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ABSTRACT

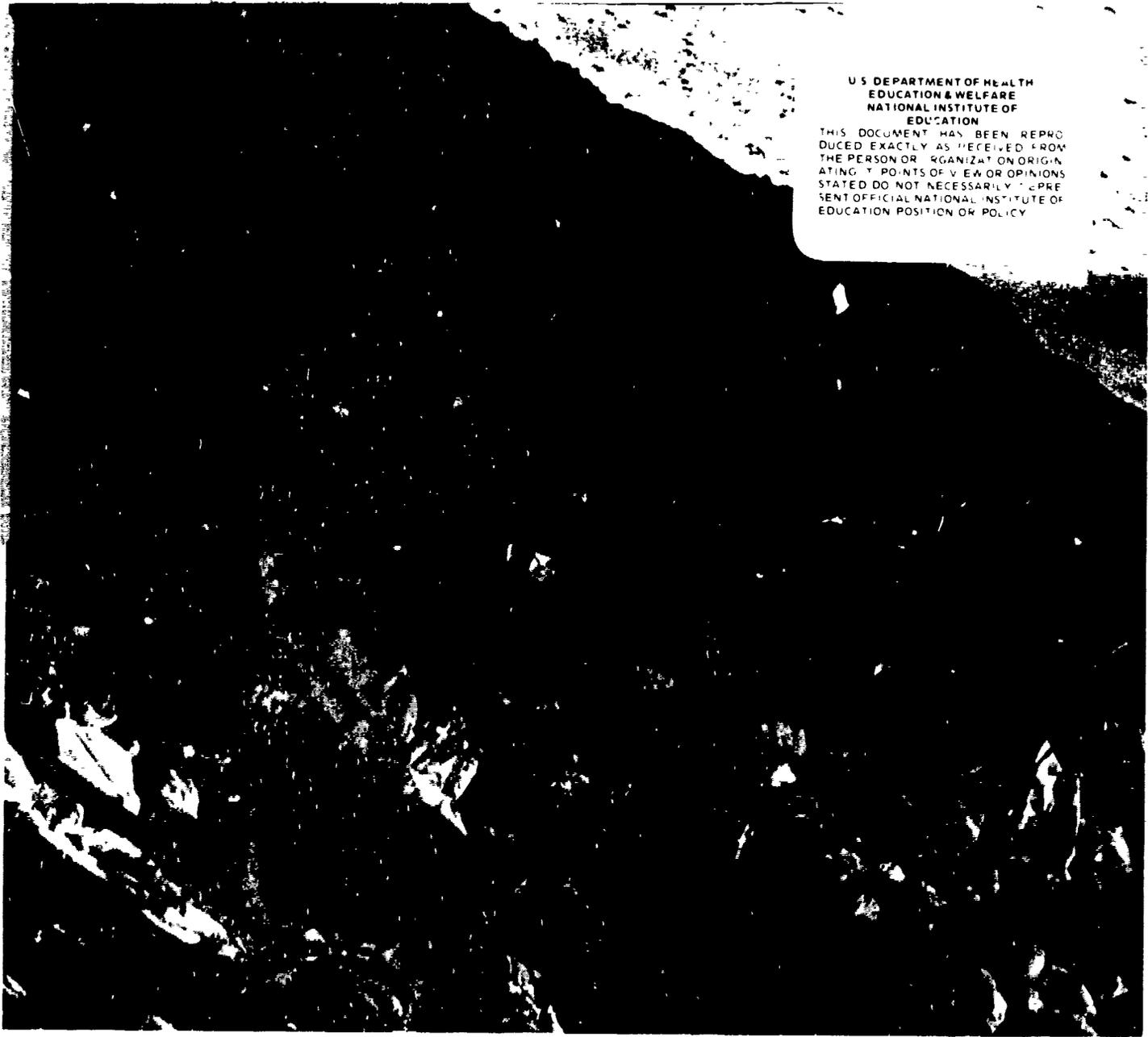
This book is the first in a series of four books emphasizing student-oriented problem solving related to environmental matters. It is divided into three activity levels: awareness, transitional, and operational. The activity sequence is designed to motivate students toward a concern for environmental quality, take action related to particular problems or concerns, and provide background for in-depth, on-going problem investigations. Process-skills dealt with at the awareness level include observation of solid waste sources and components, categorizing of solid-waste problems, qualitative comparisons, measuring the magnitude of the problem, inferring, and questioning. Each activity identifies the situation and notes open-ended questions, equipment needed, procedure, past studies, limitations, and a bibliography. Transitional activities focus on real problems of the community and involve students in predicting, data collection, data processing, data evaluation, and formulation of hypotheses. Economic, political, social, scientific, technological, and legal factors are considered. Activity format is the same. Operational activities extend those of the first two levels. Four approaches to problem solving are presented: simulation, contract projects, debating, and modeling situations. A bibliography and glossary are appended. Related documents are SE 016 525 and SE 016 614. (BL)

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A CURRICULUM ACTIVITIES GUIDE

To
SOLID WASTE
And
ENVIRONMENTAL STUDIES



Produced by

Project KARE BLUE BELL, PENNSYLVANIA Matthew M. Hickey Director

ED 080348

A Curriculum Activities Guide
to
SOLID WASTE
and
ENVIRONMENTAL STUDIES

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Draft

There were many people who contributed to the completion of this document. It is a sequel to A Curriculum Activities Guide to Water Pollution and Environmental Studies, Vols. I and II and as such, it leans heavily on the work of others who went through the ordeal of beginning something. Special thanks go to Donald L. Wright, Director of Project KARE, who encouraged the effort to formulate the Documentation Task Force (DTF) idea and to Alan C. Harman, Executive Director of Montgomery County Intermediate Unit #23, who facilitated the DTF effort in a myriad of ways from board approval to accounting procedures. The cooperation of the Intermediate Units of Bucks, Chester, Delaware, and Philadelphia Counties and the Roman Catholic Archdiocese of Philadelphia is likewise appreciated.

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This guide was organized and edited by the team of John Hershey,

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Draft

Alan D. Sexton, and Patricia Sparks. They compiled the contributions of conference participants and the DTF staff writers. The staff writers were: Peter Goldie, David Kriebel, Robert Lippincott, Jerry Ruddle, Ronald Spencer, Tim Tanaka, and Melissa Weiksnar.

The efforts of Bette Connelly, Sue Faulkner, Diana Geist, and Claire Pilzer made the writers' imperfections tolerable to the DTF.

Since the DTF began, there have been several personnel changes. Matthew M. Hickey has succeeded Donald L. Wright as Director of Project KARE. Alan D. Sexton has succeeded Mr. Hickey as the Assistant Director of Project KARE. John T. Hershey is no longer associated with Project KARE and is now the Manager of Environmental Programs for the University City Science Center, Philadelphia, Pa. Mr. Hickey and Mr. Sexton are currently administering the DTF.

This book is one of four which are being produced by the DTF. The other three deal with population, homemade water testing equipment, and in-depth studies.

**A CURRICULUM ACTIVITIES GUIDE
TO
SOLID WASTE
AND
ENVIRONMENTAL STUDIES**

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Environmental education is the study of all things that surround and affect man. Its focus is aimed at the development of an informed citizenry that will be capable of making decisions necessary to solve problems dealing with the quality of our environment. The curriculum of environmental education is contemporary and projective, that is, it deals with issues of the present and requires projects for the future.

The emphasis in this guidebook is on student-oriented problem-solving rather than problem-doing. Students who are involved in problem-solving are active learners. By being actively involved in the problem-solving process they will develop the capabilities of using resources to find information and to use this information in making decisions. As students become involved in the teaching-learning processes they begin to experience success which tends to encourage further learning and involvement.

Relevancy is seen as a major key to involvement. Learning is most meaningful when it is relevant to the students' needs, abilities, interests and personal as well as social purposes. In order for teachers to deal with transition from more traditional teaching approaches they must begin with the learner and not the subject matter. The teacher must relate to the student through rewarding classroom experiences that will meet the personal and social needs of the student.

The intent of this guidebook is initially to provide for student-oriented activities that will motivate students to more in-depth activities and finally to provide for independent problem studies. In moving from the more teacher-dominated to the more student-dominated classroom the learner must, in the words of Morris,

". . . be encouraged to identify with his subject matter, to identify with it emotionally so that he can announce a personal reaction to it. The teacher's function is to arouse the learner intellectually, spiritually and emotionally. Arousal in the learner will quicken his inner senses to perceive what his learning materials are saying to him; the affective center of 'sensation' will then be in a better condition to react to the materials themselves. For it is in the reaction, and not in the materials, that knowing and learning really takes place.

Therefore, in every subject matter a real effort must be made to involve the learner directly. He must get personally tangled up in the subject matter." (1)

In addition the students must be encouraged to generate ideas, make decisions, design and carry through a plan of action and to evaluate that action. The expected role of the teacher is that of a guide and participator rather than the ultimate authority.

The aims of the guidebook are to:

1. Aid teachers in dealing with problem-solving skills

(1) Morris, Van Cleve, Philosophy and the American School, Boston, Houghton Mifflin Co., 1961, p. 392.

2. Provide teachers with problem-focused environmental education activities that:
 - a. Are multi-disciplinary
 - b. Focus on contemporary issues
 - c. Utilize a wide range of resources
 - d. Utilize the community as a teaching resource
 - e. Help develop favorable attitudes toward man's role in the environment
 - f. Encourage student-student and student-teacher participation
3. Provide teachers with a listing of available resource material, a bibliography, a glossary and teaching hints
4. Encourage teachers to develop their own activities as a result of student reaction to these activities

The guidebook is divided into three activity levels: (1) awareness, (2) transitional, and (3) operational. The activities at the first level are designed to increase the students' awareness of environmental problems. The second level, transitional, provides activities which will allow students and teachers to take action related to particular problems or concerns. The third level provides the background for in-depth, on-going problem investigations.

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-x-

The initial concern at the first level is an assessment of the students' backgrounds regarding environmental issues. Factors that contribute to the students' awareness include: (a) the media, (b) parents, (c) youth organizations, (d) direct interaction with the environment, and (e) classroom instruction.

The teacher must utilize the students' backgrounds with respect to these factors through: (a) questioning, (b) discussing, (c) citing of examples, and (d) the observing of student behavior.

The awareness activities are designed to motivate students toward a concern for environmental quality. These activities have been developed with process-skills in mind. The skills that are dealt with at the awareness level include: (a) observing of solid waste components, (b) categorizing of solid-waste problems, (c) comparing, (d) measuring, (e) inferring, and (f) questioning.

The purpose of a process-oriented development is to set the basis for student-initiated activities. Students will be better able to deal with investigations of their own design if they have had previous experience with process-skills.

The transition activities place a strong emphasis on student involvement. Student response is encouraged. The students' need for success can be met through acceptance and positive reinforcement. An atmosphere of acceptance and rapport is needed for teacher-student participation to be effective.

Transitional activities deal with community concerns regarding the environment. The student is seen as a part of the school which in turn is part of the community. In dealing with the environmental problems of the community students are required to use the community as an educational resource. Many components of society are considered when dealing with environmental problems. These involve economic, political, social, scientific, technological and legal factors.

The focus of the transitional activities is on real problems of the community. By dealing with these problems the students are required to use the community. In so doing they greatly increase their awareness of community organization, the availability of materials and equipment, the level of community cooperation and their potential roles as community members. Because these activities are done within the context of the community, they are not contained as part of a single discipline nor do they remain contained within the four-walled classroom. In dealing with real problems as an educational approach a multi-disciplinary attack is essential.

