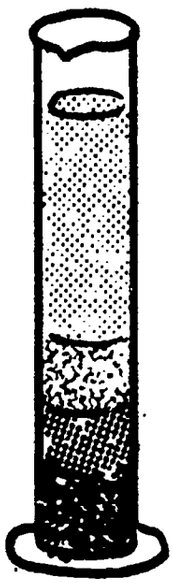
LEVEL VI OBJECTIVE

The student will know the physical differences between soil types such as texture, adhesion and composition.

TEACHER BACKGROUND

The structure of the soil determines to large degree, what can grow in that area. Whether the soil is compacted or friable will affect water retention and seed retention. The adhesive characteristics will result in soil that has particles that fall apart or cling tenaciously like gumbo. Also can seeds successfully penetrate the soil with their roots to find adequate moisture and minerals? The ability of oxygen to permeate the soil, which in turn influences microbial populations and decomposition is a function of soil.

Soil types in the world affects not only man's agriculture, but also his building foundation construction, his waste treatment methods that depend on the percolation of wastes through the soil, and the soil's ability to act as a water reservoir. In this exercise, the student will note the many variables that constitute soil.



MATERIALS

Soil samples
loam, clay, sand, gravel

100 ml graduates

Ruler (mm)

PRE-ACTIVITY

Have the students collect soil samples of many types and from many areas. Have them work in groups of four.

1. How can soil be separated into its component parts?

2. What particles make up soil structure?

3. What does soil look like through the microscope?

ACTIVITY

TASK: Your group has many soil samples to work with. You are going to test for texture, adhesion of particles, and particle size.

1. Take a soil sample and rub it between your fingers and describe its texture. Is it smooth like powder or gritty? Is it slippery or rough? Record its textural feel.

2. Make sure that the soil sample is wet. Pick up a handful and squeeze it firmly. When you release your hand, do the soil particles stay together or do they fall apart? If the soil crumbles, is it in large blocks or is it in small individual particles? Describe the adhesion (clinging together) properties of your soil samples.

3. Add water to a soil sample to make a suspension. Pour this suspension into a 100 ml cylinder. Shake vigorously and allow the suspension to settle. Using a millimeter ruler, measure each sedimentary layer. Record these measurements and calculate the % of each soil sample that is composed of silt, sand, gravel and humus.

POST-ACTIVITY

Discussion

1. Based on your chart which soil source would you predict to be most biologically productive? Why

2. What combination of characteristics recorded in your chart would produce a soil type that would not retain water well?

   What combination of characteristics would produce a soil that would hold water well?

3. What factors are responsible for the diversity of local soil types?

4. What soil additives could be added to a soil type to "condition" it?

TASK: TEXTURE, ADHESION, AND COMPOSITION

Soil Sample Source	Texture	Adhesive	Sediment in mm				Sediment in %			
			Sand	gravel	silt	humus	sand	gravel	silt	humus
1.										
2.										
3.										
4.										
5.										
6.										
7.										

R-8 SUBJECTS

Math and Social Studies

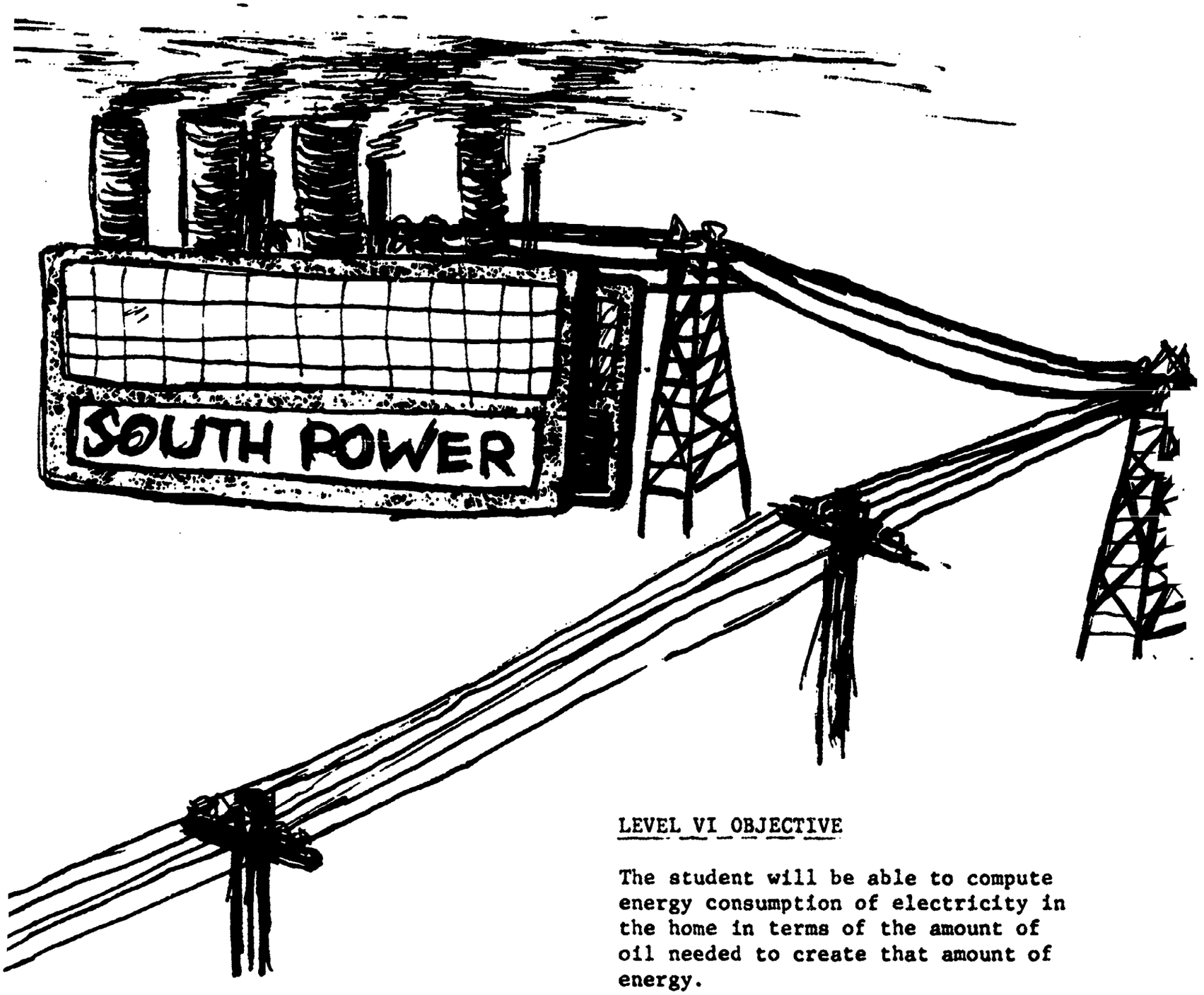
LEVEL (7 - 12)

EST. TIME (8 days)

Charting the use of electricity with the home and figuring the amount of non-renewable resources used to produce the energy.

DATA GATHERING

Steam generator plants use up natural resources in producing electric power.



LEVEL VI OBJECTIVE

The student will be able to compute energy consumption of electricity in the home in terms of the amount of oil needed to create that amount of energy.

TEACHER BACKGROUND

Give the students the following figures with which to solve the problems: One gallon of oil produces 6.2 kilowatt hours (1,000 Watts = 1 kilowatt). Run off the charts in the Appendices to help the students figure their data. Students who live in apartment complexes may get a general average by dividing the total kilowatt hours by the number of apartments occupied.

MATERIALS NEEDED

Pencil, paper, graph paper, red and blue colored pencils, copies of "How To Read Your Meter" and "Appliance Use Facts."

REFERENCES:

Local newspapers, ecology magazines, E.Q. Index from The National Wildlife Magazine

RESOURCES:

Power Companies

PRE ACTIVITY

The opening questions one may use to bring about class interest in the problem could be: "What Are Some Ways Of Controlling Our Loss Of Natural Resources In The Home?" "What ways might one use to conserve electrical energy in your home?"

