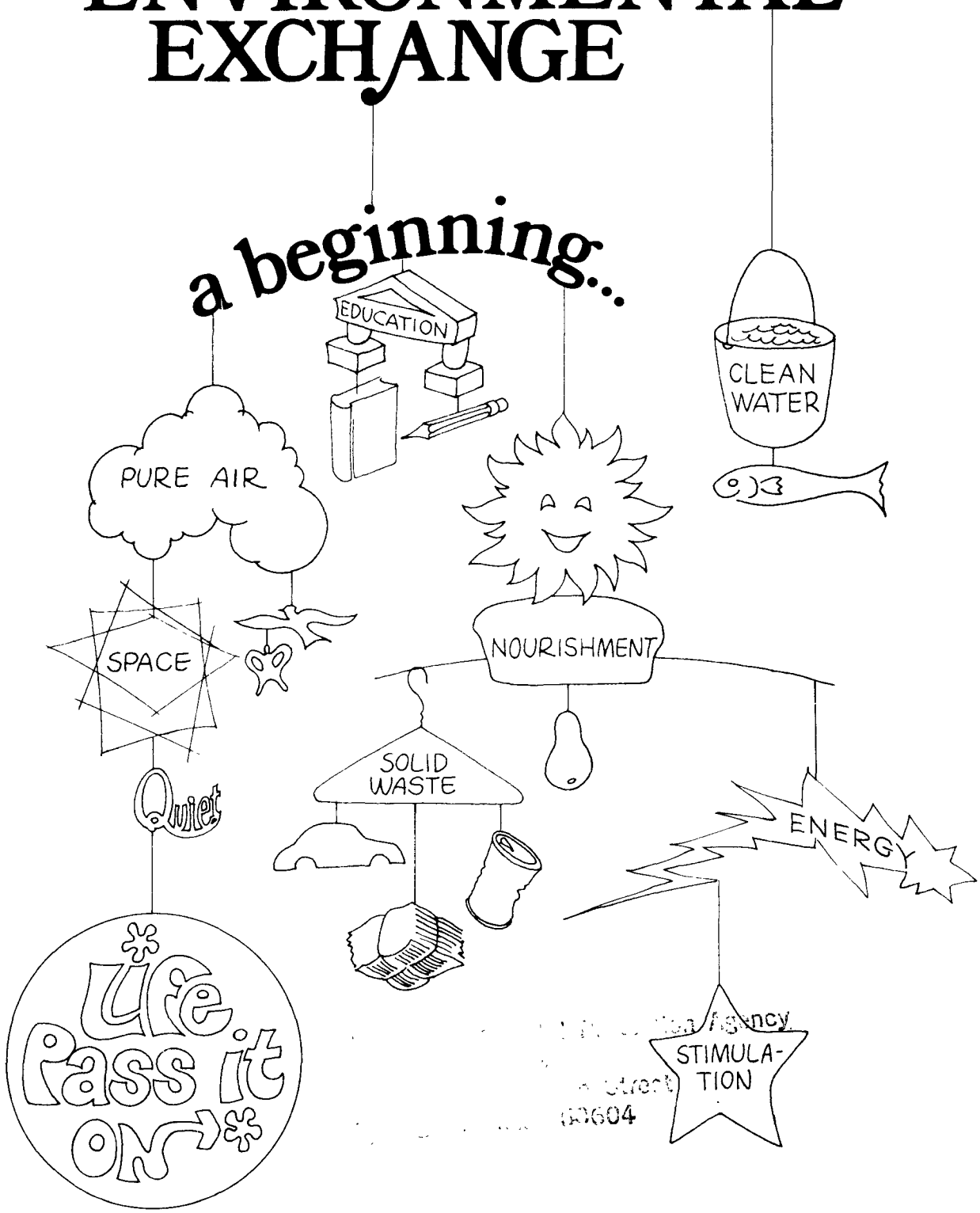
ENVIRONMENTAL EXCHANGE



PRESIDENT'S ENVIRONMENTAL MERIT AWARDS PROGRAM

U.S. Environmental Protection Agency

CONTENTS

EXPERIMENTS

Elementary Level

Air 2
Water 2
Noise 3
Solid Waste 4
General Pollution-Art 4

Intermediate Level

Air 5
Water 5
Noise 6
Solid Waste 7

High School Level

Air 8
Water 9
Noise 10
Social Studies 19
Ecology Club 19

THINGS TO DO 20
THINGS TO TALK ABOUT 21

Dear Activities Leader:

The President's Environmental Merit Awards Program (PEMAP) was created in response to thousands of letters from young people, deeply concerned about environmental problems and asking what they could do to help. To encourage participation and reward achievement in this area so critical to the world's well-being, PEMAP was launched in November 1971. The program reaches students from the elementary through high school level.

PEMAP serves as a vehicle to direct the creative talents of youth into constructive, and productive work, to provide opportunities, incentives, and rewards as we search together for answers to environmental problems. Lastly, it is to provide nationwide recognition for their efforts in improving the quality of life.

After long discussions with environmental coordinators and teachers we found that educators would like guidance in providing environmental education. Many teachers were very enthusiastic about environmental studies but they did not know where to begin. We hope this workbook will be "a beginning."

This workbook contains experiments, which we have divided into 3 sections: Elementary, Intermediate, and High School. Each level will suggest an avenue of study in the area of air, water, noise and solid waste. While these studies may be undertaken in the classroom, it is hoped that you will not be confined to the indoors. The suggestions are designed to stimulate your imagination, your curiosity and your resourcefulness. For example: In the elementary experiment on noise pollution the students could be sent with a tape recorder to tape *outdoor* sounds which would be studied *in* the classroom. If tape recorders are not available, the students might return to the classroom to write papers on the environmental noises they heard and the reactions they stimulated.

The suggested experiment on state and local government could be expanded by asking students to watch local newspapers for notices of public environmental hearings. They could then develop views on the issues at hand, prepare testimony and have a representative present at the hearings in their behalf.

The Office of Public Affairs offers many pamphlets for your use and also provides on loan environmental films which may also be used in the classroom. For a list of publications and a list of films, contact: Information Center, Office of Public Affairs, Environmental Protection Agency, Washington, D.C. 20460.

SINCERELY,
ANN L. DORE
DIRECTOR, OFFICE OF PUBLIC AFFAIRS
U.S. ENVIRONMENTAL PROTECTION AGENCY

EXPERIMENTS—ELEMENTARY

ELEMENTARY—AIR

CONCEPT

Air pollution is a part of man's total affect on his environment. This project will make children aware: (1) Of air pollution and their role in helping to solve the problem. (2) What is in the air that plants, animals and people breathe.

When air has lots of smoke, soot, and other gases, we say that air is polluted. Children can make an experiment chart showing different ways that air is polluted in their town.

By following experiments the children will become aware that air contains oxygen, carbon dioxide, dust, and other particles.

EQUIPMENT

Steel wool, soup plate, baby bottle, lime water, two clear custard cups, soda straw, tin can, flashlight or slide projector, cake pan, white paper, rock, glass slide, petroleum jelly, magnifying glass.

PROCEDURE

Experiment I.—Air contains oxygen. Push a wad of steel wool all the way down in the bottom of a baby bottle. Fill it about half full of water and shake well until steel wool is very wet. Pour off water. Get a soup plate and add water one inch deep. Now put the bottle, mouth down, into the plate and let the bottle stand for a whole day and night. Water will rise in the bottle. See how rusty the steel wool has become. The steel wool combined with oxygen in the air inside the bottle to form rust. The water then rises to take the place of the oxygen in the air that was used up by the steel wool.

Experiment II.—Air contains carbon dioxide. Put a small amount of lime water into two clear custard cups. Take a soda straw and blow into the lime water in one cup. The carbon dioxide from your breath will make the lime water milky. Place the second cup of lime water out in the fresh air for a couple of hours. Watch what happens. Whenever carbon dioxide meets lime water, the lime water becomes milky.

Experiment III.—Air contains dust and other particles. Pull down the window shades of the classroom, switch off lights, and turn on a flashlight or a slide projector light. Little specks of dust will be dancing in the beam of light. (You can often observe dust particles in a ray of sunlight coming through the window.)

Cut a piece of white paper so that it fits the bottom of a deep cake pan. Place paper in the cake pan, then put a rock on the paper to keep it down. Put the pan outside on the window sill so that the fresh air can get to it. After a day or two see how much particulate matter has collected.

Smear a glass slide with a thick layer of petroleum jelly and set it out on the window sill. Leave it for a few days, then put the slide on a piece of white paper and study it under a bright light using a magnifying glass.

ELEMENTARY—WATER

CONCEPT

A sound biological fact concerning the effects of organic wastes on aquatic life is that in a polluted environment the number **of different kinds of organisms** which can survive is drastically reduced from that of a non-polluted environment. The number of **individual organisms** which are able to survive becomes substantially increased in the polluted environment. This is because organic pollution destroys clean water associated organisms and it destroys the natural balance of competition and predation among organisms. For those tolerant organisms that are able to exist, it offers a seemingly inexhaustible food supply. Conversely, in clean water, one would expect many different kinds of organisms with relatively few individuals representing any particular kind. In clean water, immature forms of mayflies, stone flies and caddis flies abound; in polluted water, worms, leeches, and bloodworms are plentiful. [A toxic pollutant may destroy most or all of observed life for a distance downstream from its entrance. Silt pollution will support only a few organisms of any type.]

EQUIPMENT

Box frame 1′ x 1″ x 3″ covered on bottom with window screen, long-handled garden rakes, shovel, pocket knives, tweezers, nets and/or small seines. A stream site.

PROCEDURE

Start by making observations and notes of the physical stream characteristics (width, depth, rocks, and riffle areas) and any signs of pollution (slimes, discolored water). Determine where the best samples may be obtained (best sampling areas generally will be riffles). What type of organisms are being sought (fish, crawling, and attached animals and aquatic plants)? For comparability, it is important to sample for the same time period at each station.