The transitional activities provide openers for the third level, problem-solving. Students gain confidence by performing transitional activities and use these as a foundation from which they can design and develop their own problem investigations. Since the activities

are open-ended, all student contributions are considered. The expectations for each student vary according to the levels of interests and abilities.

The third level is essentially an outgrowth of the first two levels. The students function individually or in groups to investigate in-depth, specific environmental concerns. The students may design and initiate their own studies. They gain direct experience by carrying through investigations in which they are responsible for decision-making regarding data collection, data processing and data evaluation and utilization. The teacher's role is primarily that of a resource person or a guide to learning.

Once the students have completed their investigations they are required to examine their findings and to determine what potential impact these findings might have on community action. The student then interprets his results and determines how they can be utilized. In proposing or recommending action he must consider the action and the alternatives to this action as they relate to political, economic, legal, social, scientific and technical factors. The students realize through these investigations that they have a definite role as community members. They become aware of the complexity of both natural and man-made systems, and they realize that they have a responsibility that extends beyond their own interests and needs. Outgrowths of the investigations include a

greater concern for social responsibility, a consideration for environmental ethics and a greater awareness of potential career opportunities.

The development of the guidebook from an awareness level to an investigative level depends on the activity design.

Each activity follows a question-oriented format. Open-ended questioning will prevent a mechanistic step by step use of the activities. Questions, therefore, are an integral part of each activity. The questions are of five types: (a) those that lead to the activity, (b) those that initiate the activity, (c) those that continue the activity, (d) those that expand the activity, and (e) those that can be used to evaluate the activity. By encouraging student response in this manner the authority-figure role of the teacher is diminished and students gain confidence in their ability to make decisions and to initiate their own study program.

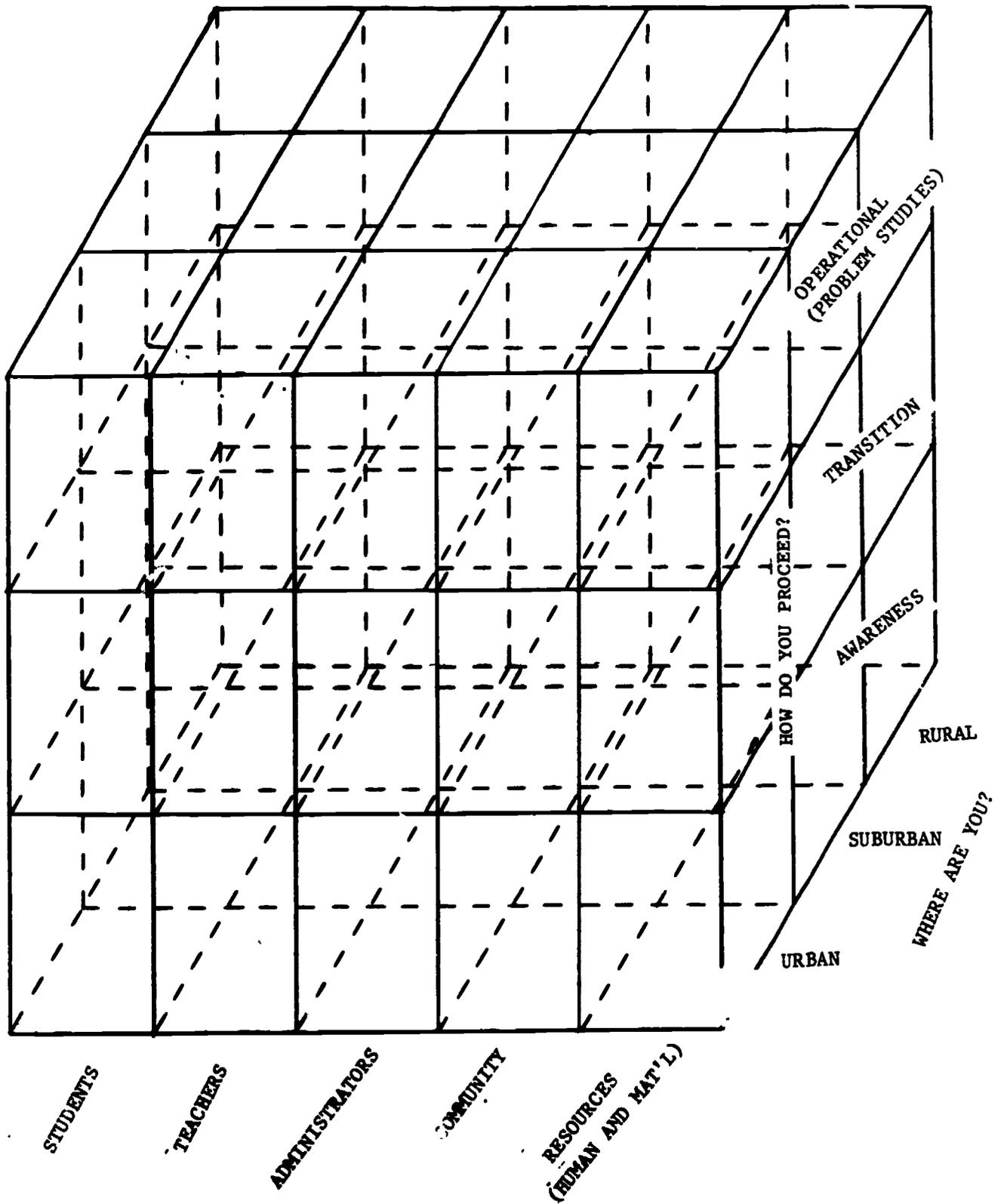
A sequential order, though implied, is not a necessary criterion of the guidebook. Teachers and students are encouraged to select those activities that best suit their purposes and needs. Scheduling should be flexible as time restrictions would interfere with the effectiveness of the activities. If a time restriction of several weeks or a term is to be used, then the activities should be

selected to fit a shorter period of time. Each activity provides questions for expanding the activity. These questions should be used as departure points for branching activities. From the few examples presented here teachers and students should be able to write their own activities and design their own study sequence.

The guidebook has been developed according to the model illustrated on the next page. The assumptions are that you are located in either a rural, suburban or urban setting and that certain variables are available to you. The concern of the guidebook is to help you move through each of these three levels.

Introduction

DRAFT



WITH WHOM AND WHAT ARE YOU WORKING?

CHAPTER 1

The following activities are concerned with environmental awareness. These activities deal with the awareness of the individual to the environmental solid-waste problems and his subsequent responsibility as a school and community member. Their aim is to motivate students towards a concern for environmental quality.

These activities have been developed with process-skills in mind. The skills that are dealt with at the awareness level include: (a) observation of solid waste sources and components, (b) categorizing of solid-waste problems, (c) qualitative comparisons, (d) measuring the magnitude of the problem, (e) inferring, and (f) questioning. The purpose of a process-oriented development is to set the basis for student-initiated activities. Students will be better able to deal with investigations of their own design if they have had previous experience with process-skills.

The initial concern of the activities in this chapter is an assessment of the students' backgrounds regarding environmental issues. Factors that contribute to the students' awareness include: (a) the media, (b) parents, (c) youth organizations, (d) direct interaction with the environment and (e) classroom instruction. The teacher must utilize the students' backgrounds with respect to these factors through: (a) questioning,

(b) discussing, (c) citing of examples, and (d) the observing of student behavior. The activity questions in this chapter deal with these factors.

The activities below are in no special order. They deal with three major questions. What is the problem? Why is there a problem and why should you care? Use the chart provided to select those activities that best suit your purposes and the interests of your students. The teacher may select one or two activities to begin the unit and then allow students' concerns and interests to dictate future choices.

ACTIVITY	GRADE LEVEL			TIME IN CLASS PERIODS	ORIENTATION	PROCESS SKILLS	PAGE NUMBERS
	PRIMARY K-2	3-6	SECONDARY 7-9 10+up				
A	x	x	x	1	Class	a,b,d,f	4
B		x	x	2	Individual/ Individual/ Community	All	9
C	x	x	x	*1	Individual/ Class	a,b,c,e	15
D		x	x	1	Class/ Community	b,c	20
E		x	x	2-4	Community	a,c,e,f	23
F	x	x	x	1-2	Individual/ Class	c,e,f	28
G	x	x	x	*1	Community	a,c,f	32
H		x	x	1	Individual/ Class	b,c,e,f	36
I		x	x	1-2	Individual/ Individual/ Community	a,b,c,e,f	43
J		x	x	1	Community	a,b,c	49
K		x	x	2	Community	b,e,f	53

Process skills:

- (a) observing
- (b) categorizing
- (c) qualitative comparisons
- (d) measuring
- (e) inferring
- (f) questioning
- * field

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A "Gee, Do We Throw Out All This?" -- Or An Introduction To Wastebaskets

I Introduction

The activity introduces the problem of solid waste. By examining the contents of a classroom wastebasket students at any grade level may become aware of the kinds and amounts of waste created in the classroom. During the course of the activity, which takes about one class period, students react by contributing many ideas for minimizing waste. No special equipment is required for this activity.

II Questions

1. To lead into the activity ask:
 - a. Why do we have wastebaskets?
 - b. What is waste?
2. To initiate the activity ask:
 - a. What kinds of waste are generated here? (procedure)
3. To continue the activity ask:
 - a. Can this be reported on a per capita basis?
 - b. What is the daily volume of such wastes?
4. To expand the activity ask:
 - a. What kinds of waste are generated by the rest of the school?
 - b. What's going to happen to the waste when we're finished with it?
 - c. If you were going to minimize trash in your school, what

factors would be considered?

5. To help the teacher evaluate the students' efforts ask:
 - a. What were their reactions to the activity?
 - b. Did each contribute a fair amount to the investigation process?
 - c. Did they raise meaningful questions?
 - d. Did they find the activity motivating or a waste of time? Did it make any type of impact on the individual students.

III Equipment

1. Full wastebaskets
2. Scales
3. Materials for recording data

IV Procedure

1. This involves dumping the contents of a wastebasket where the students can observe the wastes. Note: if the school has a dumpster for collecting trash, samples can be collected from there.
2. Depending on the age of the group, observations should be recorded.

V Past Studies

This activity has served as a good introductory investigation, because the whole class gets involved. John Hershey has used this activity with second graders, who were amazed at seeing

the variety of wastes present. "Gee - do we throw out all this?" was a typical reaction; but perhaps more importantly they wondered how these materials might have been put to better use.

These students noticed that milk cartons comprised a large percentage of the volume. They filled a grocery bag with empty cartons, then proceeded to crush other cartons to see how many more could fill another grocery bag.

VI Limitations

A student may possess a negative attitude about going through trash - possibly accompanied by an attitude of uncooperation. Let the custodian know that you're doing this project - he or she may have some pertinent information.

If the school operates an incinerator, the activity can be modified to include this situation.

Looking through dumpsters may have some prohibitive implications - check this with a proper authority.

VII Bibliography

Citizen Handbook on Recycling (A How to-do-it Guide for Individuals and Groups), Tuberculosis, Health, Respiratory Disease and Clean Air Organization, Unpublished, 1970-71. Excellent guidelines for recycling projects and several past community experiences. Also presents a list of "Hints on Sound Ecologi-

cal Living" and an invaluable appendix on Recycling Agencies in the Philadelphia-Camden and surrounding areas.

Cheney, Richard L., Glass Containers and the Environment, Glass Container Manufacturers Inst. Inc. Short booklet containing GCMCI director's speech that includes 5 recommendations to achieve long range solution to the solid waste problem. Also included is a list of industrial organizations engaged in research to develop solid waste management systems.