ACTIVITY

Each student will keep a daily log book of the total kilowatts used per day for seven days. This is accomplished by taking one reading of the electrical meter using the "How To Read Your Meter" as a guide. Enter this figure at the top of the page and take a reading 24 hours after the first reading. This will be day Number One.

Repeat the process six more times. This will give you a total of each 24 hour period for seven days. Enter these figures on a graph and then convert the kilowatt hours to gallons of oil used by dividing by 6.2 for each day's total. Enter this on the graph. Using the "Appliance Use Facts Sheet", project where some conservation of electrical energy may take place. Apply these figures to your own home and make a daily total of the difference between subtracting the kilowatts saved per day from your total. Construct a second graph showing the kilowatts used and the conversion to oil used. Make a comparison of the two graphs.

POST ACTIVITY

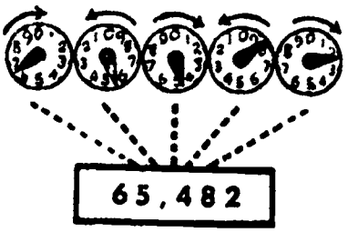
How many gallons of oil were you able to save in the seven days? Total the class differences and average (Divide class number into total). Using this figure to represent an average in fuel savings per day, multiply by 365 to give yearly total saved per family. What does this exercise represent to you in terms of controlling your non-renewable resources?

APPLIANCE USE FACTS

(Average Per Month)

APPLIANCE	AVERAGE WATTS	HRS OPER	KWH USE	AVER MO COST
Baby Food Warmer	160	44	7	5.4¢
Blanket	190	80	15	11.6¢
Blender or Liquifier	290	3	1	.78¢
Bottle Warmer	500	6	3	2.3¢
Clock	2	720	1	.78¢
Coffee Maker	850	15	12	9.4¢
Corn Popper	660	3	2	1.5¢
Dishwasher	1,200	30	36	28¢
Disposer	400	2	1	78¢
Dryer	4,350	20	92	67¢
Fan (Kitchen)	250	30	8	6.2¢
Fry Pan	1,160	25	29	22.6¢
Fryer (Deep Fat)	1,500	4	6	4.7¢
Freezer				
Freezer 15 cu. ft.	350	170	59	46¢
Freezer (Frost Free)	440	580	255	$1.98
Griddle	1,500	6	13	10¢
Hair Dryer	260	5	2	1.5¢
Heat Lamp	250	10	3	2.3¢
Heater Auxiliary	1,320	30	40	31¢
Heating Pad	60	10	1	.78¢
Iron	1,100	12	13	10.8¢
Ironer	1,500	12	18	14¢
Lawnmower	1,000	8	8	6.2¢
Mixer	125	6	1	.78¢
Oil Burner	255	100	25	19.5¢
Polisher	350	6	2	1.5¢
Post Light				
(Photo Cell)	100	350	35	27¢
Projector	1,000	2	2	1.5¢
Radio				
Table	50	120	6	4.7¢
Console	75	120	9	7¢
Range (Family of 4)			100	78¢
Self-Cleaning Oven	4,000	per cleaning	8	6.2¢
Record Player				
Console	160	30	5	3.9¢
Portable	75	25	2	1.5¢
Recorder	100	10	1	.78¢
Refrigerator 12 cu. ft.	265	150	40	3.2¢
Refrigerator-Freezer	290	500	145	$1.13
Roaster	1,325	30	40	31¢
Rotisserie	1,500	30	45	35.1¢
Sewing Machine	100	10	1	78¢
Sunlamp	280	10	3	2.3¢
Television				
Black-and-White	225	120	27	21¢
Color	315	120	38	29.6¢
Toaster	1,130	4	5	3.9¢
Vacuum Cleaner	700	10	7	5.5¢
Waffle Iron	1,100	2	2	1.5¢
Washer				
Automatic	600	12	7	5.5¢
Conventional	280	12	3	2.3¢
Water Heater	4,500	Per family of four	500	$3.90

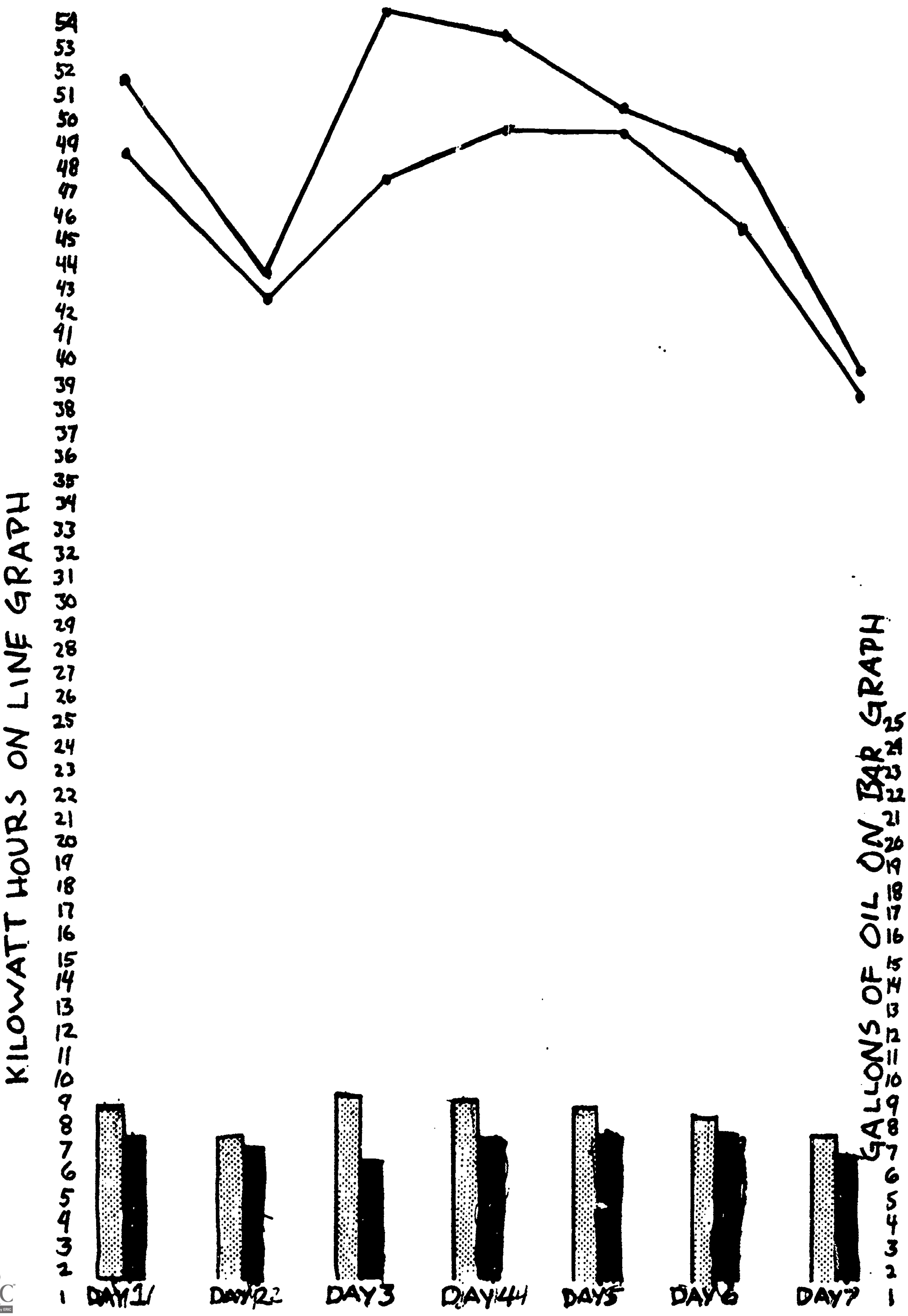
HOW TO READ YOUR METER



Your electric meter is a precise, additive device which directly records the units of electricity (Kilowatt hours) used in your home. Each meter dial records one-tenth of the dial on its left; i.e., units, tens, hundreds, thousands and ten-thousands.