Observe, two small streams—one obviously polluted, one not. **Or,** observe one stream that is polluted at a point upstream from the pollution source and at several points downstream from the source. Lift small rocks and submersed sticks and wash or scrape attached and crawling organisms into a pail of water. Pour the water and organisms through the box screen to concentrate them. Organisms may be examined alive or preserved in a formalin solution for later examination. Place a small amount of stream-bottom mud onto the screen and separate the organisms from it by shaking the screen vigorously in the water. Use long-handled garden rakes and shovels to aid in securing rocks and stream bottom; use pocket knives and tweezers to remove organisms from rocks and sticks. Dip nets and small seines to capture moving or swimming creatures. Caution: Watch out for glass! **Do not splash water on face or clothing; and take soap and towels to wash hands and arms thoroughly after sampling.**

EXTENDING THE CONCEPT

What are examples of organic wastes? (Sewage, barnyard drainage, and dead animals). Of toxic wastes? (Oil, copper, cyanide, and ammonia). Of silt pollution? (Mining wastes, farm land runoff, construction site runoff).

ACCOMPLISHMENT LEVEL*

Elementary students What is the effect of pollution on water? What did you see? How many different organisms did you find at each station? Did aquatic plants contain more organisms than the other stream bottom? What did you learn?

Intermediate students (add) Did you observe any slimes on the rocks? At which stations? What would be the cause of this? How many kinds of caddis fly larvae or mayfly nymphs were found? Of fish? What generally was the most plentiful organism found?

High School students (add) What was the source of pollution? What was the effect of the pollution on water quality? Describe the investigation and its results in a short report that includes a table showing the kinds of organisms at each station.

* For additional activities see Water Experiment in the Intermediate and High School Level

ELEMENTARY—NOISE

CONCEPT

Living things react to their environment. The lesson will make children more aware of beautiful and pleasant sounds, and of the obnoxious or unpleasant sounds around them.

EQUIPMENT

Record player, one soft music record, one loud unpleasant music record.

PROCEDURE

Ask the children to put their heads down on their desks, close their eyes, and remain quiet for a minute. When everything is quiet, the teacher slams a door, bangs a window closed, drops a book, or abruptly does something that shatters the silence and startles the children. It will cause most of them to jump. Ask the children: What happened when you heard a sudden noise? How did it make you feel? How do you feel if someone shouts at you "STOP IT?"

Ask the children to tell about the many sounds they hear around them. Then list them on the board, using the following groupings:

SOUNDS WE LIKE TO HEAR (birds singing, brook rippling, rain splashing, pleasant voices, soft music)

SOUNDS WE DO NOT LIKE (shouting, fussing, crying, automobile brakes screeching, airplanes taking off and landing)

SOUNDS THAT HELP US (horns blowing, sirens, telephone ringing)

These lists can be used to make charts or bulletin board displays. Use cut-out pictures or children's drawings to illustrate them.

First play the loud unpleasant music to the classroom. Let the record play for several minutes. Then change the record to soft music. Begin discussion—what was most pleasant to their ears.

ELEMENTARY—SOLID WASTE

CONCEPT

Awareness of litter and how it affects our environment.

EQUIPMENT

Cotton rag, piece of string, paper, peanut butter sandwich, aluminum pie tin, pliers.

PROCEDURE

Ask the children to keep an eye open for litter on their way home and to give a report to the class the next day. Teacher can check a suggested location to see if it warrants showing the whole class. If so, walk the class there and pick up all litter on the way and at the spot. Put it in a garbage bag. Point out how nice the spot looks now.

In the classroom, examine collection and list kinds of litter. How did it get there? What can the children do to keep an area clean? What can they suggest that others can do? Have each child look in his or her desk and around the room.

Draw pictures of area before and after cleanup. Write a poem or story to go along with the picture. Maybe the class would like to volunteer to keep a certain section of the playground clean.

Burn a cotton rag, piece of string, a piece of paper and peanut butter sandwich over an aluminum pie tin. Hold with a pair of pliers. **Keep children at a safe distance.** Is the smell pleasant? Have the children noticed anyone burning anything in their neighborhood? Does it look or smell good?

EXTENDING CONCEPT

Have the children list or tell you about the kinds of solid waste. Who causes it? What can be done?

ELEMENTARY—GENERAL POLLUTION—ART

CONCEPT

This activity gives students a chance to express their personal attitudes toward pollution through creative art forms. Students will become more aware of the environmental crisis through their art and pass their awareness on to others.

EQUIPMENT

Litter (have the students collect this themselves), glue, magic markers, poster paper, paints and brushes.

PROCEDURE

To lead into the activity ask some questions similar to the following: How can we communicate our concern about the pollution problems to others? Could posters, collages, and other art forms be useful in communicating this concern?

Start off by taking your class to the scene of actual pollution, nearby river, pond, beach, etc. Have them observe the pollution and react to it, then start collecting the trash, some of which may be used in the actual making of their art projects.

Should we use slogans, humor, and cliches in our posters? If we run a contest, who will be involved? Just one class, one grade, the entire school?

Students might also make useful things out of the discarded objects—pencil holders out of tin cans or candle holders out of bottles. This is the true meaning of recycling.

NOTE: TEACHERS BE SURE OBJECTS ARE NOT SHARP.

EXPERIMENTS—INTERMEDIATE

INTERMEDIATE—AIR

CONCEPT

Acid gases and aerosols are prime ingredients of urban air pollution. These gases may damage plants, corrode metals, crumble stone, and in heavy concentration, they can make men and animals ill.

EQUIPMENT

A large funnel, an air pump or aspirator (most pet shops sell air pumps), filter papers, one for each exposure site, large enough to cover the large end of the funnel, a piece of wire screen the same size. Tape to hold filter paper on funnel, 1 ounce of 0.01M sodium bicarbonate solution, 1 ounce of glycerin, 2 or 3 ounces of a dilute solution of 10 percent hydrochloric acid in a beaker, 3 eye-dropper bottles, 2 or 3 feet of rubber or glass tubing, chart and graph. See Figure 1 and Figure 1a on page 16. BARRIER (FT)

PROCEDURE

Cut filter paper big enough to fit over the large opening of the funnel with a ½-inch overlap. Tape it on. Add a drop of glycerin to the center of the paper. Add a drop of the indicator solution to the center of the paper. More drops may be necessary if the color is not apparent. Add a drop of sodium bicarbonate solution to the center of the paper.

[NOTE: Support the filter paper with a piece of wire screen cut to fit over the opening of the funnel if the moistened paper cannot withstand the flow of air through it without rupturing. Place the screen on the funnel, then place the paper over it. Secure both with tape or a rubber band.]

Attach the tubing to the small end of the funnel and to the air pump. Start the air pump and the timer. Do a preliminary test, drawing air from above the open bottle of dilute hydrochloric acid. Stop the pump when a red color is visible.

Test some air: Take samples from a chemistry laboratory, outdoors, in a kitchen, from exhaled breath. Record the results on a chart and bar graph to illustrate the presence of acid gases at the test site. (See Figure 1a) Record on the chart the site location, the time you started taking the air sample, and the time the treated filter paper began to react with the gases. Show the elapsed time figures in the form of a bar graph. Then you will have a complete picture of the acid gas concentrations encountered in the test.

INTERMEDIATE—WATER

CONCEPT

To determine the toxicity of a material to aquatic life or to determine the degree of reduction in toxicity that is necessary to protect aquatic life.

EQUIPMENT

Six one-gallon jars, 12 to 24 small fish, small nets, household ammonia, table salt.

PROCEDURE

Many of our water quality standards specify margins of safety in reference to a toxic level of a pollutant. Such a toxicity determination is called a bioassay. A bioassay is the exposure of an aquatic organism, usually fish of one to two inches in length, to a known concentration of a toxicant under controlled conditions for a specified time—usually is 24, 48, or 96 hours. A series of test concentrations of increasing toxicity in test jars is used so that in one test jar at a particular concentration, more than half, but not all, of the fish will be killed within a specified time, while in another jar at another concentration, less than half of the fish will be killed. Two, four, or more test fish are placed in each jar of the test series.

Fill six one-gallon jars with 2,000 milliliters of stream water (tap water may contain toxic chlorine). Number the jars. Use the first jar as a control and add nothing; to the second jar add a very small amount of test material (household ammonia). Increase this amount in successive jars in the series. Record amount of toxicant placed in each test jar. Add two to four small stream fish to each jar. **Handle fish with small nets—not with hands.** A good experiment will kill no fish in the control jar **or** in the jar containing the least amount of introduced toxic material but will kill all of the fish in the jar containing the most toxic matrial. Observe reaction of fish in each jar. Note when fish die in each jar and record time of fish death and percentage of dead fish in each container at end of experimental period. Remove dead fish from experimental jars at time of death.

ACCOMPLISHMENT LEVEL *

Elementary students. Have you ever seen a fish kill?

* For additional activities see Water Experiment in the Elementary and High School level.

Describe what you saw. What will kill fish? (Practically any thing or event that significantly changes water quality.)

Intermediate students. (add) How can one use the information obtained from this and similar experiments to increase our knowledge of the water environment? What does a fish kill indicate? (Usually a catastrophic event or a man introduced toxic material.)

High School students. (add) Repeat same experiment using table salt as the experimental toxicant, calculate the concentrations of both household ammonia and table salt that will kill 50 per cent of the test fish. This is done by graphing the percentage of fish killed at each concentration of toxic material against the various concentrations in the separate test jars for a particular time period. How can the information from these experiments be used to manage the discharge of pollutants? In the above experiments, which toxic material killed fish in the lowest concentration?

INTERMEDIATE—NOISE

CONCEPT

Assessing the cumulative effects of noise from various sources.

EQUIPMENT

100 ft. tape measure, reading material.

PROCEDURE

The Walk-Away Test was designed to evaluate—without reference to specific sources—the overall noise condition at a site. Since noise may vary during a 24-hour period, this test should be performed at times when noise is apt to be most severe, i.e., during peak morning and afternoon traffic periods, and at those hours when noise is apt to be most annoying, i.e., between 10 p.m. and midnight when people are trying to sleep. When performing a Walk-Away Test, you should record the information on Worksheet A.

The Walk-Away Test requires two students who exchange roles as speaker and listener; thus each person should have normal hearing and an average voice. To perform the test, you will need the tape measure and reading material with which both students are unfamiliar.

The speaker should stand at a fixed location, while the listener, starting at a distance of 2 or 3 feet, backs slowly away. The speaker should hold the reading material at chest height in such a way as not to block the direct path from himself to the listener. He should not raise his voice in an attempt to maintain communication.