Give Glass a Second Chance (Conducting a Community Glass-Recycling Project), Amherst Jay-Cees, Amherst, New York, Unpublished, 1972. A complete and detailed outline of a very successful, short-term glass recycling project in Amherst, New York. It spells out the program from conception to post clean-up with all incurred costs and equipment. Also included are a question and answer conclusion section and photographs of the project.

Litter Facts, Public Affairs Dept., Glass Container Manufacturers Institute. Litter Facts is a short, well written pamphlet on solid waste disposal in general. The factual information is well presented and worthwhile tips are provided for those interested in starting recycling efforts.

Paper Stock Institute of America (A Vital Industry Serving the Nation's Economy and Environment), Paper Stock Institute, New York. A small booklet explaining the Paper Stock Inst. and a paper recycling process.

A Pledge and a Promise, Anheuser Busch, Inc., St. Louis, Missouri, 1970. Defines solid waste, describes the problem, discusses the complexity and some possibilities for alleviating the problem. An excellent introductory pamphlet for students grade 6 and up.

Recycling and The Can in the Seventies, The Can People, 1971.

A short question and answer booklet concerning can recycling. Compares benefits of recycling steel and aluminum. Discusses litter, packaging, returnable cans and pros and cons of recycling.

Solid Waste Management and Litter Control, Glass Container Manufacturers Inst., Inc., 1971. A short booklet outlining governmental, industrial and public roles in glass solid waste programs deemed necessary by the GCMI, Inc.

B You, Your Family and Solid Waste

I Introduction

In this activity students consider the magnitude of the solid waste problem. Students examine their own waste disposal patterns and that of their families. In so doing they learn how much solid waste they discard over a period of time and the nature of that waste. The activity is designed for students from grade four through college and may require one or several days to complete depending on how long data collection continues.

II Questions

1. To lead to the activity ask:
 - a. Do you have any idea how much solid waste is discarded in your house each day?
 - b. What is meant by discarded?
 - c. How many ways are there of discarding wastes?
2. To initiate the activity ask:
 - a. How much trash and garbage (solid waste) do you personally discard each day?
 - b. To what extent are you required to separate your garbage?
3. To continue the activity ask:
 - a. What is the most common form of solid waste in your household?
 - b. Does solid waste vary from household to household?

4. To expand the activity ask:
 - a. Where and how do people acquire their habits regarding solid waste disposal attitudes?
 - b. What happens to solid waste when it leaves your home?
 - c. Where does it all go?
 - d. What does the term final disposal mean?
 - e. What are some other sources of solid waste?
 - f. From the information collected in this activity do you think you could make a solid waste key? Try it.
5. To evaluate the activity ask:
 - a. Was the collected information realistic?
 - b. Did the students use their information to generate further research?

III Equipment

1. Bathroom scale
2. Data collection sheet
3. Pen or pencil

IV Procedure

1. Over the period of one or several days, weigh all the trash and garbage discarded in your household. (You may weigh the waste directly by placing it on the scale, or by weighing yourself and the wastes together, then deducing your weight.)
2. Divide the weight of the waste by the number of persons in your household, then by the number of days on which data

collection occurred.

3. Look at your results. Compare them with the rest of the class. Determine the average amount of solid waste discarded per person per day.
4. Using the figures from your class and the approximate national population of 200,000,000 people, determine how much personal solid waste is discarded per day, per week and per year for the entire country.

V Past Studies

An activity similar to the above was conducted in a graduate course at Temple University under the direction of Dr. Albert Schatz. The purpose was to make the students more aware of the solid waste problem and their contribution to the problem. The activity generated much discussion and led to a concern for additional wastes from industrial, commercial and natural sources.

VI Limitations

1. Younger students may need some help in weighing the discarded trash.
2. Students will need to make their parents aware of their activity so they can be cooperative.

VII Bibliography

Citizen Handbook on Recycling (A How to-do-it Guide for Individuals and Groups), Tuberculosis, Health, Respiratory Disease and Clean Air Organization, Unpublished, 1970-71. Excellent guide-

lines for recycling projects and several past community experiences. Also presents a list of "Hints on Sound Ecological Living" and an invaluable appendix on recycling agencies in the Philadelphia-Camden and surrounding areas.

Glass Containers and the Environment, Cheney, Richard L., Glass Container Manufacturers Inst., Inc. Short booklet containing GCMC director's speech that includes 5 recommendations to achieve long range solutions to the solid waste problem. Also included is a list of industrial organizations engaged in research to develop solid waste management systems.

Cleaning Our Environment: The Chemical Basis for Action (A Report by the Subcommittee on Environmental Improvement, Committee on Chemistry and Public Affairs), American Chemical Society, Washington, D. C., 1969. Deals with 4 major concerns: air, water, solid wastes and pesticides. For each there is an introduction to the problem, background information, a discussion of the chemical factors, control factors, the environmental effects and recommendations for change. The book is technical and best suited to the needs of secondary or college students.

Give Glass a Second Chance (Conducting a Community Glass-Recycling Project), Amherst Jay-Cees, Amherst, New York, Unpublished, 1972. A complete and detailed outline of a very successful, short-term glass recycling project in Amherst, New York.

It spells out the program from conception to post clean-up with all incurred costs and equipment. Also included are a question and answer section and photographs of the project.

No Deposit, No Return (Man and His Environment: A View to Survival), Huey D. Johnson, Editor, Addison-Wesley Publishing Co., Reading, Mass. An anthology of papers presented at 13th National Conference of the U. S. National Commission for UNESCO. Provides excellent background to the problems societies face because of environmental exploitation. An excellent reader for students at the secondary or college level.

Paper Stock Institute of America (A Vital Industry Serving the Nations's Economy and Environment), Paper Stock Institute, New York, New York. A small booklet explaining the Paper Stock Institute and a paper recycling process.

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Solid Waste Management and Litter Control, Glass Container

Manufacturers Inst., Inc., 1971. A short booklet outlining governmental, industrial and public roles in glass solid waste programs deemed necessary by the GCMI, Inc.

C Litterbug Survey

I Introduction

Fines exist for litterbugs almost everywhere in the United States. Strangely, though, there are many places you can find where there is much litter in evidence. In this activity, we'll make a survey to find out just how much litter exists along the streets of the community. Classes may go as groups or teams to carry out this exercise during the school day. If time is not available, they may do this activity going to and coming from school. The activity is an awareness activity for almost any grade level. The activity may be carried out in the field in less than an hour.

II Questions

1. To lead the activity, ask questions like:
 - a. How much is a litterbug fined in your community?
 - b. Do you know of anyone who has ever been fined this amount or any similar fine? What does this mean to you?
 - c. Which street around your school has the least litter?
2. Initiate the activity by asking:
 - a. How can we find out which street has the least litter?
 - b. What kind of litter are we most likely to find?
3. Continue the activity after the street collections with discussion questions like:
 - a. Which street had the most (total)? The most of each kind?

- b. Can you see why each street has litter and of what sort?
(Take into account the traffic volume in terms of cars and pedestrians and other possible specific sources of litter, e.g., if you were standing in front of a hamburger stand, what kind of litter would you expect to be most common?)
4. Evaluation of students' performances should take into account factors like:
 - a. Was student resourcefulness evident in supplying answers to the why's about quantities of litter?
 - b. Did the students attempt to secure a comparable sample along the streets, collecting from a standard area?
5. To expand the activity initiate discussion with questions like:
 - a. What can you do to prevent litter? Would adding your own barrels, signs and assistance to the police force in enforcement of the litter laws have any positive effects?
 - b. What do you need to change? about people? about local laws? about packaging laws?

III Equipment

1. Paper trash bags for each member of the class.
2. Classroom blackboard for display of totals.
3. Bathroom scale or other available scale.
4. Local map of community's streets.

5. A pair of gloves for each glass collector.

IV. Procedure

1. Divide the students into 4-man litter collecting teams.
Have each member collect one type of trash: paper, bottles and glass, cans, all other debris.
2. Send each team out with bags to collect the trash they see and can retrieve from a block (or other predetermined street area if blocks are not regular or streets are not in blocks).
3. After 20-30 minutes have everyone return. Make sure the trash is separated into 4 piles for each team (paper, bottles and glass, cans, all other debris).
4. Have each team compare its 4 piles with the others, first by sight, then by weight (weigh a student, then student plus trash, then subtract student's weight from weight of both).
Have the students make their own bar graphs.
5. Make a display of the results.

V Past Studies

A Project KARE Local Action Program, Allegheny West, at Rhodes Middle School, in the Spring of 1972, had kids collect trash from playgrounds and streets. The kids were very surprised by the volume of trash they found and this led to class discussion.

VI Limitations

This activity has very few limitations in that the equipment is

universal and trash is plentiful. The activity not only forces the students to look closely at the streets they see often, but also gives them the satisfaction of cleaning them up. There are, however, a few possible drawbacks:

1. An analogous portion of each street should be examined in order to get a true value of litter volume.
2. Broken glass, common street litter, can be dangerous. It's a good idea to supply gloves for the glass collector of each team.
3. Supervision is a variable.
4. Plan ahead for disposal of collected materials.

VII Bibliography

The Litter Facts Book, Glass Container Manufacturers Institute, New York. This booklet is a good vehicle for all grades to explain the litter problem. The comic book format is an interest holder and the figures offered increase the children's fund of knowledge and experience in the area of litter disposal in America.

No Time to Waste, Continental Can Company, New York, 1971. This is an excellent tool for elementary classes. The reading level is very basic and the comic book format is a great interest holder.

Schools and The Environment, Ames, Edward A., Ford Foundation Office of Report, New York, 1969. A short treatise on

Chapter 1 Solid Waste Awareness

Draft

Education and its role in promoting environmental awareness.

Listed are a few innovative schools and some Ford Foundation grants received in Environmental Education.

D Musical Mess

I Introduction

This activity is designed to allow the student to become aware of the amount and diversity of litter on the highways and streets, and to turn this awareness into a musical experience. This activity can be used for any age student. The time required depends on the number of students.

II Questions

1. To lead to the activity:
 - a. What is litter?
 - b. What different kinds of litter are found in the streets and roads?
2. To initiate the activity ask:
 - a. Does litter make sounds? What kinds of sounds?
 - b. How many different sounds can be produced with one piece of litter?
 - c. Are the sounds contrasting or do they blend?
3. To continue the activity ask:
 - a. How can these sounds be organized into a musical composition?
4. To expand the activity ask:
 - a. How could this activity be used to communicate the problem of litterbugs littering?
5. To evaluate the activity ask:
 - a. Did the composition have a beginning and an end?

- b. Did the composition hold together?
- c. What element (or elements) held it together?
- d. Was any particular form identifiable?
- e. Was dynamics employed?
- f. How was variety achieved?
- g. Did the composition use only percussion instruments?

III Equipment

1. Tape recorder
2. Litter
3. Students

IV Procedure

1. Have students obtain objects of litter that will make a sound or sounds that can be repeated audibly; encourage some variation. This can be done individually or as a class, depending on drive and independence of the students.
2. After they have decided upon their particular sounds and produced them for the entire class with a focus on listening, divide the class into groups of about 5 or 6 students. Each group may choose a conductor.
3. Give each group about 10-15 minutes to organize a "musical" composition.
4. Tape all the compositions as they are performed for the class.
5. Replay the tape and use the evaluation questions as a guide.