As an example, the above dials read 65,482. An electric bill would be determined by subtracting the previous reading from this reading to find the net kilowatt hours consumed between reading dates. To read a meter, start with the right hand dial and read left. The pointers on the first, third, and fifth dials move clockwise and counter-clockwise on the second and fourth. If the pointer is directly on a number, read the next smaller number unless the pointer on the dial at its right has passed zero.

ACTIVITY


KILOWATT HOURS ON LINE GRAPH
GALLONS OF OIL ON BAR GRAPH
DAY 1
DAY 2
DAY 3
DAY 4
DAY 5
DAY 6
DAY 7

R-9 SUBJECTS

Math, Soc. Studies

LEVEL (7 - 12)

EST. TIME (30 minutes)

THE "FINITE" RESOURCES

PROBLEM SOLVING

There is a finite limit to the natural resources that are found in the earth.

LEVEL VI OBJECTIVE

The student will be able to predict the future world availability of the following natural resources: aluminum, coal, copper, iron, lead, natural gas, nickel, petroleum, silver and tin.

TEACHER BACKGROUND

Water continually moves through the system in the hydrological cycle, and there is a recycling of food through consumption, and a return to the ground in the form of fertilizers; but it is the non-renewable resources-the minerals of geological origin, the fossil fuels, and the nuclear fuels that are of paramount concern today.

The student is aware that these resources exist, but to him they must seem inexhaustible. The following piece of information may be useful in pointing it out to the student.

It has been calculated that MacDonald's uses 315 square miles of forest to provide paper for use with their products. To process this paper as well as to provide heat and electrical energy for their establishments, the equivalent of 12.7 million tons of coal is required to provide the energy.

This is not intended to poke a finger at MacDonald's, but to point out the energy requirements of one of the United States' smaller though well-known businesses.

Many people have cornucopian premises and say that we do not have anything to worry about.

The five main premises from which their conclusions follow are:

1. The promise of essentially inexhaustible cheap useful energy from nuclear sources.

2. The thesis that economics is the sole factor governing availability of useful minerals and metals.

3. The fallacy of essentially uninterrupted variation from ore of a metal to its average crustal abundance, which is inherent in Premise 2: and from which emanates the strange and misleading notion that quantity of a resource available is essentially an inverse exponential function of its concentration.

4. The crucial assumption of population control, without which there can be no future worth living for most of the world, (or worse, the belief that quantity of people is of itself the ultimate good, which astounding as it may seem, is still held by a few people who ought to know better-see, for instance, Colin Clark, Population Growth and Land Use, Macmillan, 1967).

5. The concept of the "technological fix."

Only through wise management of resources can we survive.

MATERIALS

Pencil
Paper

RESOURCES:

The Survival Equation: Man, Resources and His Environment. Revelle, Roger et. al. Eds. Houghton Mifflin Company. Boston 1971

The Limits to Growth: Dennis L. Meadows et.al. Potomac Associates, Universe Books, New York 1972

"The Biosphere" Scientific American September 1970

PRE-ACTIVITY

1. Can we substitute materials for those that are in short supply?

2. What is the time margin for the resources?

3. What products are made from the non-renewable resources?

ACTIVITY

ACTIVITY

The students will use the chart listed below, and answer the following questions:

1. At present the photography industry is using up more silver per year to make film, than there is silver being mined. What conservation methods can be used to extend the life of silver?

2. Experts say that even with the discovery of new reserves, petroleum supplies will be gone in 50 years time. This presents two problems.

   (a) Should we save the ramining petroleum reserves for the petro-chemical industry which manufactures plastics, drugs, dyes, and a multitude of items useful to man, and not spend it on fuel?

   (b) What alternative sources for power (heat & autos) do we have?

3. Calculate the annual consumption of natural gas.

4. What geologic minerals, if any, are kept from being wasted or lost to use? Why?

5. Nature did not evenly distribute minerals throughout the world. Therefore, some countries have and others have not. Historically, wars on occasion have been fought over the acquisition of mineral resources. As we approach the end of the supply of a resource, a global economic upheaval could occur, with large nations possibly warring over mineral resources. What controls can you devise that would insure fair equitable distribution in a non-warring world?

TABLE

RESOURCE	KNOWN GLOBAL RESERVES	LIFE SPAN AT PRESENT CONSUMPTION	LIFE SPAN WITH ANNUAL GROWTH RATE CALCULATED
Aluminum	1.7×10^{9} Tons	100 Years	31 Years
Coal	5×10^{12} Tons	2300	111
Copper	308×10^{6} Tons	36	21
Iron	1×10^{11} Tons	240	93
Lead	91×10^{6} Tons	26	21
Natural Gas	1.14×10^{15} cu. ft.	38	22
Nickle	147×10^{9} lbs.	150	53
Petroleum	455×10^{9} Bbls	31	20
Silver	5.5×10^{9}	16	13
Tin	4.3×10^{6} Tons	17	15

R-10

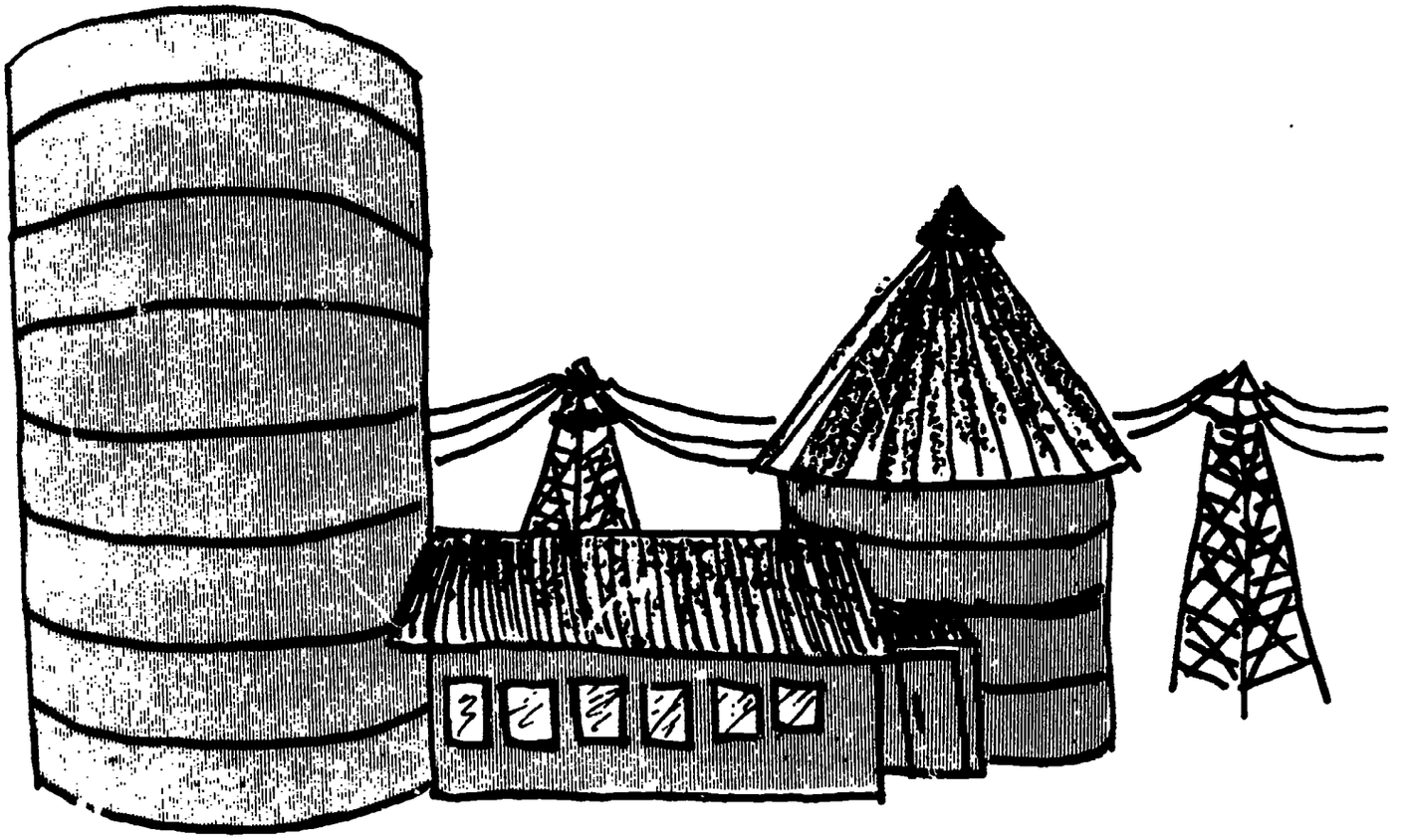
SUBJECT AREA: Social Studies

LEVEL (7-12)