At some point the listener will find that he can understand only a scattered word or two over a period of 10 seconds or more. At this point, measure the distance between the listener and the speaker.

For consistent and accurate results, this procedure should be repeated several times during each test and the distance should be averaged. Also, the roles of speaker and listener should be reversed to average out variations of normal speaking levels and hearing acuity. After each test, evaluate the site's overall noise levels by using Table I.

EXAMPLE: The site's exposure to both roadway and railway noise has been evaluated as Normally Acceptable. Therefore, we assess the overall noise levels during three separate weekday visits to the site. During Test #1, made between 8:00 and 9:00 a.m., the distances at which understanding became difficult were 50 ft., 55 ft., and 54 ft. for an average of 53 ft. The average of distance for Test #2, made between 4:00 and 5:00 p.m., was 47 ft. and the average for Test #3, made between 10:00 and 11:00 p.m., was 68 ft.

Table I shows that during each visit, the overall noise level at the site was Normally Acceptable.

TABLE I

SITE EXPOSURE TO OVERALL NOISE LEVELS

Distance Where Understanding Becomes Very Difficult	Acceptability Category
More than 70 ft.	Clearly Acceptable
26 - 70 ft.	Normally Acceptable
7 - 25 ft.	Normally Unacceptable
Less than 7 ft.	Clearly Unacceptable

WORKSHEET A — Walk-Away Test

Date and time of each visit to the site: Acceptability Category:

1. .....
2. .....
3. .....

Visit #1 Visit #2 Visit #3

Average of distances: .....

Date: .....

Signature: .....

INTERMEDIATE—SOLID WASTE

CONCEPT

Discuss the subject of solid waste with your students so they can understand the full scope of this national problem. This project is to show your students how they can help solve the solid waste problem in your own community through a student-sponsored glass container reclamation program.

EQUIPMENT

Containers or barrels, gloves, poster paper, paint.

PROCEDURE

GLASS COLLECTION SITE—Pick a suitable location (possibly a shopping center parking lot) where people can deliver their containers. Obtain permission to use the site. (Acquire any legal permit needed to carry out your collection activity). Contact the Reclamation and Recycling Coordinator of the nearest glass plant to coordinate the collection schedule with him. Each Reclamation Center has its own schedule; be sure you know when yours can accept delivery of the containers you collect.

COLLECTION SITE FACILITIES—Arrange to have containers that can transport the collected bottles and jars to the Reclamation Center. Because the glass must be separated by color—amber, green and clear—a minimum of three containers will be needed. You will also need a container to collect the bags and boxes people use to deliver jars and bottles. Signs will help your operation.

POLICE LIAISON AND TRAFFIC CONTROL—Inform local police about your plans; **a special permit may be required.** The police may want to assign someone to help direct traffic at the collection site.

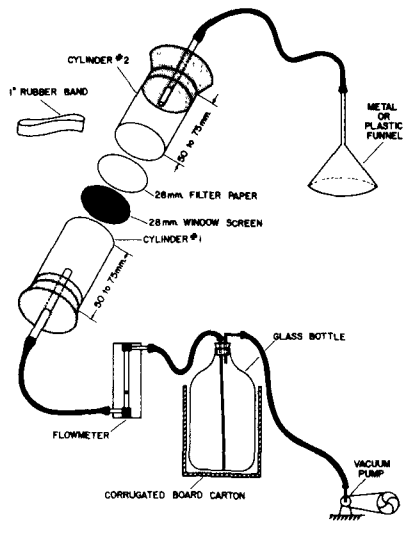
COLLECTION SITE PERSONNEL—Determine how many students will be needed to work at the site. Ask for volunteers and assign specific duties, including cleanup after the drive is over. **It is a good idea to use gloves and, if possible, safety goggles when handling glass containers.**

INSURANCE—Check to see if the collection site should be insured for liability. Rules and requirements vary. If the site is on private property, check with the owner or general manager. If it is on public property, discuss the matter with the appropriate governmental official.

TRANSPORTATION—Arrange to have the collected glass containers transported to the Reclamation Center, possibly using vehicles and equipment donated by a local company.

PUBLICITY—This responsibility can be broken down into two main areas: **Media:** Contact local newspapers and radio and television stations to let them know what your students are planning. Ask them to publish or announce your program as a public service. At the end of the drive, inform the press on the success of the program. Give credit to the people and companies who helped. Mention how much the drive netted in earnings and what the children plan to do with the money.

Political and civic: Notify your mayor, city manager, and town council of your project. Let the presidents of local civic groups know about it too. These people can be a big help in making your drive a success. For example, have the mayor kick off the project by bringing some bottles to the site. Invite the press and TV to cover this.



Assembly for Sampling Air (See page 8)

EXPERIMENTS—HIGH SCHOOL

HIGH SCHOOL—AIR

CONCEPT

This experiment demonstrates that the air in which we live and which we breathe is not always as clean as it appears to be.

EQUIPMENT

Small vacuum pump or water aspirator having an air volume capacity of approximately ¾ cubic foot per minute. Two pieces of 28-mm (outside diameter) glass tubing 50- to 75-mm long, with 1.2-mm wall thickness (be sure glass tubing is cut square and the ends are fire polished to avoid cut fingers). Window screen disc cut 28-mm in diameter, two rubber stoppers to fit glass tubing. Each stopper to have an 8-mm hole in center. Two 75-mm pieces of 8-mm outside diameter glass tubing. Whatmann #41 filter paper 28-mm diameter discs, rubber band, 1-inch wide, to fit snugly around 28-mm tubing, or 1-inch wide masking tape, burette stand with a 3-finger clamp, plastic (Tygon or Nalgon) or rubber tubing to connect filter to vacuum pump and to act as a probe to collect outdoor air, flowmeter (rotameter) of appropriate range, or a wet or dry gas meter if available. A critical orifice of proper size may be used to control air flow at the maximum rate desired. Glass bottle (1-gal. capacity) fitted with 2-hole rubber stopper containing one long and one short piece of 8-mm glass tubing. The bottle should be nested in a corrugated board box for safety.

ASSEMBLE APPARATUS

Set the screen on top of one piece of 28-mm tubing (now called cylinder #1).

Place a filter paper disc on the screen.

Place the other piece of 28-mm tubing (cylinder #2) on top of the filter paper, press the two cylinders together and make an air-tight seal with the rubber band or with masking tape.

Insert a small glass tube in a hole through each rubber stopper. Place one stopper in the lower end of cylinder #1 and the other stopper in the upper end of cylinder #2. Mount the assembly in the burette stand with cylinder #2 in the upper position.

Using plastic or rubber tubing, connect cylinder #1 to the lower tap on the rotameter or to the inlet of other type of flow measuring device. Connect the outlet of the rotameter or other flowmeter to the inlet side (long glass tube) of the 1-gallon bottle. (This bottle evens out any fluctuations due to the vacuum pump. It is called a surge or buffer bottle.)

Similarly connect the outlet tube from the surge bottle to the inlet tap of the vacuum pump or other source of vacuum.

Connect a long piece of plastic or rubber tubing to the inlet end of cylinder #2, and pass the other end through a window. The stem of the funnel should be inserted in the tubing hanging outside. The funnel should hang upside down to prevent rain from entering the tubing. See Assembly on page 7.

PROCEDURE

Start the vacuum pump and record the time. Measure and record the rate of air flow.

Allow air to pass through the filter for two hours or as long as required to darken the filter paper noticeably.

Measure and record the rate of air flow. Stop the vacuum pump and record the time.

Dismantle and observe the soiling of the filter paper.

If a photometer to measure transmittance of light through the soiled filter paper is available, a quantitative evaluation of the amount of soiling can be made.

(Physics students may be interested in investigating and building a simple means of measuring light transmittance through the tape.)

QUANTITATIVE EVALUATION

THEORY—The amount of discoloration on the filter paper is approximately proportional to the quantity of solid particles suspended in the air. This makes it possible to relate the decrease in light transmittance through the paper to the amount of particles collected on it. The light transmittance of the paper can be measured with a photometer before and after filtering the air by placing the clean filter disc and later, the exposed filter disc against the photometer window and noting the intensity of light transmitted in each test.

From these measurements the optical density of the soiled filter paper can be computed in COHs. The COH is an abbreviation for Coefficient of Haze and one COH unit represents an optical density of 0.01. The optical density of the deposit or soiling is the logarithm to the base 10 of the ratio of the intensity of light transmitted through the clean filter paper to the intensity of the light transmitted through the soiled filter paper. In terms of percentage, it can also be the ratio of percent transmittance through the clean paper (considered as 100%) to the percent transmittance through the soiled paper.

Therefore,

$$\frac{I_o}{I_t} = \frac{\log_{10} 100\%}{\%T}$$

where,

I_o = average light intensity transmitted through clean filter paper,

I_t = light intensity transmitted through the soiled paper, and

$\%T$ = percent light transmitted through the soiled paper when the light transmittance through clean paper is considered as 100%

Since $\log_{10}$ of 100 = 2.0, we have

O.D. = 2.0 − log %T

By definition, one COH unit equals an optical density of 0.01. Thus, the number of COH_S represented by the actual O.D. found equals O.D./0.01 = 100×(2.0 − log %T).

COH unit measurements are usually expressed as COH_S per 1,000 linear feet of air passed through the filter paper. The concept of linear flow, upon which the expression COH_S per 1,000 feet is based, considers that through each point on the surface of the filter a long stream of air passes leaving its load of dirt particles deposited. One might think of the sample as a long column of air the same diameter as the diameter of the exposed filter paper and with a volume equal to the measured volume of the air sample.

COMPUTATIONS

1. Volume of air = $R_2 - R_1$ (for dry or wet gas meter),
   R_2 = final reading in cubic feet
   R_1 = original reading in cubic feet
   or, volume of air

$$= \frac{t(F_1 + F_2)}{2}$$ (for rotameter or critical orifice)

F_1 = initial flow rate in cubic feet per minute
F_2 = final flow rate in cubic feet per minute
t = sampling time in minutes

CORRECTIONS FOR TEMPERATURE AND PRESSURE (if desired)

The value $R_2 - R_1$ for the gas meter should be corrected for temperature and pressure according to the Charles' and Boyles' laws.