Chapter 1 Solid Waste Awareness

Draft

Note: For best quality recording use 7-3/4, highest recording speed, to pick up the widest range of frequency.

V Past Studies

1. 7th grade inner-city girls used this activity. The outstanding characteristic of most of the compositions was the evident rhythmic patterns.
2. A sing-out group on the way home from a performance stopped to pick up litter and began producing sounds and organizing their productions.

VI Limitations

Space is needed to allow the students to compose without distracting other groups.

VII Bibliography

Litter Facts, Public Affairs Dept., Glass Container Manufacturers

Inst., New York, New York. Litter Facts is a short well written pamphlet on solid waste disposal in general. The factual information is well presented and worthwhile tips are provided for those interested in starting recycling efforts.

Manhattanville Music Curriculum Program Synthesis, Ron Thomas,
Director.

Related Listening: Varese, Elgar, Poeme Electronique Col. ML5478,

MS6146, Cage, John. Construction in Metal K08P-1498.

E Unscenic Site Census or Litterbug Bugging

I Introduction

The focus of this awareness activity is on litter, its diversity and its density in various areas of the community. In surveying the amount and density of wastes students become more sensitive to litter problems. The activity appeals to students of all ages. It takes one or more class periods to complete and requires no special equipment.

II Questions

1. To lead into the activity ask:
 - a. Have you ever littered?
 - b. What made you litter?
 - c. Where did you litter?
 - d. When did you litter?
 - e. What was the item you littered?
 - f. How much did you litter?
 - g. Why is there littering?
 - h. Is it a problem?
 - i. What types of anti-litter incentives are there?
2. To initiate the activity ask:
 - a. What is the litter situation like in this community?
 - b. Where are there occasions to litter?
 - c. What part of the community is hardest hit by the litterbugs?
 - d. How can we determine this?

- e. Is there a relationship between litter location and type?
3. To continue the activity ask:
 - a. What type of debris did you find?
 - b. What is the weight of each type?
 - c. What is the comparative volume?
 - d. Can this be expressed graphically?
 4. To expand the activity ask:
 - a. Who is responsible for suggesting remedies for problem spots?
 - b. Are there any laws regarding littering?
 - c. Are they enforced?
 - d. Is the community willing to install more litter baskets?
 - e. Does litter vary from season to season? In weight? Volume? Type?
 5. To evaluate the activity ask:
 - a. Did the students attempt to draw meaningful conclusions from data?
 - b. Did they express a desire to take constructive action other than picking it up?
 - c. Did they make use of the allotted time efficiently?
 - d. Did they talk to any litterbugs and delve deeper into the reasons?
 - e. Did they relate stores, churches, schools, etc. to litter

concentrations?

III Equipment

1. Paper trash bags (paper, not plastic-please!)
2. Field data recording equipment, (e.g. clipboard with graph paper to identify site of litter, camera).
3. Group data recording materials (charts, blackboard, etc.)
4. Scales

IV Procedure

1. Divide the students into groups and dispatch them to (preferable) predetermined sites in the school community. To conduct the study by streets is probably easiest.
2. As trash is picked up and bagged, the location of items should be recorded. (Be as specific only as is reasonable.)
3. Upon returning to the classroom, the students should separate the litter into categories.
4. Results should be graphically represented.

V Past Studies

In Eggertsville, New York, the delicatessen located across the street from, and patronized by, the students of St. Benedict Elementary School was known by its storefront carpet of candy wrappers. The town clerk was relectant to install a litter basket-- after 2 years, the litter problem is only somewhat eased, because the can is always full!

VI Limitations

REV:A:1

- 25 -

1. Sometimes litter is dangerous to handle, either because it is unsanitary or can inflict wounds.
2. The term, litter, may need to be limited before going into the field.
3. Remind students of private property and trespassing.
4. Litter may not be recognized as a problem to get excited about, depending on the location of the school.

VII Bibliography

The Litter Facts Book, Glass Container Manufacturers Inst., New York, New York. This booklet is a good vehicle for all grades to explain the litter problem. The comic book format is an interest holder and the figures offered increase the children's fund of knowledge and experience in the area of litter disposal in America.

Policies For Solid Waste Management, Ad Hoc Committee on Solid Waste Management, National Academy of Engineering, National Academy of Sciences, U. S. Department of Health, Education and Welfare, 1970. An excellent report on solid waste, problems, and policy changes required to attack it. A comprehensive set of recommendations and plans of action are supplemented by a selected bibliography.

A System Study of Solid Waste Management in the Fresno Area;
Final Report on a Solid Waste Management Demonstration,

Aerojet-General Corporation, Public Health Service Pub. No. 1959, 1969. This study attempted to determine an optimum solution and to develop technology for handling the local waste problems.

Solid Waste Management: The Federal Role, Vaughn, Richard D.

U. S. Department of Health, Education and Welfare, Bureau of Solid Waste Management, 1970. A small booklet introducing the solid waste problem. It discusses collection and transport, recycling and reuse, processing and disposal, training, technical assistance, and planning.

F Reactions to Solid Waste Problems

I Introduction

This activity is a study of human reaction to the problem of solid waste. Its grade level application is unlimited, because it serves as an awareness activity, but can also be used by more advanced students as a lead-in to studies in behavior and psychology. By observing the behavior of others, the students will gain insight into how this problem relates to large-scale environmental efforts.

II Questions

1. To lead to the activity ask:
 - a. What status must an issue have for someone to consider it a problem?
 - b. How are people made aware of problems?
 - c. Why do we make them aware of problems?
2. To initiate the activity ask:
 - a. Is solid waste disposal seen as a problem by the people in the school?
 - b. If not, can they be made to recognize it as a problem?
 - c. How might someone in the school react to trash in the corridor or on the school grounds?
3. To continue the activity ask:
 - a. Does the kind make a difference?
 - b. Does location make a difference?

- c. If the person is alone or in a group, are there differences?
 - d. Does time of day make a difference?
 - e. Does location of litter receptacles make a difference?
4. To expand the activity ask:
- a. Do you think your family would react to the solid waste problems the same way you did? Explain.
 - b. Now that you are aware of solid waste as a problem, what action would you take to remedy the situation?
5. To evaluate the activity ask:
- a. How carefully did they set up the experiment?
 - b. Were they able to logically interpret their data?
 - c. Were they able to suggest any remedial action for the problem?
 - d. How scrupulous were they about clean-up?

III Equipment

1. Trash
2. Data recording material - e.g. cameras, blackboard

IV Procedure

1. Strategically position trash and observers.
2. Record the reactions.

Note 1 - This activity may take place around a school sports event at which concessions are sold.

Note 2 - The teacher may want to try this activity on the class first without their knowledge - say having several pieces of paper on the floor and having hidden the wastebasket.

V Past Studies

At Stewart Jr. High School in Norristown, Pennsylvania, a group of Deanna Rosenbaum's elementary school students overturned a wastebasket in front of the principal's office. The students watched the reactions of those who passed it. Sometimes, someone would pick up and deposit the trash in the adjacent wastebasket. When they left, it was overturned again for the next party.

VI Limitations

1. Consult proper authorities before throwing trash in front of their doorways, moving property, etc.
2. Depending on scheduling, the conducting of observations during the class period may be difficult.
3. If you are not allowed to conduct the investigation with real trash, perhaps posters or exhibits made with trash could be used instead.

VII Bibliography

Litter Facts, Public Affairs Dept., Glass Container Manufacturers Inst., New York, New York. Litter Facts is a short well written pamphlet on solid waste disposal in general. The factual information is well presented, and worthwhile tips are provided for those interested in starting recycling efforts.

Policies For Solid Waste Management, Ad Hoc Committee on Solid Waste Management, National Academy of Engineering, National Academy of Sciences, U. S. Department of Health, Education and Welfare, 1970. An excellent report on solid waste problems and policy changes required to attack it. A comprehensive set of recommendations and plans of action are supplemented by a selected bibliography.

A Systems Study of Solid Waste Management in the Fresno Area; Final Report on a Solid Waste Management Demonstration, Aerojet-General Corporation, Public Health Service Pub. No. 1959, 1969. This study attempted to determine an optimum solution and develop technology to handle the local solid waste problems.

Solid Waste Management: The Federal Role, Vaughn, Richard D. U. S. Department of Health, Education and Welfare, Bureau of Solid Waste Management, 1970. A small booklet introducing the solid waste problem. It discusses collection and transport, recycling and reuse, processing and disposal, training, technical assistance, and planning.

G Where is the Waste Walk?

I Introduction

This activity involves a tour of the community. Students are given a question guide to help them identify the types and sources of solid waste pollution in their community. The activity is suitable for all who can read the question guide. It requires no special equipment and takes a one day field trip to complete.

II Questions

1. To lead to the activity ask:
 - a. How would you characterize your community?
 - b. Is your community polluted in any way?
2. To initiate the activity ask:
 - a. What are the probable sources of solid waste pollution in your community?
 - b. Where are you most likely to find evidence of solid waste pollution?
3. To continue the activity ask:
 - a. In what ways did you see solid waste management in effect?
 - b. What violations of solid waste management did you notice?
4. To expand the activity ask:
 - a. How could you as an individual improve the problem of solid waste management?
 - b. What actions could we as a class take to improve the solid waste management in the community?

5. To evaluate the activity ask:
 - a. How did the students react to being out of the classroom?
 - b. To what extent were the students observant of their surroundings?

III Equipment

1. Questionnaire
2. Pencil or pen
3. Binoculars (optional)

IV Procedure

1. The students are to work in groups. They are to use the following questionnaire as a guide.
2. The students should be encouraged to add information to the questionnaire even if no questions relate directly to that information.
3. Questionnaire:
 - a. As you leave the school look about you. What is the first evidence of solid waste you see?
 - b. Are there any trash receptacles along the sidewalk?
 - c. Pick a leaf off a tree. Rub it with a piece of white paper. Did any dirt rub off? If yes, where does this dirt come from?
 - d. Sniff the air as you walk along. Is it clean and fresh? List all the odors you smell.

- 1.
- 2.
- 3.
- 4.
- 5.

What causes odors? Where do they originate?

- e. List all the different places where you find litter.
 - 1.
 - 2.
 - 3.
 - 4.
 - 5.
- f. Do you see any "do not litter" signs?
- g. Do you see any "no dumping" signs? Has someone been dumping here? If yes, what?
- h. How is solid waste stored by the various establishments you pass?
- i. How many trash receptacles are filled to overflowing?
- j. Do you see any trash compactors?
- k. How does the community dispose of its solid waste, waste water, and industrial waste?
- l. Do you see any black smoke? If yes, where is it coming from? How is this a form of solid waste?
- m. Do you see any evidence of abandoned cars or appliances? If present, are these hazards and/or pollutants?
- n. Walk along the waterways. Do you see any pipes emptying into the water? If yes, can you tell where they come from? Is anything flowing out of them? What does it look like?

V Past Studies

A group of junior high school students at the Bristol Jr.-Sr. High School in Bristol, Pennsylvania, used a questionnaire similar to the one above in making a survey of their community's pollution problems. They are to use this information in establishing in-depth studies of specific pollution problems in their community.

VI Limitations

1. The major limitation is the questionnaire. Teachers should modify the questionnaire to suit their needs.
2. A route needs to be planned with periodic rest spots so that groups that get separated can get together again.

VII Bibliography

Environmental Education Objectives and Field Activities, Major, James M. and Cissell, Charles A., Paducah Public School, Environmental Education Staff, 10th and Clark Streets, Paducah, Ky. 42001, 1971. A collection of interdisciplinary activities. Primarily oriented to outdoor education. Offers many helpful hints.