Application of an electrical power company to build a nuclear power plant in a specific county

SIMULATION GAME

The supply and demand of electrical power may conflict with local interests.



LEVEL VI OBJECTIVE

The student will know the legal procedures involved in obtaining a permit from a county zoning board in order to build a nuclear power plant.

TEACHER BACKGROUND

Simulation games involve students playing the roles of various interest groups, who are involved in the solving of an ecological problem. Each interest group will be selected from class members. It is possible to expand or limit each group to meet the needs of your class size. An example of a Role Card is included for your reference. The student will develop an understanding of the procedures and pressure groups involved in zoning for an industrial complex, which may or may not have an adverse affect on the surrounding environment. A map showing the site should be provided.

ROLE CARD - Local Interest Group
(Farmer)

1. What affect will the radiation have upon plant life in the surrounding area?
2. What affect will the release of hot moist air have upon local weather conditions?
3. What affect . . . .
4. etc.

REFERENCES

Washington Air Pollution Laws and Local Laws. Newspaper articles on the Proposed Nuclear Site at Sedro Woolley.

RESOURCES

Radiation Laboratory - University of Washington; Washington State Department of Ecology; Local Pollution Control Agency; Atomic Energy Commission at Hanford, Washington.

MATERIALS NEEDED

1. Role Cards
2. White Butcher Paper
3. Marking Pens
4. State Environmental Laws
5. Scientific Information available concerning the effects of radiation upon plant life.
6. Other materials considered important by teacher.

PRE-ACTIVITIES

The class will be divided into groups, each representing the special interest groups A through D, and a zoning board of from 3 to 5 members. Each student will be given a role card indicating the role to be played, and some of the effect that might occur (i.e., zoning board will have to reach a decision whether or not the area will be zoned to permit the building of a nuclear power plant). Each student should be clear as to the role he or she has assumed and the teacher should check to make sure the role is clear to the student.

The roles are as follows:

Group A - Corporate Power

Electrical Engineer, physicist, biologist, Federal Power Commission Representative. Some of the following interests might be expressed by this group:

1. What type of electrical energy crisis now exists?
2. What is the prediction of energy needs over the next ten years?
3. Will the planned facility meet the energy needs predicted?
4. Are precautions planned for radioactive waste disposal?
5. What are the advantages of nuclear power over water or steam power plants.

Group B - Local Interests

Farmer, sportsman, dairyman, and a representative from local business interests. Some of the interests of this group might be:

1. What affect will the radiation have upon plant life in the surrounding area?
2. What affect will the radiation have upon milk production through contamination of grazing pastures?
3. What impact would the construction and maintenance of a nuclear plant have upon the community?
4. What affect would the dumping of the water into the river have upon the fish life?

Group C - Economics

Economist, Representative for the Standard of Living Council, Industrialist, representative for advertising groups.

Some of the interests of these groups might be the following:

1. If power sources are not increased, would there be a cut back in the standard of living?
2. What restrictions would have to be placed on the power load of industries, if new power sources are not implemented?
3. What affect would a reduction of power have upon business firms in terms of power priorities?
4. What affect would limiting power have on the economy in relation to the availability of more power?

TASKS

Each group will have one day to review questions of each others' role card and have answers available for the next day.

On the day of the simulation game, each group will have 10 minutes to come up with arguments to convince the zoning board to allow or not allow the zoning regulation, to permit the construction of a Nuclear Power Plant. When the time is up the groups will have 3 minutes each to present their case to the Board. They may use comparison charts, maps or any other visual aid to help them with their presentation.

After the presentations, the Board will recess for 5 minutes and come up with the solution to the problem.

POST ACTIVITY

A brief summary of the procedures involved and the current public feeling towards a construction of a Nuclear Power Plant would be appropriate.

Group D - Environmentalist

Sierra Club Representative, Local Pollution Control Board Representative, Department of Fisheries Representative, State Game Department Representative, Member of the Environmental Protection Agency.

Some of the areas of interest of this group might be the following:

1. What provisions will be made to cool the water to prevent harm to river life?
2. Why not limit power usage since there is a decline in population?
3. What provisions will be made as a safety factor in controlling the critical mass from emitting dangerous radiation into the air?
4. Will there be testing procedures in the strontium 90 count to indicate the amount of radioactive material fallout in the area? If so, would there be an emergency plan to shut down the plant until a safe level is obtained?

R-11 SUBJECTS

Science

LEVEL (7 - 12)

EST. TIME (30 min. 4 weeks)

S O I L: F E R T I L I Z E R

INVESTIGATION

Each soil type requires a different proportion of essential substances added to it to bring it up to optimum levels for plant growth.

LEVEL VI OBJECTIVE

The students will know how certain types of fertilizers affect the growth of grass seeds.

TEACHER BACKGROUND

The health of a plant depends upon many factors, but one of the basic requirements is that it have the necessary minerals to synthesize the essential proteins, fats, and carbohydrates. A healthy plant grows more vigorously, bears fruit more heavily, resists disease and can withstand drought for longer periods of time. These attributes can apply to food plants, grasses, forest trees, and ornamentals.

In this exercise the student can make some judgments on the comparative effectiveness of fertilizers. As for other American products, a great deal of money is spent advertizing the product, touting one fertilizer to be better than another based on plant performance. Not only can the student judge this on data obtained, but also a long-term project can be maintained on the length of time the fertilizer is effective. Placing this in the context of economics, the student can determine if the most expensive fertilizer per square foot may be the cheapest in total viable time.

Newspaper articles mention the request for American technological aid in the development of fertilizer plants by emerging nations as well as developed nations such as Russia. Man has to supplement the natural resources that are often lost or were nonexistant in an area. Truly the production of fertilizers is a measure of a country's agricultural productivity level.

MATERIALS

Soil samples - clay, sand, loam, gravel
Containers for soil
Fertilizer samples
Seeds (grass, petunia)

RESOURCES

A Study of Soil Science,
2nd. ed. Dr. Henry. D. Foth
LaMotte Chemical Products Co.
Chestertown, Maryland 1970

LaMotte Soil Handbook
LaMotte Chemical Products Co.
Chestertown, Maryland 1972

PRE-ACTIVITY

Have the students collect a variety of soil samples and purchase or bring from home fertilizer samples. Since this is a long term project have space set aside that will not be needed to place the containers. Garden stores can provide information, fertilizer varieties, and the attributes of each kind. Research should be done by the students using the LaMotte Soil Books, Sunset Western Garden Books, and similar reference materials.

Do all fertilizers supply the basic requirements?

Is more expensive fertilizer cheaper ir the long run?

What minerals are essential for the growth of plants?

POST-ACTIVITY

Discussion

1. Which fertilizer produced the most vigorous growth?

2. Which fertilizer produced the longest termed benefits?

3. Read the label on the fertilizer containers and get the nitrogen-phosphorous-potassium content. Does this have any apparent relationship to the answer in Question #1? What seems to be the most important factor?