Each F value for the rotameter or orifice should first be corrected to what it would be at the standard temperature and pressure at which the measuring device was calibrated:

$$F_S = F\sqrt{\frac{T_S}{T}\cdot\frac{P}{P_S}}$$

2. Area = $\frac{\pi d^2}{4}$, where d is the inside diameter of the cylinder in feet.

$$\text{Ft.} = \text{mm.} \times \frac{\text{cm.}}{\text{mm.}} \times \frac{\text{in.}}{\text{cm.}} \times \frac{\text{ft.}}{\text{in.}}$$

3. Linear feet of air = $\frac{\text{Volume}}{\text{Area}} = L$

4. COH_S per 1000 feet = $\frac{(2.0 - \log\%T)\times 100}{L/1000}$

$$\frac{(2.0 - \log\%T)\times 100\times 1000}{L}$$

$$\frac{(2.0 - \log\%T)\times 10^5}{L}$$

HIGH SCHOOL—WATER

CONCEPT

An everyday problem facing an operator of a water treatment plant is the amount of chemical coagulant that must be added to the water to remove natural color. Substances that cause color in natural waters are actually colloidal particles whose sizes range from 10^{-7} cm. to 10^{-4} cm. Each of these particles generally carries a negative charge and repels other particles similarly charged. The coagulants used have positive charges and act to neutralize the charge on colloidal particles. The neutralized particles coalesce into much larger particles called "floc". The floc is denser than water and will settle from the suspension removing the color.

EQUIPMENT

Chemicals required: filter alum or aluminum sulfate, sulfuric acid, soda ash (sodium carbonate), 6-500 ml. or 1,000 ml. beakers, stirring rods, laboratory balance, pH meter. Aluminum sulfate or filter alum is the most common coagulant. For proper reaction and floc formation it requires some form of alkalinity which can be present naturally in the water or may be added. If insufficient alkalinity is present, sodium carbonate can be added to provide the alkalinity.

PROCEDURE

If naturally colored water is available from a local stream or lake, it can be used. If not, an artificially colored water can be made using 1-2 teaspoons of instant tea per gallon of tap water.

Set up 6 beakers with known amount of water (250 ml. or 500 ml.). Add filter alum and soda ash (if required) according to the following table:
(initially try test without soda ash.)

Table 1

Jar No.	Amount of Alum Added (Mg.)		Amount of Soda Ash Added (Mg.)	
	250 ml.	500 ml.	250 ml.	500 ml.
1	2	4	4	8
2	4	8	5	10
3	6	12	6	12
4	8	16	7	14
5	10	20	8	16
6	12	24	9	18

Stir vigorously for about 1 minute until floc forms (about 3 revolutions per second). After floc formulation, stirring should be reduced to just keep the floc in suspension (about 1 revolution every 4 seconds). Slow stirring should continue for 10-15 minutes. NOTE: If the floc does not form initially, reduce the pH in one jar to about 4 by adding sulfuric acid. Floc should then form. If floc still does not form, try adding sodium carbonate in another beaker to see if floc will form. If either addition is required, begin test over again with the addition of the required chemical.

Allow beakers to stand for 10 minutes while floc settles to the bottom. Record the results achieved in each beaker. In practice, the beaker with the lowest chemical dosage that produced an acceptable color level would be the chemical dosage used in the water treatment plant.

ACCOMPLISHMENT LEVEL *

Elementary students. Could the same procedure be used to remove clay turbidity from water? (Answer: —yes, exactly the same.)

Intermediate students. After treating the water, test the pH. How would the pH be increased or decreased to avoid corroding pipes in a distribution system? (Answer:—by adding either a base—lime, sodium carbonate or an acid—sulfuric acid.)

High School students. Calculate the required chemical dosages for a water treatment plant treating 10 million gallons of water per day for each of the test chemical dosages. (Hint: 1 mg/liter is equivalent to 8.34 pounds per million gallons.)

* For additional activities see Water Experiment in the Elementary and Intermediate level.

HIGH SCHOOL—NOISE

CONCEPT

Noise is a harmful intruder in our daily lives—it is distracting and injurious when excessive. If noise levels are unacceptable, steps should be taken (planting bush barriers, re-routing traffic, etc.) to reduce the level.

To evaluate a site's exposure to roadway noise, you will need to consider all major roads within 1000 ft. The information required for this evaluation is listed below under headings that indicate the most likely source.

EQUIPMENT

A map of the site area, a ruler (straight-edge), a pencil, and perhaps a 100-ft. tape measure. (The worksheets needed for the analysis are at the end of the lesson.)

PROCEDURE

Before beginning the evaluation, you should try to obtain any available information about approved plans for roadway changes (e.g., widening existing roads or building new roads) and about expected changes in road traffic (e.g., will the traffic on this

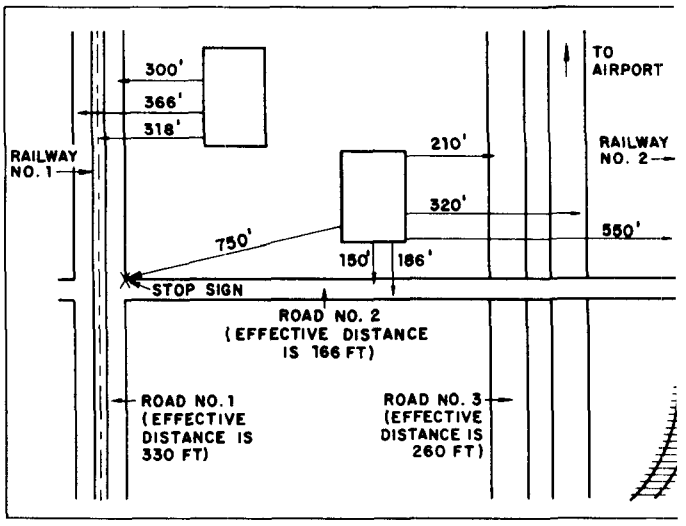


Figure 1—Plan view of site showing how distances should be measured from the location of the dwelling nearest to the source.

road increase significantly in the next 10 or 15 years?) Then record the following information on the worksheet A page 15.

From an area map and/or the City (County) Engineer: The distance from the site to the centerlines of the nearest and farthest lanes of traffic.

From the City (County) Director of Traffic: The peak hourly automobile traffic flow in both directions, combined.

The peak number of trucks (buses count as trucks) per hour in each direction. (If the road has a gradient of 3 per cent or more, record uphill and downhill numbers separately as these figures will be necessary later; if not, simply record the total number of trucks.)

NOTE: You may also need to make adjustments for the following circumstances:

—A road gradient of 3 per cent or more
—Stop-and-go traffic
—Mean speed
—A barrier

The information required for these adjustments can be obtained from the City (County) Director of Traffic. Traffic surveys show that the level of roadway noise depends on the percentage of trucks in the total traffic volume. To account for this effect, these guidelines provide for separate evaluation of automobile and truck traffic.

Before proceeding with these separate evaluations, however, determine the effective distance from the site to each road, by locating on Figure 2 the distances from the site to the centerlines of the nearest and farthest lanes of traffic.

The site shown (Figure 1) is exposed to noise from three major roads: Road #1 has 4 lanes, each 12 ft. wide, and a 30-ft. wide median strip which accommodates a rapid transit line. Road #2 has 4 lanes, each 12 ft. wide. Road #3 has 6 lanes, each 15 ft. wide, and a median strip 35 ft. wide. The distance shown (Figure 1) will be used for all roadway examples in this experiment.

Return to Fig. 2—lay a straight-edge to connect these two distances and read off the value at the point where the straight-edge crosses the middle scale. This value is the effective distance to the road and should be recorded on line 4 of worksheet A.

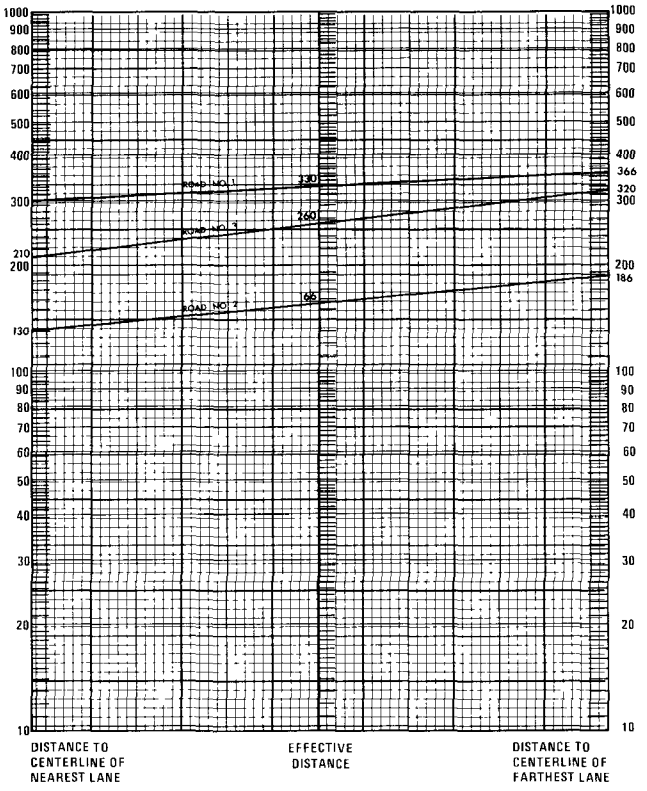
AUTOMOBILE TRAFFIC

The numbers in Figure 3, which is used to evaluate the site's exposure to automobile noise, were arrived at with the following assumptions:

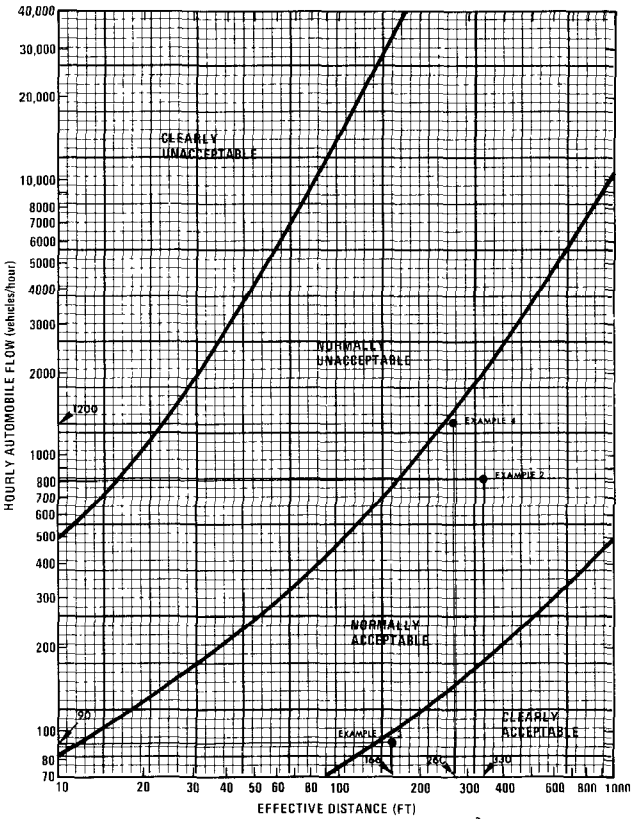
—There is no traffic signal or stop sign within 800 ft. of the site.