H Ecologically Yours?

I Introduction

This activity is a survey of habits of students and their families, using a series of 30 "ecological habits". The students will initially check those which they or their families have acquired. They will then try to convert them to as many as possible of those recognized as desirable. Most students who can read will be able to participate in the activity.

II Questions

1. To lead into the activity ask:
 - a. Does your family contribute to the solid waste problem?
 - b. Are some families worse than others?
 - c. Why are there differences?
 - d. What is meant by the term, "ecological habits" or "ecological living"?
2. To initiate the activity ask:
 - a. What habits do you or you family have (from the list)?
 - b. How long have you had them?
 - c. Can you change a habits?
 - d. What will make you change or acquire habits?
3. To continue the activity ask:
 - a. "What used to be called stingy is now referred to as ecological.: Agree or disagree? Explain.
 - b. Whose standards were you using?

- c. "Says who" are they "ecological"?
 - d. "Some people spend more time separating garbage, other waste, and more gas transporting stuff to recycling centers than its worth." Evaluate.
 - e. Could you convert your family at all?
4. To evaluate the students' efforts ask:
- a. How did the students react to the activity (resentment, enthusiasm, frustration?)
 - b. Did they act according to belief or forced criteria?
 - c. Did they expand the concepts involved in the activity to real solid waste problems?

III Equipment

None foreseen as being needed.

IV Procedure

1. Students should regard the following list of habits, and evaluate them -- as being ecologically valid and whether or not they are employed in their households.

Avoid buying aerosol cans. They are dangerous and disposal presents problems. Sixteen percent of the cost of a product in an aerosol can goes for the container.

Buy bulk, dry, dog chow. Fortify the chow with unsaturated oils, bouillon, vegetables, cottage cheese, or leftovers.

If you must buy canned goods, buy all-aluminum cans and save them to be reused. They can be identified by the lack of side and bottom seams.

Aluminum foil should be used, reused, reused again, and then recycled.

Put your pop-top inside the can as soon as you have pulled the tab.

Buy only returnable bottles. Return them.

Reuse jars for other purposes, e.g., storing nuts and bolts, leftovers, canning and freezing fruits and vegetables.

Do not accept plastic bags at the grocery store or dry cleaners.

Obtain as few plastic bags as possible; wash, dry and reuse them several times.

Use a durable metal tape dispenser rather than disposable plastic ones.

Ball-point and felt-tip pens are wasteful. Fountain pens last much longer and can be economically refilled.

Collect styrofoam egg and meat containers. Return them to the dairy or meat market responsible.

Specifically ask for fresh meat wrapped in paper rather than in plastic.

Do not purchase frozen foods packaged in plastic cooking pouches.

Refuse bags at a store and tell them why.

Take your own shopping bags with you.

Use a lunch box instead of a paper bag.

Save and bundle your newspapers.

Share magazines. Set up a system whereby each neighbor buys one magazine subscription and then circulates the magazines among the group.

Write on both sides of the page.

Use foldable stationery that makes into its own envelope.

Use the backs of used sheets of paper for notepads.

Use cloth napkins, towels and sponges.

Reuse the wax paper liners of cereal boxes as wrapping materials for foods.

Avoid disposable diapers and diaper liners.

Return used coat hangers to your dry cleaners for reuse.

Don't throw away leftovers. They make terrific casseroles and lunches, or can even be added to pet foods.

Don't throw away items you can no longer use. Give them directly to people who can use them, or donate them to groups or organizations that will see that they reach potential users.

Bring your own drinking glass or coffee mug to occasions where disposables will be used.

Use cloth handkerchiefs instead of paper ones.

Do not buy individually wrapped slices of cheese.

Use paper clips instead of staples.

Note - These "habits" have been adapted from those appearing in the Everyman's Guide to Ecological Living, (see bibliography).

2. They will decide to which habits they will try to convert their families. A time limit may be set.

V Past Studies

Seventh graders at Germantown Academy queried their parents and checked their households for poor practices. They were amazed at how interested their parents were in all the facets of environmental concerns. Each student elected to try to carry out a summer project on his property.

VI Limitations

A discussion in a stimulating atmosphere will foster the flow of the activity, as students will daily have experiences with habit-forming attempts to relate.

VII Bibliography

Cailliet, Greg, et. al., The Everyman's Guide to Ecological

Living, MacMillan, New York, New York, 1971. Probably one of the best references on individual and limited group environmental action activities stressing the acquisition of "ecological habits". It contains supplementary facts. Selling for \$.95, it is highly recommended. It should present no problem for the average reader, as it is not technical in presentation.

Howard, Jane, The Diary of a Polluter, Time, Inc., New York, New York, published in Life Magazine, April 23, 1971, p. 71-72.

A day in the life of an American Girl shows our dependence on al¹ that is not good for Mother Earth. It is the type of article by which students will see the finger pointed at them as contributors to the problems. Especially good is the emphasis on solid waste.

Swatek, Paul, The User s Guide to the Protection of the Environment (The Indispensable Guide to Making Every Purchase Count), Ballantine Books, New York, New York, 1970. Gives a factual interpretation of the implications of our food, shelter, clothing and lifestyle in general. It emphasizes ecologically

vs. non-ecologically sound purchases and suggests action on the part of the individual. Students in grade seven and up can handle the straight forwardness of the book.

Trash is Taking Over, Environmental Science Center, Golden Valley, Minnesota, 1970. The booklet explores, through the medium of the story, the concern for solid waste litter, and provides the method to show the extent and source of the problem. The booklet provides a method for discovering the kinds of solid wastes in a community and what can be done about them. The booklet is good to read to early elementary classes and may be used and read by upper elementary students themselves.

Meadows, Donella and Meadows, Dennie L. and Randers, Jorgen and Behrens, William W. III, The Limits to Growth (A report for the Club of Rome's Project on the Predicament of Mankind), Universe Books, New York, New York, 1972. "In the summer of 1970, an international team of researchers at M.I.T. began a study of the implications of continued worldwide growth. They examined the five basic factors that determine and, in their interactions, ultimately limit growth on this planet—population increase, agricultural production, nonrenewable resource depletion, industrial output, and pollution generation. The M.I.T. team fed data on these five factors into a global computer model and then tested the behavior of the model under

several sets of assumptions to determine alternative patterns for mankind's future. The Limits to Growth is a non-technical report of their findings." Numerous graphic projections appear. High school students may have moderate difficulty understanding many parts without explanation, but it really points out the fate of uncontrolled growth and wastefulness.

I Scrap Crafts

I Introduction

This activity gives students a chance to express their personal attitudes toward pollution through creative art forms. Students will be asked to examine the contents of a trash "container" (roadside, dumpster, etc.) and to create art objects with the discarded materials. Students will become more aware of the waste problem, and through their art, communicate an awareness to others. This early transitional activity can be used with any age group. It can be conducted in as little as one class period, but student interest often extends the activity several days.

II Questions

1. To lead to the activity ask:
 - a. How can we communicate our concern about the solid waste problem to others?
 - b. Is there any way of communicating our concern without generating more waste?
 - c. Could art be used as a means of communicating concern?
2. To initiate the activity ask:
 - a. What types of art forms might be effective?
 - b. Where can we go to gather materials?
3. To continue the activity ask:
 - a. What can we do with our creations?

- b. Should they be displayed? Where?
- c. Who should see them?
- d. What do you want to see happen when people see the work?
- 4. To expand the activity ask:
 - a. How could we assess the effectiveness of our art forms as a means of communication?
 - b. How might the impact of the art forms be increased?
- 5. To evaluate the students' efforts ask:
 - a. What was the reaction of the students to the activity?
 - b. Did they involve themselves with planning and executing the project?
 - c. Did they incorporate concerns from previous activities into this one?
 - d. Did they express concern for additional wastefulness if the activity yielded any?
 - e. Were they concerned about what happened once the art work was finished?
 - f. Did any of the art works exhibit aesthetic and/or creative qualities?

III Equipment

- 1. Refuse
- 2. Construction materials, possibly including:
 - a. scissors
 - b. adhesive tapes or liquids

- c. paper clips or staples
- d. marking implements (pen and ink, paint and brushes, crayon, etc.)
- e. string

Note: Encourage the students to create as little additional waste as possible by using just what trash they have. Discourage magic markers where crayons can be used, staples where paper clips can be used, etc.

IV. Procedure

1. Begin by taking your class to the scene of actual "pollution" - a nearby body of water, junkyard, roadside, etc.
2. Have them observe the trash and react to it and then start collecting it. Some of it may be used in the actual making of the projects.
3. Plan the projects and collect any additional materials individuals may need.
4. Create.
5. Get reactions to the work - especially aesthetic appraisals.

V Past Studies

People are usually startled when made to see and to think about the use of something they considered useless or finished.

1. A judged environmental art contest held Earth Day 1970 included not only posters and collages, but also an assortment of oddities ranging from mobiles to a piece of artwork made

using an old toilet. Awards consisted of humorous yet "ecologically sound" type gifts, e.g., waste paper baskets (?) and fly swatters (instead of DDT).

2. A team in Tilton, New Hampshire, decided that the items of metal trash were heavy enough to require welding. Some of the collection they had to work with resembled parts of animals and plants. Pieces were spread out on the floor and arranged and rearranged by trial and error. They adopted the theme that pollution is killing our natural flora and fauna, and possibly in the future man might only be able to enjoy synthetic plants and animals made from these pollutants. They produced a heron-type bird, a cattail, a turtle, and a skull and cross bones. Three years later, this bird is still rusting and remains a beautiful piece of art.
3. At a KARE Local Action Program, the School Environmental Contamination Study, at the Hartcarft School in the spring of 1972, the first grade constructed a display board of all trash collected in the classroom. This was a whole class activity which successfully involved young children utilizing an action-oriented, interdisciplinary, binary learning approach

VI Limitations.

1. Enthusiasm. Be enthusiastic and interested in this project and your students will be too.
2. Make sure the necessary precautions are taken when working

with so-called unsanitary trash, and also broken items with sharp edges.

3. Transporting refuse may be a problem - heavy duty paper bags or garbage cans might be helpful.
4. No special clothing is necessary, but make sure the students know and are ready to handle trash extensively.
5. If time or accessability is a limiting factor, students can be asked to bring in solid waste for the project from individual scavanging.

VII Bibliography

A Curriculum Activities Guide to Water Pollution and Environmental Studies, Institute for Environmental Education, Cleveland, Ohio, Second Edition, May, 1971.

Fun with Pure-Pak Plasticartons, Ex-Cell-O Corporation, Detroit, Michigan, 1969. Creative art objects made with plastic cartons. Complete with diagrams, material and directions. Ideal for all ages.

Ickis, Marquerite, Handicrafts and Hobbies for Pleasure and Profit, Careystone Press, New York, New York, 1948. An interesting idea book of crafts and art projects written for the amateur and the professional, utilizing many different materials.

Mattil, E. J., Meaning in Crafts, Prentice Hall, Inc. Englewood Cliffs, New Jersey, 1965. An excellent collection of day-

to-day craft ideas for elementary level art handicraft activities. The materials and end products are multiple and diverse.

Paper, People and Pollution, Scott Paper Company, Philadelphia, Pa., Volume I, pgs. 4-93 -- 4-96. This booklet is available by writing to SCOTT, Scott Paper Company. Scott Plaza, Philadelphia, Pa. 19113.