4. Do all soil samples used by the class have the same growth rates?

5. How would you perform an experiment to find out which nutrient your soil needed?

ACTIVITY

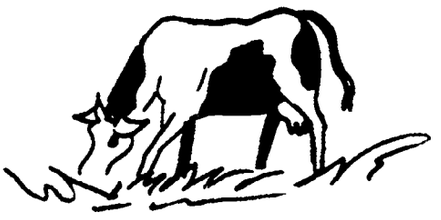
TASK

Each group will have to divide their soil sample into four parts and place it in the planting containers according to directions. Your group will calculate the amount of fertilizer necessary for the container used. (Don't put any fertilizer on one to serve as a control.) It will state how many pounds per 1000 sq. ft. for new lawn construction you should apply. Determine the square footage of your container and calculate the proportional amount of fertilizer necessary. After the grass germinates, record daily its growth and its apparent condition (good green color, sturdy plants, etc.) This may take a few weeks, but it is necessary to make good records.

CALCULATIONS

TASK
Comparison of Fertilizers
Type of Grass Used_____

Type Fertilizer (Scotts, Vigaro)	Amt. per 1000 sq.ft.	Amt. per container	Growth in mm.	General Condition
1.				
2.				
3.				
4.				



R-12 SUBJECT

Science

LEVEL (7-12)

EST. TIME 45 min. - 4 Weeks

pH OF THE SOIL

LABORATORY INVESTIGATION

The acidity or alkalinity of the soil affects plant growth.

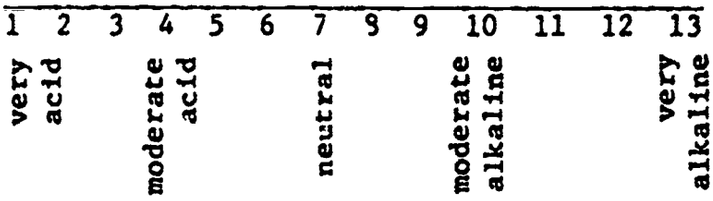
LEVEL VI OBJECTIVE

The student will know how alkalinity and acidity effect plant growth.

TEACHER BACKGROUND

The pH of the soil has an important bearing on its chemical and microbial activity, but also has a total effect on the growth of a plant.

Soils generally lose their alkaline characteristics due to the leaching of some minerals and the loss of some due to plants. The pH is due to the hydrogen ion concentration in the soil. As the hydrogen ion concentration increases in proportion to the hydroxide ion the soil becomes increasingly acid; as the hydroxide ion increases in proportion to the hydrogen ion the soil becomes increasingly alkaline.



Plants have narrow tolerance limits. The pH can affect such things as scabbiness of potatoes. In a text when the pH was 4.5-5.0 the percent of scab was 0.2.; when the pH was 6.0-6.5 the percent of scab was 97.5. The student can test the pH on plant growth and determine the species tolerance.

MATERIALS

soil samples
pH test kit or
pH test papers
pots
slaked lime
alum
plant seeds

PRE-ACTIVITY

Have the students collect soil samples and place them in pots. Explain pH and how it affects life. An interesting example to illustrate pH is to make a solution of red cabbage juice in a blender. In two separate containers, one containing 0.1 Molar HCl (hydrochloric acid) and one containing 0.1 Molar NaOH (sodium hydroxide), add a few drops of the cabbage juice. The color changes are indicators of pH and were derived from a plant source.

ACTIVITY

Plants and the Soil pH

The minerals in the soil can influence the pH and subsequently the type of plants that grow in that soil. Calculate the pH of your soil sample using a soil test kit or by making a slurry (distilled water plus soil forming a consistency of whipped cream) and testing that with pH paper. After the pH has been determined for the soil sample divide your soil sample into three parts. Adjust the pH of the soil samples using the chart below:

Sample 1 - pH 4-5
Sample 2 - pH 5-6
Sample 3 - pH 6-8

The surface area of your container needs to be determined and the amount of chemical (lime or alum) can be calculated by the following means:

$$\#\text{lbs. needed} = \frac{\#\text{lbs/yd}^2 \times \text{container area}}{}$$

POST ACTIVITY

1. How does pH influence plant growth?
2. What is pH, and what causes it?
3. Can the pH be altered to affect plant growth?

Soil pH	Soil Type	DESIRED pH 4	5	6	7	8
4	sandy	←--1/8 lb.----→	←---1/4 lb.-→	←-----	---1/2 lb.-----	----------→
	sandy loam	←--1/4 lb.----→	←---1/2 lb.-→	←-----	------1 lb.-----	----------→
	loam	←--1/4 lb.----→	←-----1 lb.-→	←-----	-1 1/2 lb.-----	----------→
	silt clay	←--1/2 lb.----→	←-1 1/2 lb.-→	←-----	------2 lb.-----	----------→
5	sandy	←---none----→	←---1/8 lb.-→	←-----	---1/4 lb.-----	----------→
	sandy loam	←---none----→	←---1/4 lb.-→	←-----	---1/2 lb.-----	----------→
	loam	←---none----→	←---1/4 lb.-→	←-----	------1 lb.-----	----------→
	silt clay	←---none----→	←---1/2 lb.-→	←-----	-1 1/2 lb.-----	----------→
6	sandy	←--1/2 lb.----→	←----none---→	←-----	---1/8 lb.-----	----------→
	sandy loam	←----1 lb.----→	←----none---→	←-----	---1/4 lb.-----	----------→
	loam	←----1 lb.----→	←----none---→	←-----	---1/4 lb.-----	----------→
	silt clay	←1 1/2 lb.----→	←----none---→	←-----	---1/2 lb.-----	----------→
7	sandy	←----1 lb.----→	←---1/2 lb.-→	←-----	----none-----	----------→
	sandy loam	←1 1/2 lb.----→	←---1/2 lb.-→	←-----	----none-----	----------→
	loam	←----2 lb.----→	←-----1 lb.-→	←-----	----none-----	----------→
	silt clay	←----3 lb.----→	←-1 1/2 lb.-→	←-----	----none-----	----------→
8	sandy	←----2 lb.----→	←-----1 lb.-→	←-----	----none-----	----------→
	sandy loam	←----3 lb.----→	←-----2 lb.-→	←-----	----none-----	----------→
	loam	←----4 lb.----→	←-----2 lb.-→	←-----	----none-----	----------→
	silt clay	←----6 lb.----→	←-----3 lb.-→	←-----	----none-----	----------→

Plant one of the following types of plants in each of the samples and compare growth.

Record the growth rate and general condition of each type of plant.

PLANTS

Alfalfa	Clover	Onion
Arbutus (trailing)	Corn	Pea
Aster	Cucumber	Radish
Barley	Fescue	Rye
Bentgrass	Lettuce	Tomato
Bluegrass	Lima bean	Turnip
Carrot	Oats	Wheat

Plant used:

Days	Soil Sample #1 Height	Soil Sample #1 General Condition	Soil Sample #2 Height	Soil Sample #2 General Condition	Soil Sample #3 Height	Soil Sample #3 General Condition
1						
2						
3						
5						
6						
7						
8						
9						
10						

DISCUSSION

1. What pH seems to be the best range for your particular plant?

2. Does it have tolerance for other pH ranges?

3. Is the farmer limited to planting only certain plants or can he modify the environment?

4. Investigate the economics of modifying the ground and planting desired crops contrasted with planting crops naturally suited to the soil pH.

ACTIVITY

R-13

THE NATURAL ENVIRONMENT OF

EVERETT AREA CONCERNING

GEOLOGY, CLIMATOLOGY, & POLLUTION

RESOURCES

NATURAL ENVIRONMENT OF THE EVERETT AREA

Slope, Soil Erosion, Landslide Hazard

There are many areas of steep slope, generally forested or otherwise vegetated. Therefore, under existing conditions, soil erosion is nominal; but potential for erosion is very high.