—The mean automobile traffic speed is 60 mph.

—There is line-of-sight exposure from the site to the road—i.e., there is no barrier which effectively shields the site from the road.



Example of how Figure 2 is used to determine effective distances.



Example of how Figure 3 is used to evaluate site exposure to automobile noise.

If a road meets these three conditions, proceed to Figure 3 for an immediate evaluation of the site's exposure to the automobile noise from that road. **BUT** if any of these conditions are different, make the necessary adjustment(s) and **then** use Figure 3 for the evaluation.

ADJUSTMENTS FOR AUTOMOBILE TRAFFIC

Stop-and-go Traffic:

If there is a traffic signal or stop sign within 800 ft. of the site, multiply the total number of automobiles per hour by 0.1. Record your answer on line 5.

Mean Traffic Speed:

If there is no traffic signal or stop sign within 800 ft. of the site and the mean automobile speed is other than 60 mph, multiply the total number of automobiles by the appropriate adjustment factor (see table below). Record your answer on line 6.

Mean Traffic Speed	Adjustment Factor	
	car	truck
20 (mph)	0.12	1.60
25	0.18	1.20
30	0.25	1.00
35	0.32	0.88
40	0.40	0.75
45	0.55	0.69
50	0.70	0.63
55	0.85	0.57
60	1.00	0.50
65	1.20	0.46
70	1.40	0.43

Barrier Adjustment:

This adjustment affects distance and applies equally to automobiles and trucks on the same road.

A barrier may be formed by the road profile, by a solid wall or embankment, by a continuous row of buildings, or by the terrain itself. To be an **effective** shield, however, the barrier must block all residential levels of all buildings from line-of-sight to the road, and it must not have any gaps that would allow noise to leak through.

This adjustment is necessary **only** when the site's exposure to noise from a road has been found Normally or Clearly Unacceptable.

To make the barrier adjustment, you should first record on line 10 the distance between the site and the barrier and on line 11 the distance between the center of the road and the barrier; then you should determine the differences in effective elevation between (1) the site and the road, and (2) the barrier and the road as follows:

Step 1. From the City (County) Engineer, obtain the elevation of the road. (Roads may be elevated above the natural terrain or may be depressed, as in our example; make certain, therefore, that the figure you obtain for road elevation takes any such change into account.) Add 5 ft. to this figure to obtain the effective road elevation and record your answer on line 12.

Step 2. From the applicant, obtain the ground elevation of the site and the number of stories in the proposed housing. Multiply the number of stories by 10 ft. Add the site elevation and then subtract 5 ft. from this total to obtain the effective site elevation. Record your answer on line 13.

Step 3. From the City (County) Engineer or a contour map, obtain the elevation of the terrain where the barrier is located. Add the actual height of the barrier to obtain the effective barrier elevation. Record your answer on line 14. (Note that in some cases, as in our example, the barrier is formed by the road profile and the elevation of the terrain is the effective barrier elevation.)

Record the difference in effective elevation between the site (line 13) and the road (line 12) on line 15. Record the difference in effective elevation between the barrier (line 14) and the road (line 12) on line 16. To find the barrier adjustment factor, you will need Figure 5, a straight-edge, and the information recorded on lines 10, 11, 15 and 16. The Example of Barrier Adjustment explains how to use Figure 5.

When you have determined the barrier adjustment factor, multiply line 4, the effective distance, by the adjustment factor to obtain the adjusted distance from the site to the road. Record your answer on line 17.

* **EXAMPLE 2:** Road #1 meets the three conditions that allow for an immediate evaluation. In obtaining the information necessary for this evaluation, we found that the hourly automobile flow is 800 vehicles.

On Figure 3, we locate on the vertical scale the point representing 800 vehicles/hr. and on the horizontal scale the point representing 330 ft. (Note that we must estimate the location of this point.) Using a straight-edge, draw lines to connect these two values and find that the site's exposure to automobile noise from this road is Normally Acceptable.

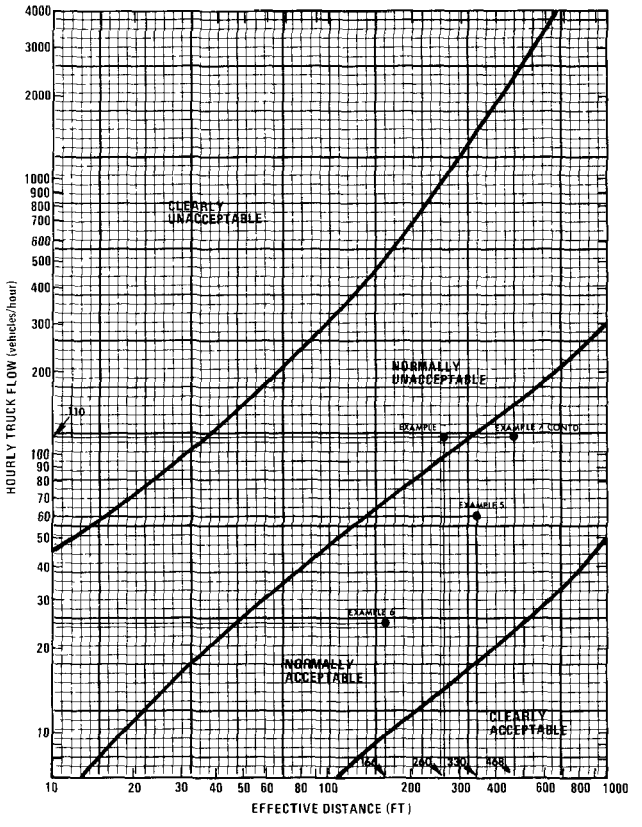
EXAMPLE 3: Road #2 has a stop sign at 750 ft. from the site. The hourly automobile flow is reported as being 900 vehicles. Adjust for stop-and-go traffic.

$$900 \times 0.1 = 90 \text{ vehicles}$$

and find from Figure 3 that the exposure to automobile noise is Clearly Acceptable.

EXAMPLE 4: Road #3 is a depressed highway. There is no traffic signal or stop sign and the mean speed is 60 mph. The hourly automobile flow is 1200 vehicles. The road profile shields all residential levels of the housing from line-of-sight to the traffic. The only adjustment that can be made is the barrier adjustment. This adjustment is necessary, however, only when the site's exposure to noise has been found Clearly or Normally Unacceptable. Figure 3 shows that the exposure to automobile noise is Normally Acceptable. Therefore, no adjustment for barrier is necessary.

* See Page 14



Example of how Figure 4 is used to evaluate site exposure to truck noise.

TRUCK TRAFFIC

The numbers in Figure 4, which is used to evaluate the site's exposure to truck noise, were arrived at with the following assumptions:

- There is a road gradient of less than 3%.
- There is no traffic signal or stop sign within 800 ft. of the site.
- The mean truck traffic speed is 30 mph.
- There is line-of-sight exposure from the site to the road—i.e., there is no barrier which effectively shields the site from the road.

If a road meets these four conditions, proceed to Figure 4 for an immediate evaluation of the site's exposure to truck noise from that road.

But

if any of the conditions are different, make the necessary adjustment(s) listed below and **then** use Figure 4 for the evaluation.

ADUSTMENTS FOR TRUCK TRAFFIC

Road Gradient:

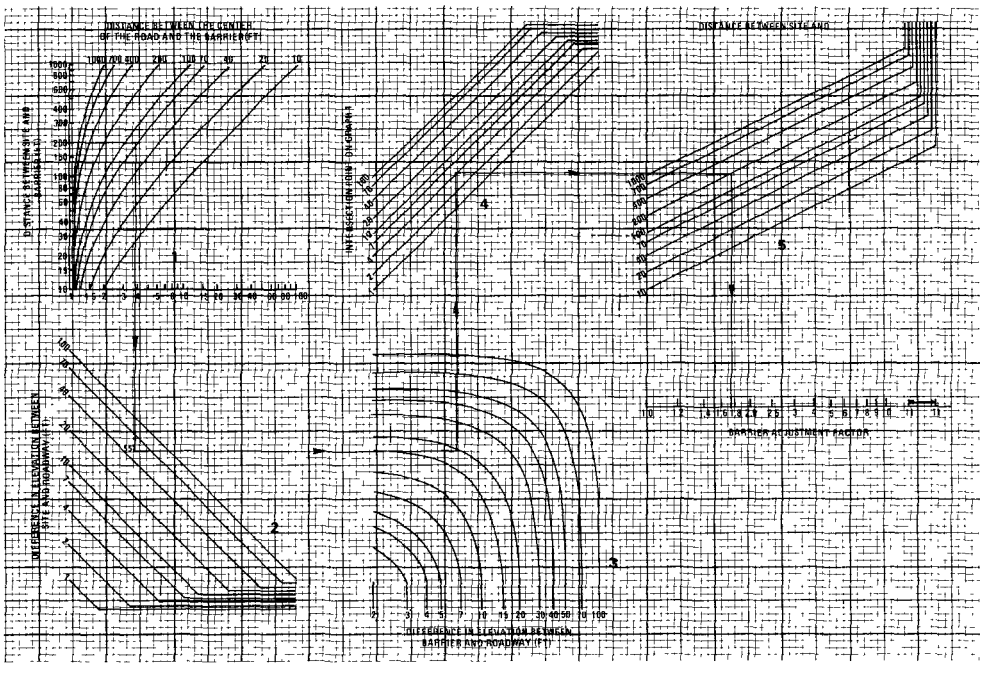
If there is a gradient of 3% or more, multiply the number of trucks per hour in the uphill direction by the appropriate adjustment factor.