J Web of Waste

I Introduction

In this activity students will use the information gathered on a tour of the community to make a map of waste sources and routes. In so doing, they will develop a picture of solid waste complexity. They will determine how the system of disposal is inter-connected. The activity provides an excellent introduction to an industrial analysis. Students of all age levels can participate in the activity. No special equipment is needed. The activity takes from three to five class periods to complete.

II Questions

1. To lead into the activity ask:
 - a. Do you live in a clean, moderately clean, or dirty community?
 - b. What industry is present in your community?
2. To initiate the activity ask:
 - a. What type of community do you live in?
 - b. What kind of work does your father do?
 - c. Does your father work in the community?
 - d. Can you describe the physical environment where you live?
3. To continue the activity ask:
 - a. How is solidwaste disposal related to the quality of life?
 - b. What questions does your map answer?
 - c. What questions are left unanswered?

4. To expand the activity ask:
 - a. How could the efficiency of solid waste disposal be increased from an economic standpoint and from a community standpoint?
 - b. What proportion of the solid waste problem is industrial, commercial, and/or residential?
5. To evaluate the students' participation in the activity ask:
 - a. Did the students show indications of relating their lives to that of their community?
 - b. Did the activity open discussion toward community action?
 - c. Were suggestions given to further the activity?

III Equipment

1. Map of the community
2. Results of community tour
3. Translucent paper
4. Masking tape
5. Stars or symbol stickers in assorted colors
6. Colored pencils or pens
7. Map of sewage piping system in the community

IV Procedure

1. Place a map of your community on the wall or blackboard.
2. On that map, locate all the industries, municipal buildings, hospitals and commercial establishments. Mark the location of

each in some manner.

3. Place a translucent piece of paper over the map. Transfer the location of all buildings noted above. Include all waterways also.
4. Transcribe the details of the sewage pipe lines onto your map. Distinguish between storm sewers and sanitary sewers.
5. Examine the map. Where is the sewage treatment plant located? Can you determine if all the industries use the system. Note any obvious inadequacies. What added information do you need to fully examine solid waste disposal in your community?

V Past Studies

A 1972 Local Action Program, Planned Development or Urban Sprawl (PDUS) at Central Bucks West High School, Doylestown, Pa., used mapping as the basis of a transportation study. The map, measuring 12' x 24', was a 3-D relief map of the Central Bucks area. The map is to serve as a focal point for showing the effects of development in the area.

VI Limitations

1. If no map is available, students can make their own by locating the major roads and buildings from there.
2. If you are located in a large urban area you may prefer to examine only a sector of the city.

VII Bibliography

Storin, Diane, Investigating Air, Land and Water Pollution, Pawnee

Chapter 1 Solid Waste Awareness

Draft

Publishing Company, Inc., Bronxville, New York, 1971. A collection of activities for students in grades 7-12.

Provides background information, materials needed, questions and procedures.

K Wrapping Rapping

I Introduction

This activity is suitable for students who already have some awareness of the solid waste problem. It is an early transition activity, and it is one in which the families of the students play an important role. Due to the impracticalities of shopping with an entire class, students will be asked to shop with their families for a week, paying careful attention to the wastefulness involved with food merchandising. Students then evaluate the types and volumes of solid wastes their families acquire through grocery shopping. No special equipment is needed in the classroom. The activity is suitable for grades four through ten. Data sharing will take one to three class periods.

II Questions

1. To lead into the activity ask:
 - a. Have you been grocery shopping lately?
 - b. How does your family get groceries?
 - c. What do you consider when you buy food?
 - d. What are your priorities from these considerations -- nutritional value, price, convenience, presentation?
 - e. Does packaging influence your buying patterns?
2. To initiate the activity ask:
 - a. How much packaging do you buy in a week?
 - b. How much of a product which you buy is intended to be thrown away?

- c. Can we compare packaging-consumption differences among families?
 - d. Is there wastefulness in a supermarket?
3. To continue the activity ask:
- a. What are the relative percentages of the packaging materials (glass, paper, plastic, metal, etc.) which you have purchased?
 - b. Can these be categorized in terms of needed and excess packaging?
 - c. How does this fit in with the concept of wastefulness?
 - d. How much do you know about the packaging of materials - either by previous knowledge or by what appears on each packaging?
 - e. What is the environmental impact of each type of packaging?
 - f. Could any of the packaging have harmful side effects?
4. To expand the activity ask:
- a. Do you have any remedial suggestions for any problems which you have seen?
 - b. Who controls the packaging used - who determines the standard packaging of ice cream cones?
 - c. Is there a relationship between the packaging and popularity or sanitary and cost reasons?
 - d. How willing are companies to release information about packaging?

5. To evaluate the activity ask:
 - a. How cooperative were the students?
 - b. What was the quality of the data they collected?
 - c. Have they begun to show a favorable attitudinal change?
 - d. To what degree did students involve their families?
 - e. Did the students contact anyone who is responsible for determining the kind of packaging used?

III Equipment

1. The students will need:
 - a. kitchen, bathroom, baby and/or postage scales, if available.
 - b. notebook and pencil
2. In the classroom, data sharing will require:
 - a. blackboard and chalk
 - b. a calculator (extraneous, but nice to have for the mathematical operations which will result)

IV Procedure

1. In the grocery store:
 - a. Students should record each item purchased - a sample data sheet follows:
Date _____
Time _____
Type of Store _____

Packaging

Item	Weight of product
Glass jar	
Metal lid	
Plastic lid	
Plastic container	
Heavy-duty paper	
Wax paper	
Foil paper	
Styrofoam	
Saran	
Pulp tray	
Plastic bag	
Tin can	
Aluminum can	
Aerosol can	
Plasti-pak carton	

b. Other examples of what students consider to be wastefulness in the stores should be recorded.

2. At home

- a. Each bag of groceries should be weighed.
- b. As each item is unpacked, the weight should be recorded if it appears on the product. Otherwise, the product should be removed from its packaging and then weighed.
- c. The total weight of the bagged groceries should be compared to the total weight of packaging, i.e.:

Bag weight: _____

Product weight: _____

Packaging weight: _____

- d. They may take a typical bag of groceries and remove all the packaging from the products. This is then cleaned (where necessary) and put back into the bag to get an idea of packaging volumes.
3. At school:
 - a. When the data come in, much can be done with them, e.g. average amount per family, differences in per person weights in families, etc.
 - b. Students may wish to discuss the differences of the weights.

V Past Studies

1. Students from one school removed all the packaging from the groceries at the check-out counter of a supermarket. The volume of packaging vs. the volume of groceries was compared by placing each in a bag.
2. The author of this activity upon trying it was taken by surprise to notice that 64.5 pounds of groceries was actually 12.5 pounds of packaging. When items such as tin foil and wax paper are purchased, these are considered to be packaging. She had not realized that nearly every item purchased included plastic of some kind as part of its packaging.
3. One enterprising student wrote a letter to a produce company to express concern over the fact that they were wrapping bananas in plastic. The reply follows:

"Dear Miss Weiksner:

I have at hand your recent letter expressing concern over the packaging of _____ bananas in plastic bags and relating this practice to environmental pollution.

It is true that plastics are part of the solid waste disposal problem. It is also true that plastics are increasingly replacing glass, metal, kraft paper and cardboard as a packaging material in many areas because they offer distinct advantages over the other materials, i.e., its light weight, which reduces both the expense and burden of transportation; resistance to mold, rust and bacterial growth, thus enhancing its value for health and sanitation purposes; and its impermeability which affords the high cleanliness factor so important in foods and drugs.

For fresh produce, and very specifically bananas, pre-packaging in the field, or harvest time wrapping, produces a significant decrease in bruising, scarring and all kinds of external damage. Prepackaging minimizes human handling with the obvious benefit of greater sanitation and it affords more rapid movement of product at the store level. All these factors bring improvements both in the quality of the end product and in the efficient presentation of the product to the ultimate consumer and user.

Now to our product in particular. _____ bananas have registered significant decreases in bruising and scarring since the introduction of the cluster bag. Naturally, this, in turn, delivers you a better-than-ever-before product. We would like to point out that until recently polyethylene slip sheets have been utilized to cushion bananas within a fiber board carton during shipping. As of the past month, these slip sheets have been replaced by the individual polyethylene bags with each cluster of fruit separately enclosed. Contrary to many impressions, polyethylene film presents no insurmountable problems as a pollutant. It is extremely susceptible to degradation by sunlight and to a lesser extent by soil - you may have noticed that polyethylene film, when exposed to sunlight, will, in a matter of relatively a few weeks, start to yellow, crack and break up into smaller and smaller segments. It is also readily combustible, burns with a smokeless flame and produces no toxic vapors provided sufficient oxygen is supplied. The increased protection afforded by these bags has resulted in markedly higher quality fruit with a decided reduction in scarring and/or bruising of peel and pulp - a definite added consumer benefit.

Pollution of our environment is a recognized and acknowledged problem. Packaging materials of all kinds contribute to the problem, particularly when it is further compounded by careless litter, inefficient collection and even more inefficient incineration or improper methods of landfill dumping.

Society has never backtracked or foresworn progressive new methods which afford convenience, luxury, quality or efficiency. It is against human nature. When methods have been found that have a derogatory feature, science and man's ingenuity have gone forward to eliminate the defective elements while maintaining the advantageous ones. Thus, science and industry are spending vast sums to develop bio-gradable films, to perfect incineration methods of existing non bio-degradable solids and to generally improve the whole pollution problem.

We at _____ bananas share your concern with the need to attack the total environmental pollution problem. In the meantime, during this period of research, the desire to deliver better quality produce and economic realism cannot be completely ignored by our company or the produce industry.

Thank you for expressing your feelings to us."

VI Limitations

1. Some families shop during the school day, and may be unwilling to change this pattern.
2. Students may be unwilling to be very precise in data collection. Emphasis should be placed on the necessity of accuracy for meaningful results.
3. Although not a limitation to conducting the activity, the families of the whole class may shop exclusively at supermarkets. Interesting comparisons might be made between supermarket, food co-op, market and specialty shop purchasing, if possible.

VII Bibliography

Cailliet, Greg, et. al., The Everyman's Guide to Ecological

Living, MacMillan, New York, 1971. Probably one of the best references on individual and limited groups environmental action activities stressing the acquisition of "ecological habits". It contains supplementary facts. Selling for \$.95, it is highly recommended. It should present no problem for the average reader, as it is not technical in presentation.

Plastics in Solid Waste, Sub-Council Report, 1971-March, National

Industrial Pollution Control Council, Superintendent of Documents, U. S. Government Printing Office, Washington, D.C., March, 1971. Comprehensible booklet, grades 5 and up, dealing with the plastic industry summary, the volume of plastics in solid waste, the industry's current activities, the immediate problem, reclamation of plastics, the industry's response to immediate problems, and research and development in the longer term. Packaging is considered. This is a non-technical report.

Swatek, Paul, The User's Guide to the Protection of the Environment (The Indispensable Guide to Making Every Purchase Count),

Ballantine Books, New York, 1970. Gives a factual interpretation of the implications of our food, shelter, clothing and lifestyle in general. It emphasizes ecologically vs. non-ecologically sound purchases and suggests action on the part of the individual. Students from grade seven upward could handle the straight forwardness of the book.

CHAPTER 2

The following transition activities place a strong emphasis on student involvement. Student response is widely encouraged. The students' need for success can be met through acceptance and positive reinforcement. An atmosphere of acceptance and rapport is needed for teacher-student participation to be effective.