Certain areas, where certain geologic formations crop out, and/or particular soil types occur on slopes of 25% or greater, constitute landslide hazard areas. Steep slopes are a scenic resource, especially forested slopes at the edges of the plateau overlooking the Snohomish River floodplain and Possession Sound and the bluff west of Grand Street overlooking the Port.

Due to rising land costs, developments are more frequently tending to occur on areas of steep slope, a practice which results in severe erosion at the time of construction and continuing erosion thereafter, great public expense to build and maintain roads and services on steep slopes, loss of visual amenity, and increased landslide hazard.

At present, the County Planning Department discourages development on slopes 15% or steeper because of the expense of roads and utilities. There are no (known) restrictions designed to minimize soil erosion.

Surface Water

Bay, estuary, river, streams, springs, lakes, ponds, swamps, marshes and intermittently flowing drainage swales are considered to be surface water.

In its natural condition it is clean, drinkable and clear with minimal fluctuation between flood and drought. (Note: this does not refer to the Snohomish River which is little influenced by the natural conditions of the study area.)

At present, development occurs close to watercourses and drainageways. Culverting and filling of streams and drainage and filling of swamps and marshes is common.

Development on and close to watercourses and intermittent drainageways causes:

pollution
siltation
increase in flood flow in streams
longer, more frequent periods of low flow
loss of visual amenity
loss of wildlife habitat
increased cost of storm sewer systems
There are no restrictions presently in force within the study area which are designed to preserve surface water except limits on discharge of pollutants to streams.

Geology: Ground Water

The entire site was glaciated during the most recent ice age. Its geology, as a result, quaternary (i.e. very recent) and unconsolidated. The oldest formation revealed at the surface is a preglacial clay. On top of that is a sand formation placed at the time of the advance of the glaciers. Over both of these, particularly on the level plateau, a thin layer of fill, or hardpan, was deposited in place by the retreating ice. The Snohomish River floodplain, once a deep arm of the sea, was then filled with older alluvium and, in a continuing process, younger alluvium.

The ground water qualities of the site are dictated by its geology.

Geology also has implications for Landslide Probability, see section on "Slope."

Ground water is plentifully available at various depths and from various formations throughout the study area, most reliably and in greatest quantities from the sand formation. It is generally of good quality except in some areas of the floodplain near the mouth of the Snohomish River.

Ground water used directly for domestic or other water supply is relatively unimportant around Everett. However it is of great importance as a contributor to stream flow, particularly during the late summer, when rainfall is normally so much less than at other times. Even during the remainder of the year, under natural conditions, much of the water flowing in streams does not originate in rainfall running over the surface of the earth and directly into the creek bed, but rather from rain which has soaked into the ground (which it can do best in heavily vegetated areas) to raise the level of the ground water, which in turn slowly feeds water to streams by seepage along banks and beds. This has two closely interrelated effects: it reduces immediate flash runoff and it provides slow and gradual runoff at a time when there would otherwise be none. In other words ground water is essential to the health of a natural drainage system.

Urbanization has the effect of increasing flash runoff and decreasing seepage, by covering previously absorptive surfaces with impervious surfaces (buildings, roads and parking lots.) The exact extent of these effects is not known, since it varies with soil, slope, climate, geology, vegetation and density of development, but it is considerable and, bearing in mind the importance of the natural drainage system, amply justifies considering the best areas for ground water recharge as bad places to build.

There are at present no restrictions in force within the study area which are designed to maintain recharge to ground water reserves, and no restrictions on excessive withdrawals from ground water reserves.

Floodplain

The floodplain is fertile farmland renewed by periodic flooding, yet not flooded so frequently as to make farming difficult.

The Snohomish River flows high in winter from rainstorms, high in spring from snow melt, low in summer. Major floods occurred in '32, '33, '51, '59. Each time a major portion of the floodplain was covered. The river can rise to flood stage in 24 hours or less.

There is no reason to believe that future floods will be any less severe or less frequent than past ones. Indeed, due to increased development of the watershed of the Snohomish River, with consequent faster and greater runoff, they may be worse.

The floodplain is a scenic resource and a valuable wildlife habitat with recreation potential.

In particular, ducks, geese, and brants occur and rest along the sloughs of the lower Snohomish River. There is much waterfowl hunting, mostly by private clubs.

A moderately high density of pheasant is also found.

There is increasing development of the floodplain, combined with flood protection measures. Moderately intensive farming continues, mostly pastures, but with some cropping, including truck cropping, particularly in the southern part of the study area, in places with the use of irrigation.

Floods are inevitable and cause much damage at very high cost. More elaborate and expensive flood protection devices give a false sense of security encouraging accelerated development, resulting in greater damages and cost next flood. The process repeats itself.

Technological solutions to flooding are usually only temporary and always very expensive.

Urbanization has the effect of worsening floods on small creeks, though this is not a severe problem in itself on the study area. For an explanation of this see section on "Geology--Ground Water"

There are at present no formal measures to discourage development in the floodplain. The State can do this but at present limits its authority to the top of the banks or dikes of river channels, and not the floodplain itself.

Productivity--Food Producing Areas

Most areas on the floodplain are flat, fertile soils suita-le for intensive farming to some extent self-fertilizing from periodic flooding.

Some small areas of good soil occur on the plateau.

The Snohomish River estuary is extremely productive (in terms of organic matter) and important to the food chains on which the Possession Sound fisheries are based.

Development occurs on productive soils almost irrespective of their long term value. Farming in general is declining both in terms of number of persons employed and acreage farmed. The estuarine resource has been damaged by pollution and is threatened with destruction through landfill.

The bad results are:
increased food prices
decreased food quality
decreased local income
loss of income from commercial fishing, recreation from sport fishing, and food value from both.

There are measures to encourage farming but no restriction on development on soils constituting a productive resource. Measures restricting filling of tidelands are being considered.

Unsuitable Soils

This section applies to all forms of development but particularly to suburban style housing. Other forms of development, e.g. industrial use, as a matter of course, employ structural systems that make surface soil conditions somewhat less important, as far as actual building is concerned. Difficulties may remain, however, with road and site development.

All floodplain soils and some soils on the plateau have severe restrictions for building.

Almost all soils except a few on the plateau are unsuitable for septic tank filterfields.

Artificial soil (fill) is almost always a poor building foundation at least until full natural compaction has occurred.

Development is likely on these soils irrespective of their qualities, except that septic tank filter fields are generally not built on soils totally unsuitable for that use.

Development on excessively wet soils is expensive and may result in health risk if on-site sewage disposal systems are constructed. Basements may be permanently damp.

Buildings and roads constructed on soils with excessive repeating shrink/swell characteristics (certain clays) or with excessive initial shrink (peats) may suffer structural damage.

Soils poorly adapted for any given use can often be adapted and can become acceptable but at high first cost and maintenance cost.

There are restrictions on the use of on-site sewage disposal systems in areas of unsuitable soil.

Climate--General

Because most of the air masses that reach Puget Sound originate over the Pacific Ocean, the climate of Everett is marine, that is, it has a cool relatively dry summer with few hot spells and a mild wet winter with little severe cold, little snow and little sunshine.

The Olympics to the West give protection from the more severe Pacific storms. The Cascades to the East and Northeast prevent cold arctic air masses from reaching the region.

The daily temperature range is small in summer and very small in winter.

Wind velocity is generally low.