% of Gradient	Adjustment Factor
3-4%	1.4
5-6%	1.7
More than 6%	2.5

Add to this adjusted figure the number of trucks per hour in the downhill direction and record your answer on line 7.

Stop-and-go Traffic:

If there is a traffic signal or stop sign within 800 ft. of the site, multiply by 5 the total number of trucks. Record your answer on line 8. (If the truck traffic has already been adjusted for gradient, use the number on



Example of how Figure 5 is used to find the adjustment factor.

line 7; if not, use the number of trucks on line 3c for this calculation.) See Example 6.

Mean Traffic Speed:

Make this adjustment only if there is no traffic signal or stop sign within 800 ft. of the site **and** the mean speed is not 30 mph.

If the mean truck speed differs with direction treat the uphill and downhill traffic separately. Multiply each by the appropriate adjustment factor on page 12.

Add these two numbers and record your answer on line 9. (Remember that the uphill traffic may have been adjusted for road gradient.)

But

if the mean truck speed is the same for both directions, then multiply the total number of trucks (from either line 3c or line 7) by the appropriate adjustment factor. Record your answer on line 9.

***EXAMPLE 6:** Road #2 has a stop sign at 750 ft. from the site. There is also a road gradient of 4%. No trucks are allowed on this road, but 4 buses per hour are scheduled 2 in each direction.
We adjust first for gradient

uphill:	$2 \times 1.4 = 2.8$ vehicles
downhill:	2. vehicles
total flow:	4.8 vehicles

And then adjust for stop-and-go traffic
$4.8 \times 5 = 24$ vehicles (per hour)

Figure 4 shows that the exposure to truck (bus) noise from this road is Normally Acceptable.

If truck noise is found to be normally unacceptable we proceed to make the barrier adjustment.

EXAMPLE 7: Example 7 explains how to use Figure 5. The barrier, which is formed by the road #3 profile, has no height other than the 150 ft. elevation of the natural terrain. Thus, the effective barrier elevation is 150 ft.

The difference in effective elevation between (1) the site and the road is 55 ft. and (2) the barrier and the road is 20 ft.

We now use Figure 5 to find the barrier adjustment factor.

Example of Barrier Adjustment:

—The distance from the site to the barrier is 200 ft.

—The distance from the center of the road to the barrier is 70 ft.

—The difference in effective elevation between the site and the road is 55 ft.

—The difference in effective elevation between the barrier and the road is 20 ft.

On the vertical scale of Graph 1, we mark 200 ft. and draw a straight horizontal line to meet the curve marked 70 ft. Then, we draw a vertical line down to Graph 2 to meet the point which represents 55 ft. (note that we must guess the location) and a horizontal line over to Graph 3 to meet the curve marked 20 ft.

NOTE: If the line from Graph 2 does not meet the appropriate curve on Graph 3, then the barrier is not an effective shield and there is no adjustment.

Next, we draw a vertical line to Graph 4 to meet the curve marked 4 (which is the number intersected by the line going from Graph 1 to Graph 2) and a horizontal line over to Graph 5 to meet the curve marked 200 ft. From Graph 5, we draw a vertical line down to the adjustment scale and find that our multiplier is 1.8.

Using this multiplier, we adjust the effective distance
$260 \times 1.8 = 468$ ft.
and find from Figure 4 that the site's exposure to truck noise from this road is Normally Acceptable.

*Example 1 and Example 5 (which appear on the appropriate graphs) were omitted as no adjustments were required for the calculations.

Worksheet A—Roadway Noise

Noise Assessment Guidelines

Acceptibility Category:

List all major roads within 1000 ft. of the site:

	Automobiles	Trucks
1.		
2.		
3.		
4.		

Necessary information:	Road #1	Road #2	Road #3	Road #4
1. The distance in feet from the site to the centerline of				
a. nearest lane:				
b. farthest lane:				
2. The total number of automobile per hour in both directions:				
3. The number of trucks per hour				
a. uphill direction:				
b. downhill direction:				
c. both directions:				
4. Effective distance from site to road:				
Adjustments for Automobile Traffic				
5. Stop-and-go:				
6. Mean speed:				
Adjustments for Truck Traffic				
7. Road gradient:				
8. Stop-and-go:				
9. Mean speed:				
Barrier Adjustment				
10. Distance from site to barrier:				
11. Distance from center of road to barrier:				
12. Effective elevation of road:				
13. Effective elevation of site:				
14. Effective elevation of barrier:				
15. Difference in elevation between site and road:				
16. Difference in elevation between barrier and road:				
17. Adjusted distance:				