The focus of the transitional activities is one real problem of the community. By dealing with these problems the students are required to use the community as a resource. Transitional activities allow the students to extend themselves by using equipment, references, audio-visual aids, human resources and other components of the community at large. In so doing, students greatly increase their awareness of community organizations, the availability of materials and equipment, the level of community cooperation, and their potential roles as community members. Because these activities are done within the context of the community, they are not contained as part of a single discipline nor do they remain contained within the four-walled classroom. In dealing with real problems as an educational approach a multidisciplinary attack is essential. Many components of society are considered when dealing with environmental problems. These involve economic, political, social and legal factors.

Like the awareness activities, transitional activities are process-oriented. The processes involved, however, are of a higher order and include: (a) predicting, (b) data collection, (c) data processing, (d) data evaluation, and (e) the formulation of hypotheses. The transitional activities provide the basis for the third level, problem studies. Students gain confidence by performing the transitional activities and use these as a foundation from which they can design and develop their own problem investigations. Successes in the transition activities allow students to handle problems of a larger and larger scope. Since the activities are open-ended, all student contributions are considered. The expectations for each student vary according to the level of the students' interests and abilities.

Use the chart given below to select those activities that best suit your needs and the interests of your students. The intent of the chart is to provide a quick assessment of the activities according to grade level, time required, process skills considered and specified equipment or resources needed.

ACTIVITIES & PAGE NUMBERS	GRADE LEVEL				10-tup	MINIMUM TIME IN CLASS PERIODS	PROCESS SKILLS	SPECIAL EQUIPMENT AND RESOURCES
	K-2	3-6	7-9	10-12				
A - 64	x				x	1	a,b,d	Old Appliances
B - 68		x	x		x	2	a,b,c,d	None
C - 73			x		x	3	a,b,c,d	None
D - 77	x		x		x	1	b,c,d	None
E - 81			x		x	2	a,b,c,d	None
F - 85			x		x	2	a,b,c,d	None
G - 90	x		x		x	4	a,b,c,d,e	Oven and Sludge
H - 94			x		x	2	a,b,c,d,e	Collection Devices
I - 100			x		x	2-4	a,b,c,d,e	Field Trip, Water Eq
J - 105			x		x	1-4	a,b,c,d,e	Microscopes
K - 109	x		x		x	2-3	a,b,c,d,e	None
L - 113		x	x		x	1-4	a,b,c,d,e	Water Proof Boxes
M - 117			x		x	2-4	a,b,c,d,e	None
N - 121			x		x	1 (week wait)	a,b,c,d,e	Aquariums
O - 124		x	x		x	2	a,b,c,d,e	Foods, Millipore
P - 128					x	2 (week apart)	a,b,c	Fats
Q - 133		x			x	2	a,b,c,d	Outside Area
R - 140		x	x		x	2	a,b,c,d	None
S - 145		x	x		x	1-3	a,b,c,d	Microscopes
T - 150			x		x	1	a,b,c,d,c	Fume Hood, Goggles
U - 156		x	x		x	2	a,b,c,d,e	None
V - 161			x		x	2	a,b,c,d,e	None
W - 166	x		x		x	2 (long obs.)	a,b,c,d,e	None
X - 170			x		x	1	a,b,c,d,e	None

Process Skills:

- a. predicting
- b. data collection
- c. data processing
- d. data evaluation
- e. formulation of hypotheses

A Devastation Delight (or Learning by Undoing)

I Introduction

In this activity students consider the concept of waste by discovering how much material is or is not wasted by disassembling discarded merchandise - e.g., small appliances. A transition activity, it is adaptable for any grade level, can probably be conducted in one class period.

II Questions

1. To lead into the activity ask:
 - a. Can solid wastes be classified as either simple or compound?
 - b. Where does "junk" fit into the hierarchy of refuse?
 - c. What types of compound wastes are generated?
 - d. Are these a more serious problem than more simple forms of refuse?
2. To initiate the activity ask:
 - a. Can you "simplify" these wastes?
 - b. What parts are wastes?
 - c. How many different materials went into the product?
 - d. Why was the product discarded?
 - e. What is "planned obsolescence"?
 - f. Was the original product necessary?
3. To continue the activity ask:
 - a. What is a resource?

- b. What is a natural resource?
 - c. What are renewable resources?
 - d. What are non-renewable resources?
 - e. What substitutes are there for these materials?
4. To expand the activity ask:
 - a. How long was the product made to last? The parts?
 - b. Do any organizations make use of discarded appliances?
 - c. What wastes does this product contribute?
 - d. Are all the wastes visible?
 5. To evaluate the students' efforts ask:
 - a. How thorough was the disassembly?
 - b. How far beyond the confines of a classroom did the students pursue the activity?
 - c. What was done with the information learned?
 - d. What was done with the disassembled product?

III Equipment

1. Discarded appliance of some sort - e.g., electric can opener, toaster, dishwasher.
2. Disassembly tools - e.g., screwdrivers, pliers, scissors, flashlight.

IV Procedure

1. Have students obtain discarded appliances.
2. Disassemble the item as thoroughly as possible.
3. Report the findings. Note the students' reactions.

V Past Studies

Studies like this have often shown that a fancy or "high quality" exterior is often filled with shoddy and poorly planned inner workings. Two of the most commonly observed faults: poor design, i.e., wasted space, inefficient layout, and sacrifice of safety and durability for price. Planned obsolescence is common in household appliances. One student was told by a repair man that a fan motor needed lubrication, but since it had a sealed case, the whole motor would have to be replaced. This student then took the motor, opened it up, lubricated it and resealed it.

VI Limitations

1. it's a good idea to avoid obtaining the appliances from dumps because of potential health hazards.
2. Limit the size or complexity of the product to be disassembled if time will be a limiting factor.
3. Have someone who "knows what he's doing" with each group that is disassembling.
4. Do not allow television sets to be disassembled, even by someone who "knows what he's doing".

VII Bibliography

1970 National E.Q. Index, National Wildlife Magazine, Washington, D.C. A monthly magazine which situates the degree of environmental degradation. It has an easy to read style, with many

colorful pictures and diagrams. Multiple copy purchasing entitles one to discounts, and a filmstrip and teacher's kit are also available.

Young, James F., Materials and Processes, General Electric Company, 1945. In textbook form, a one volume study of materials and manufacturing processes used by design engineers. Although of average difficulty for the high school student, it considers many facets of appliances which may be used in the activity, Devastation Delight.

The Way Things Work (An illustrated Encyclopedia of Technology), Simon & Schuster, Rockefeller Center, 630 Fifth Avenue, New York, New York, 1967. "From the ball point to the computer, from the Polaroid camera to the atomic clock with 1071 two-color drawings and diagrams." Very technical but good. I hear there is a Volume II but haven't seen it. One problem is a lot of common items aren't included while very complicated things are. Missing are flashlights, doorknobs, and chainsaws.

B Recycled Paper in Schools

I Introduction

This transitional activity begins by introducing students to the volume of paper used by their school. Students consider possible constructive action by studying the feasibility of recycled paper in the school. The activity requires one to two days for preliminary investigations, and perhaps up to a week for remedial action to take place. Grades five and up would be most capable of conducting this study.

II Questions

1. To lead to the activity ask:
 - a. What paper products are found in this classroom?
 - b. What do we use paper for?
 - c. Is much of it wasted?
 - d. How much paper do you use in a day?
 - e. Can you trace the path of a piece of paper, starting from you, all the way back where it came from and then to where it ends up?
2. To initiate the activity ask:
 - a. Where does the paper come from?
 - b. Who buys it?
 - c. Who in the school is responsible for buying paper?
 - d. How much paper does the school use in one day?
 - e. What does recycled paper mean?

- f. Are there uses for recycled paper in the school?
 - g. Can you represent a tree by a certain quantity of newspaper?
3. To continue the activity ask:
- a. Should we encourage the use of recycled paper?
 - b. Can we take action on this problem?
 - c. What do we have to know to take action on the problem?
 - d. How do people react to "recycled paper"?
4. To expand the activity ask:
- a. Who should know about the use of recycled paper in the school?
 - b. Is the manufacturing of recycled paper polluting more than that of virgin fibers?
 - c. How much waste paper is recyclable?
 - d. What is a two-wastebasket system?
 - e. What outlets are there for used paper? Does demand fluctuate?
5. To evaluate the students' efforts ask:
- a. What type of action was taken?
 - b. How was their enthusiasm level?
 - c. How adequate was their research?
 - d. How hypocritical were they - e.g., did any favorable attitudinal changes take place?
 - e. What did they learn, in terms of both process and content?

III Equipment

No unusual equipment is required; paper and pencils are needed for notes.

IV Procedure

The students will investigate the issue of recycled paper and will determine whether or not they can promote its use in the school community.

V Past Studies

Students of the Nichols School in Buffalo have impressed many people by representing trees with bundles of newspapers, determined by the fact that it takes seventeen trees to produce one ton of newsprint.

Two juniors at Nottingham Academy in Buffalo traced the source of the school's ditto and mimeo paper to the Diocesan Purchasing Division, which also buys for all parochial schools in the Buffalo Metropolitan Area. The man in charge of paper buying was appreciative of information concerning recycled paper and bid for some to be tried in the 1972-73 school year.

VI Limitations

Before the students attempt to convert those responsible for purchases, they should be well informed on the issues. Teachers can help by asking the students questions to which the students will get the answers before a premature meeting.

VII Bibliography

Cailliet, Greg, et. al., The Everyman's Guide to Ecological

Living, MacMillan, New York, New York, 1971. Probably one of the best references on individual and limited group environmental action activities stressing the acquisition of "ecological habits". It contains supplementary facts. Selling for \$.95, it is highly recommended. It should present no problem for the average reader, as it is not technical in presentation.

Industrial and Specialty Papers, Robert H. Mosher, Editor,

Chemical, New York, New York, 1968. A three volume "encyclopedia" of paper types and manufacturing processes. Very technical for classroom use, although an excellent reference. Especially helpful are the sections of the professional terminology.

Paper From Paper Not From Trees, Marcal Paper Mills, Inc., East

Patterson, New Jersey. This booklet is best used from grade 5 upward. Its colorful format will help to hold children's attention as they get into some very basic facts on paper recycling. The booklet will trace the paper as refuse resource all the way through until it becomes new paper again.

Paper Made From Paper Made From Paper, Housewives to End Pollution,

Compilers, Erie and Niagara Counties Regional Planning Board, Grand Island, New York, May, 1971. This is a compilation of

the varieties of recycled writing and book papers and printing bostols. Information is printed on each sample concerning sizes, colors, textures, etc. which are available. It does not advocate specific brands; nor does it give prices; rather it can be given to printers, purchasing agents, etc. who usually are impressed by the types available.

C Product Packaging Design

I Introduction

In this activity, junior and senior high school students examine packaging as a solid waste problem. The purpose of packaging from consumer and producer/advertiser viewpoints is considered also. Students will design and make packages for products in order to consider the utility and advertising value of a specific design. Several class periods are needed to complete the study, however, no special equipment is needed.

II Questions

1. To lead into the activity ask:
 - a. What is meant by packaging?
 - b. What is meant by overpackaging?
 - c. How many types of packaging can you list?
 - d. Can these be divided into necessary and unnecessary?
2. To initiate the activity ask:
 - a. What comes first - the product or the packaging?
 - b. How dependent is a product on its packaging?
3. To continue the activity ask:
 - a. What was the reason for designing such a package?
 - b. What was the most difficult part of the design?
 - c. How often did the problem of solid waste enter your mind at the various stages of development?
 - d. How important are the concepts of reuse? recycling?

disposability?