Temperature

Averages and extremes (°F)

Data	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Av. Max.	44.7	48.1	52.6	58.8	64.2	68.1	72.4	71.7	67.4	59.8	51.2	47.0	58.8
Av. Min.	32.5	33.9	36.5	40.4	45.1	49.7	52.3	51.9	48.3	43.7	37.6	35.5	42.3
Mean	38.6	41.0	44.6	49.6	54.7	58.9	62.4	61.8	57.9	51.8	44.4	41.2	50.6
Highest	72	69	76	80	88	98	93	92	88	83	73	65	98
Lowest	1	7	10	26	29	37	41	40	33	25	8	10	1

Probability of Frost: Growing Season

	90%	75%	50%	25%	10%	10%	25%	50%	75%	90%	(Days)
32°F	Mar 9	Mar22	Apr 4	Apr17	Apr30	Oct 7	Oct18	Oct30	Nov11	Nov22	209
28°F	Feb13	Feb26	Mar11	Mar24	Apr 5	Oct25	Nov 5	Nov18	Dec 1	Dec18	252
24°F	-	-	Jan29	Feb15	Feb26	Nov13	Nov25	Dec10	Dec31	-	315

The temperature of the water in Northern Puget Sound ranges from 45°F in February and March to between 55°F and 58°F in August. Shallows and protected bays are several degrees warmer.

Precipitation

Average Monthly and Annual Precipitation (Inches)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
4.45	3.58	3.33	2.39	2.26	2.25	.93	1.12	1.98	3.54	4.55	4.86	35.24

Precipitation extremes

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Greatest Mo. & Yr.	7.97	6.75	6.03	4.57	6.37	5.52	2.61	3.65	4.10	8.01	8.51	10.81	50.29
Least Mo. & Yr.	1.96	1.14	.99	.65	.35	.33	.00	.03	.21	.64	.56	1.27	22.57
Greatest daily	1.39	1.14	1.77	1.47	2.02	2.12	1.60	.92	2.26	2.28	1.77	2.74	2.28

Average Monthly and Seasonal Snowfall (Inches)

Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total
				.7	1.7	5.0	2.3	1.1	.2			11.0

Average Number of Days With Precipitation

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
.01" or more	19	16	18	13	11	10	5	6	9	15	18	21	161
.10" or more	13	12	11	9	6	7	2	4	5	10	12	12	103
.50" or more	3	2	1	1	1	2	*	1	1	3	3	2	20

Design Rainfall Intensities (Precipitation in Inches)

	PUGET SOUND LOWLANDS Return Periods				
Duration	2 years	5 years	10 years	25 years	50 years
30 minutes	0.3	0.4	0.5	0.6	0.6
1 hour	0.4	0.5	0.6	0.7	0.8
2 hours	0.6	0.8	1.0	1.1	1.2
3 hours	0.8	1.0	1.4	1.5	1.6
6 hours	1.5	1.6	1.9	2.2	2.4
12 hours	1.8	2.0	2.3	3.0	3.2
24 hours	2.0	2.8	3.0	3.8	4.0
48 hours	2.5	3.0	3.8	4.0	5.0
96 hours	3.0	4.0	5.0	6.0	7.0

Intensities estimated from Weather Bureau Technical Papers Nos. 28, 40, and 49.

There is an 8" to 10" annual precipitation difference N.W.-S.E. across the site. Mukilteo is more dry and the S.E. corner of the site more wet.

Relative Humidity

Month	Relative Humidity (1949-58)			
	4A	10A	4P	10P
(a)	10	10	10	10
J	87	84	82	86
F	89	83	78	87
M	88	76	70	85
A	89	70	63	82
M	90	70	62	82
J	91	75	65	85
J	91	72	58	83
A	92	74	60	85
S	91	75	64	84
O	92	81	76	89
N	89	82	82	88
D	89	86	85	88
Yr	90	77	70	85

(a) length of record

Sun, Cloud Cover

Month	Average sky cover sunrise to sunset	Percent of Hours Cloud Cover in Tenths of Sky Covered Sunrise to Sunset		
		0-3 Clear	4-7 Partly Cloudy	8-10 Cloudy
		%	%	%
J	8.5	10	8	82
F	8.5	9	10	81
M	8.3	9	14	77
A	7.6	16	15	69
M	7.2	20	18	62
J	7.4	18	15	67
J	5.1	43	13	44
A	5.3	37	14	49
S	6.0	32	15	53
O	7.6	16	15	69
N	8.1	12	11	77
D	8.8	6	9	85
Yr	7.4	19	13	68

Evaporation

Annual evaporation (from a class A pan) is 25"-35". In an average season, monthly amounts are:
April: 3.0"
July: 6.5"
Sept: 3.5"

Annual loss of water by evaporation from lakes and reservoirs is an estimated 20"-25".

Extreme Winds

Speeds at 30' above the surface can be expected to reach:
50 to 60 m.p.h. once in 10 years
60 to 70 m.p.h. once in 25 years
70 to 80 m.p.h. once in 50 years

The strongest winds are usually from the South or Southwest.

Seasonal Surface Flow Patterns

Northwesterly spring winds from the Pacific sweep around both sides of the Olympics and tend to converge North of Seattle, In summer this area of convergence moves south to Tacoma, North or Northwest winds at Everett are the result in both cases.

The Winter Southwesterly Pacific winds flow south of the Olympics and up Puget Sound producing South or Southeast winds at Everett.

Sea Breeze

Because of the temperature difference between land and water, a sea breeze is common at Everett on summer afternoons. This often reverses itself at night.

Cloudiness & Sunshine

The number of clear or only partly cloudy days each month is 4-7 in winter, 10-15 in spring and fall and 20+ in summer. The amount of sunshine received as a per cent of the possible is 20% in winter, 40-50% in spring and fall, and 60-70% in summer.

Vegetation

Major Forest Tree Species
Pseudotsuga menziesii. Douglas fir.
Tsuga heterophylla. Western hemlock.
Thuja plicata. Western red cedar.

Sporadically Occurring
Abies grandis. Grand fir.
Pinus monticola. Western white pine.
Pinus contorta. Lodgepole pine.
Libocedrus decurrens. Incense cedar.
Taxus brevifolia. Western yew.

Hardwoods
These are not common except on recently disturbed sites or along watercourses.

Subordinate in coniferous forest:
Alnus rubra. Red alder.
Acer macrophyllum. Bigleaf maple.
Castanopsis chrysophylla. Golden chinkapin

Along major watercourses:
Populus trichocarpa. Black cottonwood.
Fraxinus latifolia. Oregon ash.
Acer macrophyllum. Bigleaf maple.
Alnus rubra. Red alder.

Rarely on drier, lower sites:
Arbutus menziesii. Madrone.
Quercus garryana. Oregon oak.

Understory

Dry sites:
Holodiscus discolor. Ocean spray.
Gaultheria shallon. Salal

Mesic sites:
Berberis nervosa. Oregon grape.
Acer circinatum. Vine maple.

Wet sites:
Polystichum munitum. Sword fern.
Oxalis oregana. Red sorrel

Wettest sites:
Lysichitum americanum. Skink cabbage.

Swamp and Bog

These are many poorly drained sites with swamp and bog vegetation.

Successional Patterns
After logging, burning or other disturbance.
(1) Herbaceous vegetation.
(2) Shrubs: Species on site before the disturbance plus:
Ceanothus velutinis. Snowbrush ceanothus.
Salix spp. Willow.
(3) Pseudotsuga menziesii. Douglas fir.
A very longlived and persistent subclimax. It often remains dominant for 400 years and sometimes for 600 years. It is found on any site that has been logged and/or burned during the last 150 years.
(4) Tsuga heterophylla. Western hemlock.
Thuja plicata. Western red cedar.
Climax species.

Water Pollution

A main source of pollution of the waters of the study area is the sulfite waste liquor (S.W.L.) discharged into the bay by the deep diffuser outlet owned jointly by the Scott and Weyerhaeuser companies. The diluted S.W.L. disperses through the entire surface waters of Port Gardner Bay and Possession Sound. Concentrations of S.W.L. greater than 10 p.p.m. can be found throughout most of the bay.

Concentrations in the order of 5-15 p.p.m. have been shown to damage the larval forms of fish and shellfish; particularly English sole eggs and Pacific oyster larvae, but many other forms of marine life are expected to be similarly affected, for example: other species of sole, cod, herring, anchovy, smelt, clams and crabs.