Signature: _____ Date: _____

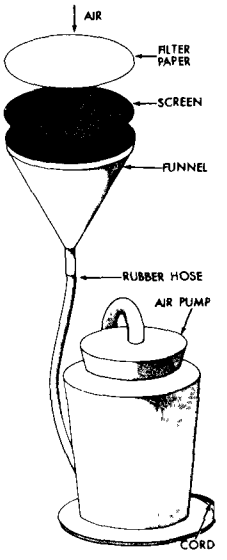


Figure 1
Air Assembly

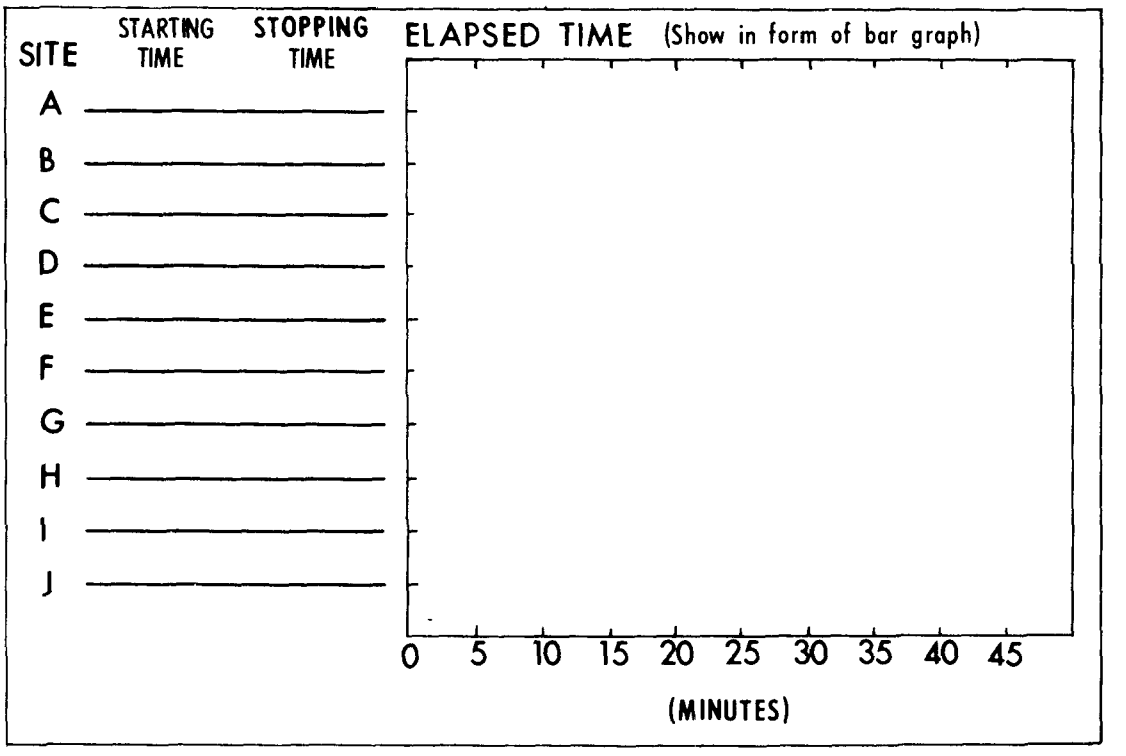


Figure 1a Air Graph

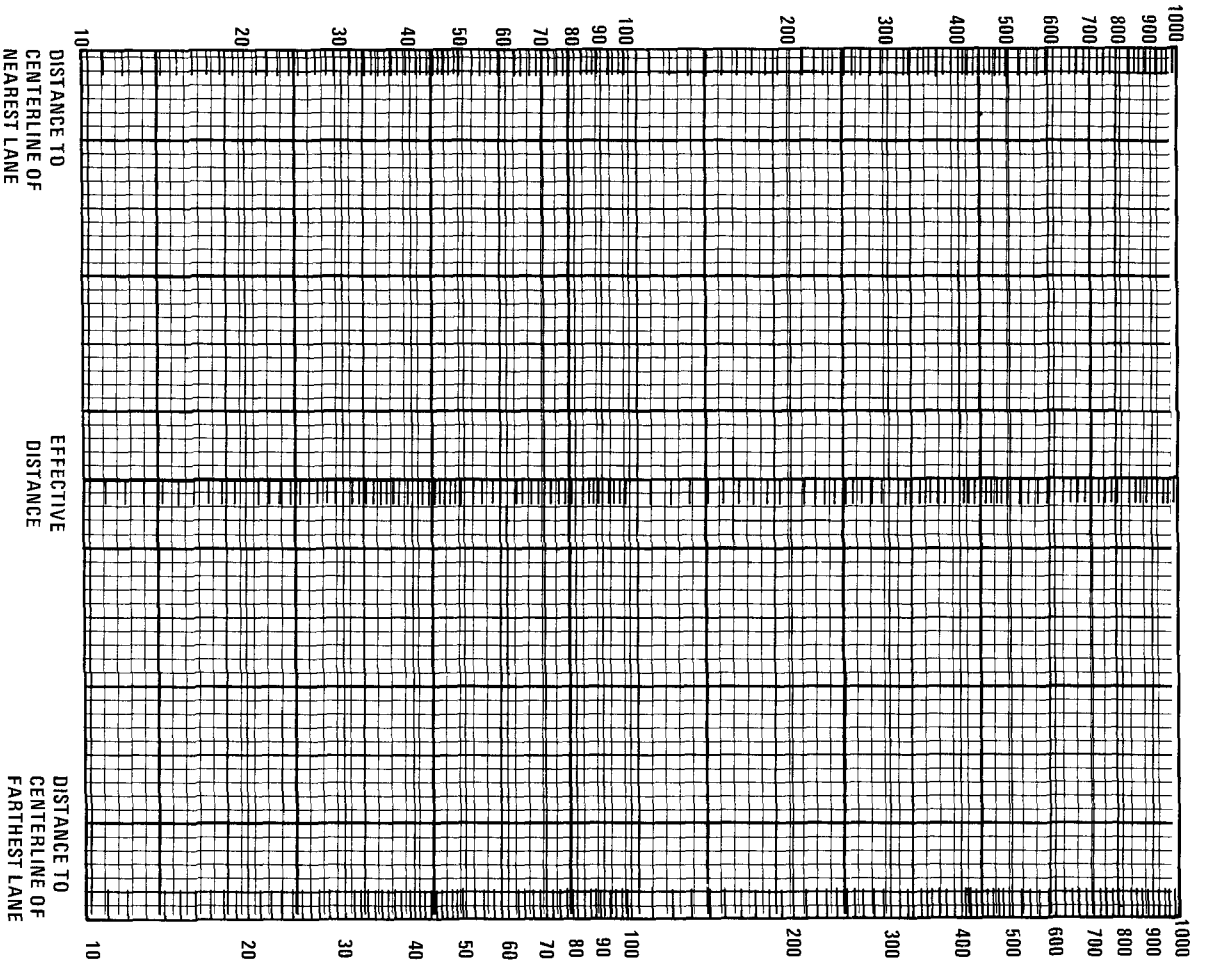


Figure 2

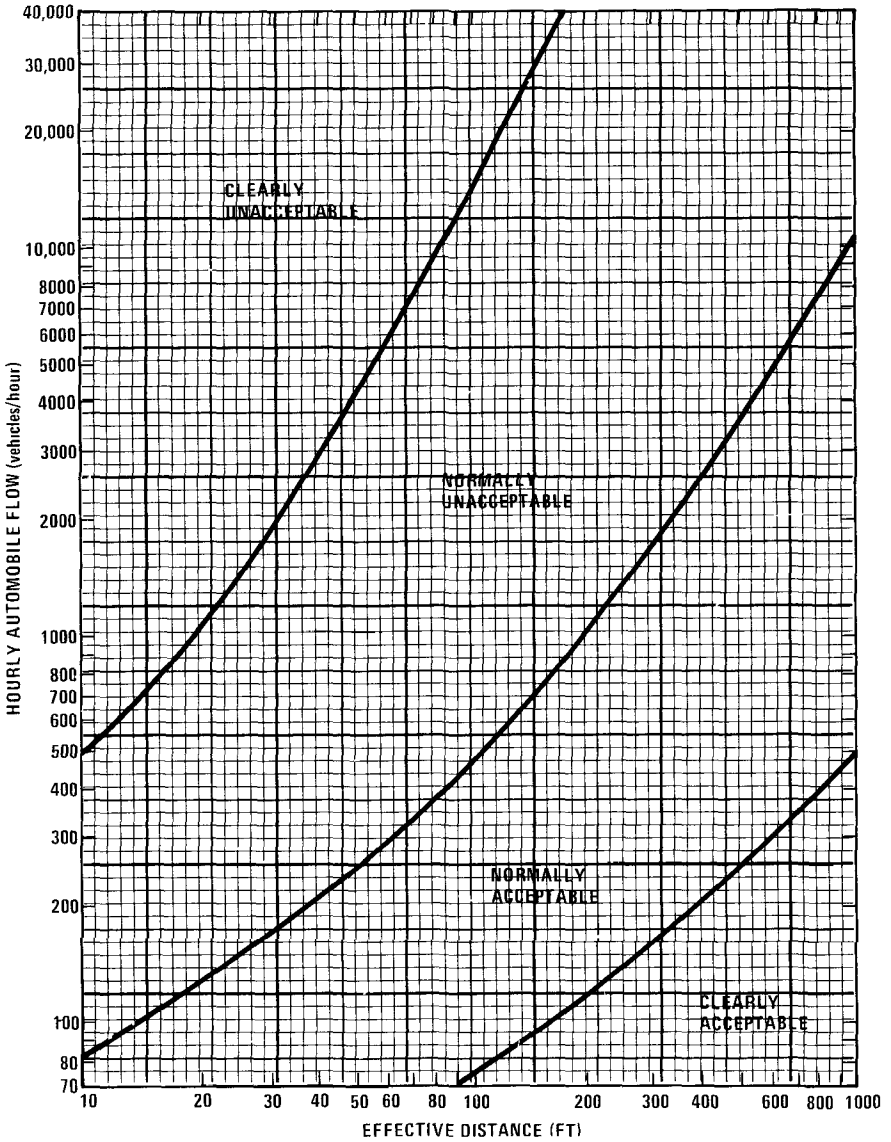


Figure 3

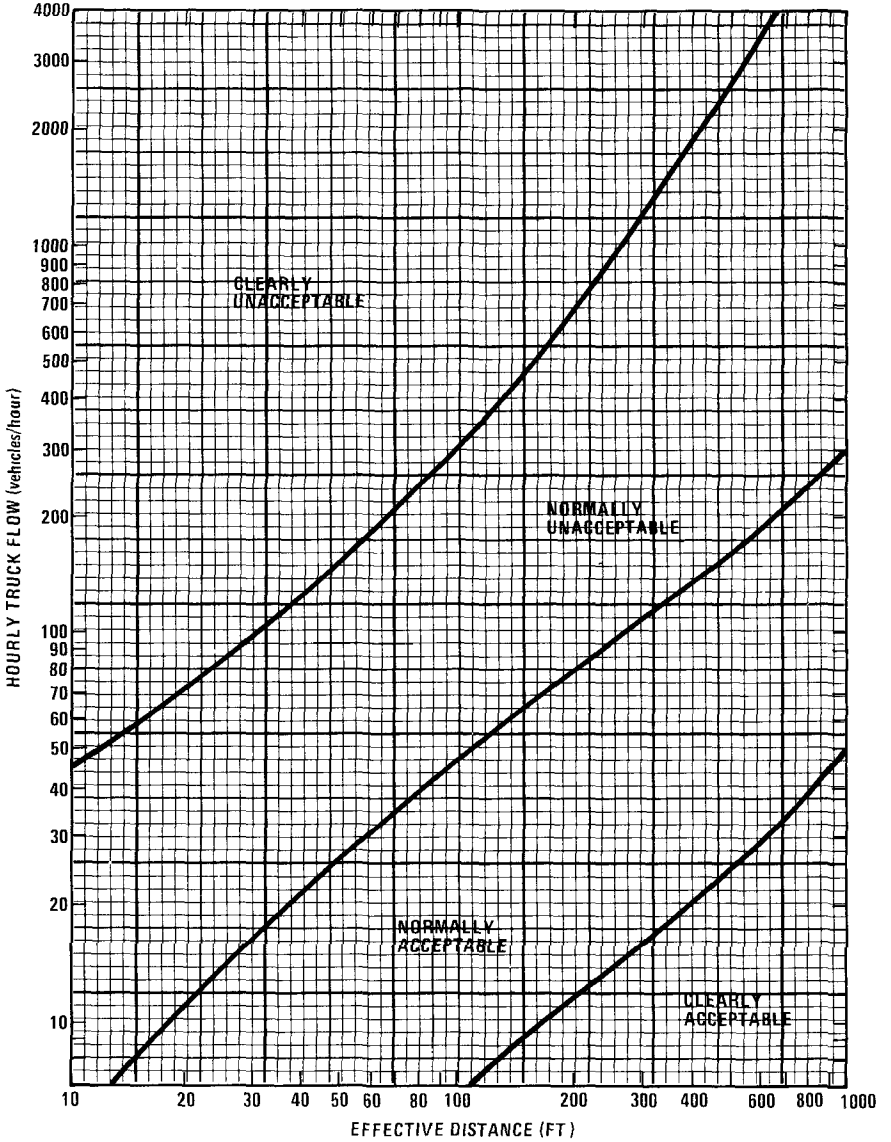


Figure 4

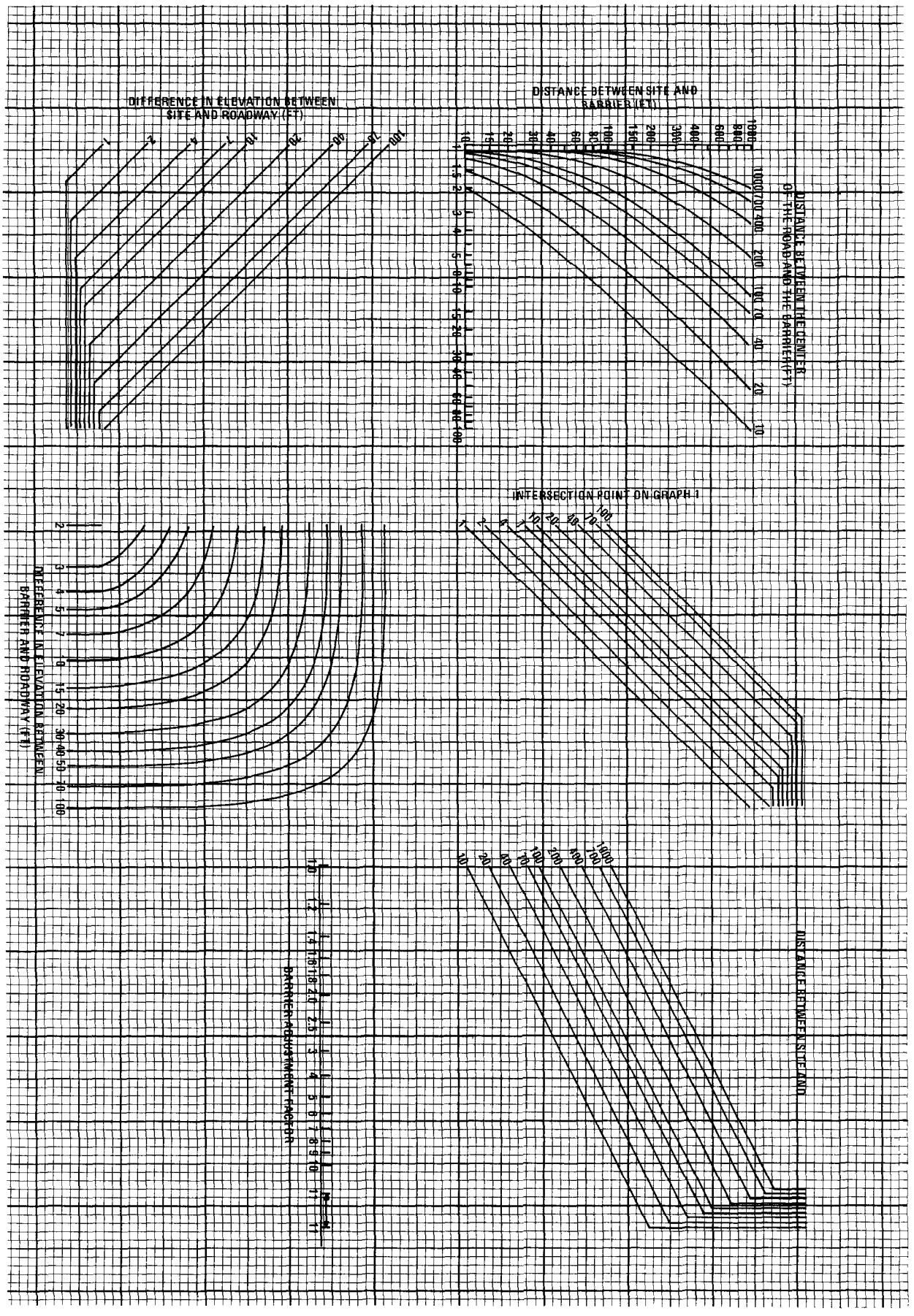

DIFFERENCE IN ELEVATION BETWEEN SITE AND ROADWAY (FT)
DISTANCE BETWEEN SITE AND BARRIER (FT)
DISTANCE BETWEEN THE CENTER OF THE ROAD AND THE BARRIER (FT)
INTERSECTION POINT ON GRAPH 1
DISTANCE BETWEEN SITE AND
DIFFERENCE IN ELEVATION BETWEEN BARRIER AND ROADWAY (FT)
BARRIER ADJUSTMENT FACTOR

Figure 5

HIGH SCHOOL—SOCIAL STUDIES

CONCEPT

This activity is to introduce the students to State and local government structure. As a result, the student should know where to go within his local or State government to deal with a water, air, noise, or solid waste problem.

EQUIPMENT

Use of school library, pamphlets released by legislative services, EPA regional office, comptroller's office, water pollution board office; poster board, pens, magic markers and rulers.

PROCEDURE

The students should visit the site of a particular pollution problem. The local area should be scanned beforehand for various pollution offenders along bodies of water, streets, parks, etc.

Either through use of the library or individual investigation, the student will obtain information concerning State laws and State agencies. Their research should lead to questions dealing with pollution. They should discover the responsibilities and relationships between various State and Federal agencies in order to deal with them more effectively.

The students may be encouraged to work in groups on some or all of the following: State, Federal and local laws dealing with pollution, biological studies of pollution, duties and relationship of Federal, State and local agencies.

HIGH SCHOOL—ECOLOGY CLUB

CONCEPT

This activity is designed for high school students interested in starting a club dealing with a pollution problem.

EQUIPMENT

The equipment required will be determined by the activities of the club.

PROCEDURE

The method for starting an organization will vary, depending on the school itself and the kind of program desired. Students interested in any aspects of pollution (i.e., science, legislation, philosophy, etc.) should be encouraged to participate, because differing skills will be needed for every project. If the students show an interest in establishing a club or similar student organization, help them out by:

1. Defining the purpose of the club (write a charter).
2. Choosing a project or setting a goal.
3. Publicizing the club.

In defining purpose, the activities that the club hopes to carry out or the possible lines of action should be considered.

After the club has been functioning for a while, it might be advisable to sit down as a group and list the activities the group has engaged in. This list should include failures as well as successes. From this, a short explanatory program of what the club is doing could be evolved very easily.

The program could utilize any posters, charts and anything else the club has produced to explain or exemplify pollution.

A 10-to 30-minute slide program of sufficient subject matter with a narrator can be very effective. It could be presented to students in other schools to encourage them to form their own club.

CLUB FUNCTIONS

PROJECTS:

1. Cleanup of polluted areas

Organize a basic plan for the cleanup of community rivers, streams, and highways. Use volunteers. View the sites to get an idea of how and what to clean up. Needed materials could include trash containers, vehicles for pickup, and transportation. Plastic or canvas bags are stronger waste containers than most paper bags.

2. Erosion

Find an erosion problem in your community that needs attention. Determine what would be involved to correct the problem. If it is a major undertaking, seek help of others in the community. If it is a small project, gather the needed equipment and materials and set up a work day for the club and other interested students.

DISTRIBUTION CENTERS

A club booth can be set up to sell or distribute material concerning pollution. Buttons, posters, and stickers can be made by the students and sold for a

profit. A number of students can be selected to receive these materials free, in order to stimulate interest. Materials that could be distributed could include pamphlets, free upon request from any government agency. You could also write to your Congressman and request that your name be added to his list of people who receive The Congressional Record. The Congressional Record will keep you informed of enviroinmental legislation being introduced and voted upon. Keep the materials at the booth.

COMMUNICATION

It is necessary to inform the public so that it can be an effective force in the school and community. Methods of communication available are unlimited. In the school, use the school newspaper or distribute dittoed sheets at information centers. Outside of the school, the students could talk to the local radio station managers and newspaper editors about time and space to publicize their activity.

POSTER AND ART EXHIBITS

For any art exhibits, proper hanging space must be available. There are several exhibits made up for exhibition in schools; check with your local library or museum. Poster contests can be sponsored in your school by the art or science department. All you need to do is arouse enough enthusiasm for the project so that you have enough contestants. One idea for promoting the enthusiasm is to make materials available to the students. Often, when some kind of prize is offered, more of the older students will participate. Otherwise your best participants will be the students in the lower grades. Encourage multi-dimensional posters made up from discarded objects as opposed to the one-dimensional kind.