To prevent this, S.W.L. concentrations must be kept below 10 p.p.m. (beyond the initial dispersion zone.)

There is however no evidence of damage to marine life inhabiting the deeper waters of the area. A preliminary assessment of the English sole suggests that the fish (adult or young) are not adversely affected by the effluent from the deep diffuser outfall. The growth of the English sole fishery since the installation of the outfall is probably coincidental and related to increased fishing activity.

A second source of damage to marine life arises from the large quantities of solid-bearing wastes dumped into Everett Harbor, or into the Snohomish River about 10 miles from its mouth. This is mostly waste from log-barking, pulp-washing, and bleaching processes. It occasionally contains toxic chemicals and always accumulates to form bottom sludge which gradually decomposes giving toxic concentrations of sulfites.

Numerous fish kills have occurred in the past and the area is generally considered marginal for anadromous fish, as well as many other marine organisms.

Both adult and juvenile salmonids must pass through these waters on their migrations to and from the spawning grounds. This is particularly dangerous for the juveniles since they must remain in the area for a period varying from a few days to several weeks to become accustomed to the salt water environment. Injury or death is common.

The City of Everett is responsible for a third major type of pollution. Its municipal treatment system produces wastes of 45,000 P.E. (population equivalent). Treatment is by lagoon only, and the wastes, which are released into the Snohomish River 3.5 miles from its mouth, are rated at 18,000 P.E., the efficiency of the treatment being 60%.

Bacterial concentrations have been observed in the Estuary and harbor which exceed the State recommended levels.

The Lower Snohomish River often exhibits high temperature during the low flows of summer. This is seldom lethal in itself but tends to worsen the unfavorable fish habitat.

Air Pollution

This should be read in conjunction with the section on climate, particularly wind speed and direction.

At present no air quality data nor actual local emission data are available. It is hoped that data presently being collected by the Puget Sound Air Pollution Control Agency and the State Department of Ecology will be available for later stages of this report.

Consequently this section deals only with two aspects of Air Pollution:

(1) local climatic and topographic conditions, or pollution potential, with generalized discussion of actual pollution problems.

(2) regulations.

The main sources are:

(1) Industry, especially paper mills.

(2) Automobiles.

(3) Domestic heating, etc.

In general, local climatic and topographic characteristics create potential for severe air pollution.

Visible build-up of pollution does occur in a number of common weather conditions over Everett and to a greater extent over the Snohomish Valley, particularly in fall and winter.

Sulphur dioxide (SO_2) concentration from paper mill smoke stacks can exceed present official Air Quality Standards (0.4 p.p.m.) This can happen in several common meteorological conditions. In fact it is less influenced by weather than by topography, amount emitted, and the height of the stack, rather than an overall area-wide condition.

Summary of wastes from paper and allied industries Puget Sound Area

Basin	Industrial Plant	Average Production Tons/Day	Untreated Waste PE	Treatment Facilities	Discharged Waste PE	Treatment Efficiency
Snohomish	Simpson Lee Paper Co.	270	75,000	Pond	60,000	20%
	Scott Paper Co.	1,400	4,481,000	Solids Removal	4,481,000	none
	Weyerhaeuser Co.	300	1,910,000	Solids Removal	1,910,000	none
	Weyerhaeuser Co.	420	-	Holding Lagoon	238,000	*1

*1 Treatment efficiency of lagoon has not been determined. Effluent is discharged into Steamboat Slough over a five-hour period on each ebbing tide.
PE=Population equivalent

A common situation, given a low mixing depth (arising from an atmospheric inversion), is the slow drift of plumes from the waterfront industries across the city, then south along the valley of the Snohomish River, where the pollutants then tend to accumulate.

Stable inversion situations occur about 30% of the time, normally with light winds which aggravate pollution problems. Fortunately, however, the inversion layer is rarely very low, allowing some mixing depth.

Still air is common and lasts generally 2 to 3 hours.

The sea-breeze effect frequent at Everett on summer afternoons can cause pollution trouble because of (a) still air at the time of reversal of this breeze from on-shore to off-shore; (b) an occasional circular flow pattern which can persist for several days and, if combined with an inversion, can cause a general buildup of pollutants in the area.

Excerpts from:
Washington Clean Air Act. 1967.

"Air contaminant" means dust, fumes, mist, smoke, other particulate matter, vapor, gas, odorous substance, or any combination thereof.

"Air pollution" is presence in the outdoor atmosphere of one or more air contaminants in sufficient quantities and of such characteristics and duration as is, or is likely to be, injurious to human health, plant or animal life, or property, or which unreasonably interfere with enjoyment of life and property.

"Air quality objective" means the concentration and exposure time of a contaminant or multiple contaminants in the ambient air below which undesirable effects will not occur.

The counties of Whatcom, Skagit, Snohomish, King, Pierce, Thurston, Kitsap, Mason, Jefferson, Clallam, Island, San Juan, Grays Harbor and Pacific shall constitute the Puget Sound air pollution control district.

Noise Pollution

Noise is defined as an unwanted sound.

Two main sources of noise are aircraft, particularly large jet aircraft, and expressways.

The Federal Aviation Agency recommends that the areas most affected by the noise of aircraft takeoff be kept free of residential development and places of public assembly and should be used for open space or types of development not so sensitive to noise, e.g. industry.

The noise level at the edge of a heavily used expressway is variously reckoned at 80-94 dB.

This means that no housing (living rooms or bedrooms) can face onto such a road and maintain a tolerable internal environment, unless set back at least 800', or unless windows are permanently closed.

Another alternative is one-sided housing having only service rooms with small windows on the side facing the expressway.

Vegetation does not diminish expressway noise by any worthwhile amount, but it may make proximity to an expressway more psychologically acceptable.

RESOURCES - FILMS

TITLE	TIME	COST	FILM #	COMPANY	GRADE
1. Dairy Farm In The Alps	16	Free	EF-1600	District	7-12
2. Dams	14	Free	EF-1388	District	3-9
3. The Earth: Resources In Its Crust	11	"	EF-335	"	4-9
4. Grasslands	16	"	EF-1703	"	10-12
5. Great River Of The West: The Columbia	22	"	EF-1068	"	4-12
6. Green Plants And Sunlight	11	"	EF-1466	"	3-8
7. Indians Of California - Part I	15	"	EF-1301	"	3-12
8. Indians Of California - Part II	15	"	EF-1302	"	3-12
9. Is Gold Obsolete?	15	"	EF-1661	"	7-12
10. Japan Harvests The Sea	29	"	EF-2070	"	3-12
11. Japan: Our Pacific Neighbor	16	"	EF-1410	"	3-9
12. Life Between Tides	16	"	EF-1440	"	5-9
13. Life In The Nile Valley	11	"	EF-479	"	3-9
14. Life In The Sahara	15	"	EF-1364	"	4-9
15. Life In The Sea	11	"	EF-1020	"	4-9
16. Life In The Woodlot	17	"	EF-1501	"	7-12
17. Man And His Environment - Part I	18	"	EF-1688	"	4-9
18. Man And His Environment - Part II	17	"	EF-1689	"	4-9
19. Open Spaces	11	"	EF-1645	"	11-12
20. Our Mr. Sun - 2pts.	60	"	EF-2116	"	3-12

TITLE	TIME	COST	FILM #	COMPANY	GRADE
21. Land Between The Lakes	13	Free	A 72-00246	TVA	Gen.
22. But What About Tomorrow, Christine?	27	"	A 72-00276	PICCA	Jr.H.
23. Wilderness River Trail	28	"	A 72-00281	CCM	Gen.
24. No Room For Wilderness	26	"	A 72-00282	Sierra Club	"
25. Men, Mountain, and Mud	28	"	A 72-00283	Texaco	"
26. Miner's Ridge	22	"	A 72-00284	Sierra Club	"
27. Glen Canyon	26	"	A 72-00285	Sierra Club	"
28. An Island In Time	28	"	A 72-00286	CCM	"