Having any kind of exhibit in the halls of a school building will help to interest students. You will find a contest motivates some students who would not have been motivated otherwise.

FIELD TRIPS

Field trips are interesting and useful to a club. But trips should have interest and relevancy such as areas of established pollution. The date, time, and methods of transportation should be set up before the designated time. It is possible to get help or maybe permission from authorities if you write ahead of time or call to ask.

The purpose of the trip, either testing or knowledge seeking, can be discussed beforehand to look for key points during the trip. In the case of testing water, legal complications should be taken into consideration.

THINGS TO DO

Build a balanced aquarium or terrarium to learn how plants and animals depend on each other. Then change one element at a time to determine the effect on this environment.

Make a windowsill garden to learn how plants grow and how to take care of them; keep a weekly record of plant growth.

Take a walk on a windy day to observe how wind moves flags, clouds, leaves, seeds and soil. Show how grass and shrubs keep soil from blowing away.

Select a plant and an animal found on the school site; explain what they need for survival and how the environment meets their needs.

Start a school garden with different kinds of plants. Learn how to manage soil and water resources to encourage the growth of these plants.

Study the plants and animals on and near the school site,—in a vacant lot, in a nearby field, in the woods, and in a pond. How do these plants and animals differ in one area from those in another? How are they similar? How has man changed these areas? Prepare a report explaining how plants or animals have adapted to the environment in these areas.

Write stories about some of the ways man has either improved or harmed the environment for living things, or how your environment has changed because of man's influence.

Visit a city's water supply plant. Where does the water come from? Does the water have to be treated before it can be used by people? Why?

Find an area in which natural resources have deteriorated. Form small groups to prepare reports detailing conservation needs. Outline a plan of action for improving the area.

Select a conservation organization or agency and prepare a report on its origin and its action programs that have had a lasting effect on some aspects of conservation in your community.

Visit an art gallery or museum to learn how painters

sculptors use natural resources as inspiration for r works.

npile a list of local, State, and Federal agencies ı conservation and resource management respon-lities. Identify those that do conservation work in r community.

ly State laws affecting natural resources and their use and management. Write a model ordinance that would help solve a specific resource-use problem in your community.

Assume that all electric power has been cut off in your community for a week. Write a day-by-day account of the effect this would have on your life and on the life of the community.

THINGS TO TALK ABOUT

:uss how your everyday activities affect natural ›urces. How do you make use of soil, trees, shrubs, 'ers, water, domesticated animals, and wildlife?

npare plants and animals living in your community ı those in the ocean, in a pond, in a desert, and ı forest. How are they similar? How are they dif-nt?

at is an environment? What are some of the natural ors that limit plant and animal life in your com-ıity?

at is sediment? How does sediment in rivers and :s affect fish and wildlife? The water you use every ?

w are plants, animals, soil and water affected when n uses large areas of land for houses, shopping ters, highways, and airports?

w does man use science and technology in adapt- to his environment? Have scientific discoveries ınged your environment? Has agriculture or industry .nged your environment? How?

w do droughts, floods, fire, soil erosion, water and air pollution, and the construction of cities and highways affect plants? Animals? Man?

Name five sources of energy used by man. What impact has the use of, and search for, energy sources had on the industrial development of this country?

How does the price of space in congested areas influence decisions affecting the environment?

What are man's responsibilities to other living things in making use of resources?

How do some of the decisions on resource-use in your community affect your State or the Nation? What conservation practices can be used in your community to improve resources needed or used by other communities?

Who makes the plans for the way in which your community develops? Who plans the use and management of water resources, land area developments, parks, and open spaces? How are these plans carried out? What government agencies are responsible for using and managing natural resources? Applying conservation practices in your community? In your State?

Dear Teacher:

P.E.M.A.P.—the President's Environmental Merit Awards Program was created to encourage and recognize student involvement in cleaning up the environment.

Certificates bearing the Presidential seal and signature are granted students who participate in award-winning projects.

For information on how to enroll your class, club or school in the program write:

Ms. Joan Donnelly
The President's Environmental
Merit Awards Program
U.S. Environmental Protection Agency
401 M Street S.W.
Washington, D. C. 20460

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