4. To expand the activity ask:
 - a. Could you design a T.V. commercial to advertise your product?
 - b. In what other ways could you present your product for advertising?
 - c. Is advertising a product necessary?
5. To evaluate the activity ask:
 - a. How efficiently did the students work?
 - b. How realistic were the students' designs?
 - c. How well did the students make use of the available resource materials?

III Equipment

The students will need materials for product design and advertising campaigns. This probably includes standard "art" supplies - paper, scissors, marking pens, etc.

IV Procedure

This can be handled in one of two ways.

1. A group of students (no more than 6 or 8) is responsible for four jobs: (a) designing a product, (b) naming it, (c) packaging it and (d) promoting it.
2. Each of the four jobs is handled by a different group, so that the total responsibility for one product was not controlled by one group. (If there are not four groups, lumping of jobs

is permissible.

V Past Studies

This activity was conducted with a 10th grade communications class at Nottingham Academy in Buffalo. Although it was used in the unit on advertising, less emphasis on the advertising campaign can make it an effective activity from the packaging standpoint.

VI Limitations

The teacher has a very limited role in this activity. The activity will probably take up to a week to complete - a deadline is recommended. Frustration levels can run very high in this activity; so the teacher should review the progress of the design with individuals frequently.

VII Bibliography

David, Alec, Packaging and Print (The Development of Container and Label), C. N. Potter, New York, 1968. An excellent reference; predominantly illustrations. The text is very readable - grades seven and up should have no difficulty, and the information given is very helpful. Much emphasis is on packaging in the first half of this century.

Generating New Product Ideas, The Conference Board, Inc., New York. This is a professional guide to "creativity", suitable for grades seven and up.

McHarg, , Design with Nature, Doubleday, Garden City, New

York. This book combines a wealth of technical information about land use planning and ecological planning with a good discussion of the philosophy of the kind of thinking that must accompany ecological planning. It places equal emphasis on the practical and theoretical aspects of ecological thinking.

Packaging's Role in Physical Distribution, American Management Association, New York, 1966. A booklet containing information about packaging considerations; readable by most high school students.

Sperling, Jo Ann, The Emergence of the Packaging Executive, American Management Association, New York, 1970. With an emphasis on careers, the booklet points out the responsibilities and pressures of the packaging executive. Because of its slant toward careers, it would be most useful for high school students.

D Cafeteria Crisis

I Introduction

In this activity students learn about their school cafeteria as it relates to the issue of solid waste. It is a late awareness activity which has many opportunities for expansion into the area of action. The basic activity, a tour of the cafeteria, talking with the personnel, working in it, or any combination of these, can be conducted in a class period. No equipment is needed, and grades two through twelve can be included.

II Questions

1. To lead into the activity ask:
 - a. Do people in industrial roles think differently about wastes than we do?
 - b. How is the school cafeteria an industrial operation?
 - c. Is solid waste a problem?
2. To initiate the activity ask:
 - a. What types of input are there into the kitchen daily?
 - b. How are these packaged differently from those we purchase for individual use?
 - c. How do the products change as they go through the cafeteria?
 - d. What kinds of waste are produced by the cafeteria?
 - e. What kinds of waste are produced by those who use the cafeteria?

- f. Are all the wastes produced visible?
3. To continue the activity ask:
 - a. How are these wastes categorized?
 - b. What happens to each category?
 - c. What is the status of composting?
 - d. Are your ideas about wastefulness the same as those of the people in the kitchen?
 - e. Are waste and convenience synonymous?
4. To expand the activity ask:
 - a. What types of sanitary laws govern the operations of a commercial kitchen?
 - b. Do these conflict with "wastefulness"?
 - c. Can you suggest any remedial action to any undesirable situations?
 - d. How would these suggestions be received?
 - e. Do people see the cafeteria as a solid waste disposal problem?
 - f. Could we let people know what happens behind the scenes?
 - g. What other establishments in the community might have similar problems?
5. To evaluate the students' efforts ask:
 - a. What information did they learn?
 - b. How well did they perform their investigations?

III Equipment

Preliminary investigations will require no special equipment.

IV Procedure

The students will conduct a study of the school cafeteria and its role in solid waste problems. The construction of a flow chart may be encouraged.

V Past Studies

Among actions taken in various school cafeterias are:

1. Signs encouraging ecological habits - lunchboxes instead of bags, using bread bags instead of new sandwich bags, discouraging food wasting, etc. (Amherst Senior High School, Amherst, New York)
2. Kitchen managers can sometimes be persuaded to switch from disposable plastic to paper cups if they will not use non-disposable glasses.

VI Limitations

This activity is a fantastic learning experience. However, that does not imply that results will necessarily occur. Students must be led to understand legal and public health aspects of cafeterias, before they become discouraged over an inability to take constructive action.

VII Bibliography

Cailliet, Greg, et. al., The Everyman's Guide to Ecological

Living, MacMillan, New York, New York, 1971. Probably one of the best references on individual and limited group environmental action activities, stressing the acquisition of "ecological"

habits. It contains supplementary facts. Selling for \$.95, it is highly recommended. It should present no problem for the average reader, as it is not technical in presentation.

Joslyn, M. A., Food Processing Operations: Their Management, Machines, Materials, and Methods, Avi Publishing Company, Westport, Conn., 1963-65. A rather technical, two volume set, packaging is considered in the second volume.

Longree, Karla, Quantity Food Sanitation, Interscience, New York, 1967. A moderately technical, usable in high schools, text considering food sanitation, but not emphasizing waste and packaging.

West, Bessie Brooks, Food Service in Institutions, Wiley, New York, 1966. A very comprehensive, though somewhat technical guide. The guide considers little about packaging, but much about the health aspect, thus, students can draw corollaries.

E The Magnitude of Solid Waste Problems - As Seen by the Community

I Introduction

Dealing with solid waste in our disposal oriented society is a controversial issue, one of the reasons being that the magnitude of the problem is evaluated differently by most leaders in a community. This investigation is a survey by mail which attempts to determine how various people in the community view solid waste problems. The students will be split into teams, conduct the investigation, and evaluate the responses. This can not only alert students (grades six through twelve) to the particulars of the problem and potential solutions, but also could arouse the potential school and community interest that would exert important public pressure. This activity provides a direct lead into work with recycling and solution seeking.

II Questions

1. To lead to the activity ask:
 - a. What solid wastes are generated in the community?
 - b. How are these disposed of?
 - c. Are there any solid waste problems in your community?
2. To initiate the activity ask:
 - a. Says who? (that an issue is or is not a problem)
 - b. What is a problem?
 - c. Who is connected with the problem?
 - d. Would they have any facts or opinions which might be

helpful to us?

3. To continue the activity ask:
 - a. What niches do the following occupy in the problem:
 - (1) industry
 - (2) the community at large
 - (3) garbage disposals
 - (4) sanitation men
 - (5) junk and scrap dealers
 - (6) local, state, and federal government?
 - b. How responsibly are these roles enacted?
4. To expand the activity ask:
 - a. How is the problem viewed differently by those involved?
 - b. This activity might well expand into an environmental simulation, if a particular problem is isolated.
5. To evaluate the activity ask:
 - a. How extensive was the investigation?
 - b. How effective were the letter constructions?
 - c. How was the evaluation of data relayed?
 - d. What activities did the students end up pursuing?

III Equipment

1. Paper and envelopes - school letterheads or recycled paper products.
2. Appropriate writing implements.
3. Postage.

4. Data repository.

IV Procedure

1. Have the students select a specific issue, if a "hot" one is available.
2. Draft appropriate letters to appropriate people connected with the problem, to obtain their evaluation of the problem.
3. Have the whole class or school sign the letters, if appropriate.
4. Evaluate all materials received.

V Past Studies

Students of the John F. Kennedy Preparatory School in St. Nazianz, Wisconsin, under the auspices of Father Melvin Tracy, conducted a survey by mail of the solid waste situation, specifically disposal sites, in Manitowac County. A 100-page report of the survey has been compiled. Copies or information can be obtained through the Institute For Environmental Education, 8911 Euclid Avenue, Cleveland, Ohio 44106.

VI Limitations

1. Letters should be screened to assure that they reflect the constructive interests of the class as a whole.

VII Bibliography

Marx, Wesley, Man and His Environment: Waste, Harper and Row, New York, 1971. Deals with the causes, problems and treatments of solid waste.

Chapter 2 Transitional Solid Waste Activities

Draft

Small, William E., Third Pollution: The National Problem of Solid Waste Disposal, Praeger, New York, 1971. A general reference for most students grade 5 and up.

F Recycling: Investigating By Mail

I Introduction

Recycling is an ecologically sound method of dealing with solid waste in our disposal oriented society. This investigation is a survey by mail of the many factors involved in the problem of recycling. The students will be split into teams and conduct the investigation, compiling a scrapbook of answers from many different organizations. This will not only alert students, grades '6-12, to the particulars of the problem and potential solutions, but could arouse the potential school and community interest that would exert important public pressure. The activity can be used as a preliminary step in the process of developing a community or school recycling project.

II Questions

1. Questions which lead into the activity:
 - a. How is solid waste disposed of in your community?
 - b. What are the problems with these methods?
 - c. How practical would it be to recycle paper? aluminum? glass? other?
2. To initiate the activity ask:
 - a. Is there or has there been a recycling project in your community? If so, who, what, when, where and how effective was it?
 - b. Where can you write to find out about the practicality

of recycling?

- c. What is your congressman's knowledge of the problem and his position regarding solid waste legislation?

3. Questions which continue the activity:

- a. What other stages of the recycling process have you not examined?
- b. What part does packaging play in the waste problem?
- c. What do your school and community think of the concept of recycling?

4. Questions to evaluate the activity:

- a. How extensive was the search?
- b. How effective was the letter construction?
- c. Was the scrapbook circulated broadly?
- d. Did the students want to do other related projects?

III Equipment

1. Paper
2. Pencils
3. Stamps
4. Envelopes
5. Data repository (cardboard box)
6. Scrapbook
7. Glue
8. Scissors
9. Tape

IV Procedure

1. Split the class into teams of three. However, the number of teams and number per team depends somewhat upon number in class and extent of involvement.
2. Have each team select an organization or topic upon which they will do research and finally formulate a letter requesting information or inviting a speaker. The letters could be sent to:
 - Your state and national congressmen.
 - Glass container corporations which make NO DEPOSIT NO RETURN bottles. Determine their corporate policies and the locations of recycling centers.
 - Aluminum companies to determine locations of recycling centers and their corporate policies.
 - Any local offices of state or federal agencies. (The EPA, any offices of HEW or other environmental branches.)
 - Paper companies for recycling center information, prices, and corporate policy.
 - The Local Sanitation Department to determine the local method of solid waste disposal and provisions for recycling, possibly arrange for a tour or a speaker.
 - The community at large in the form of a questionnaire to determine attitudes and habits concerning solid waste.
 - Local supermarkets to determine policies on recycling and waste packaging.

3. Have the whole class or school sign the letters. Numbers add weight to these letters.
4. Collect everything you receive and make a scrapbook.
5. As an outgrowth of the letters, speakers and/or tours, start a recycling movement on an appropriate scale. The school, home and/or community for newspaper, glass, aluminum or anything else you can discover and recycle.
6. Display and circulate the scrapbook around your school and community. Perhaps you might even send it to the President.

V Past Studies

This has not been completed as a class activity. However, many individuals and organizations have contacted many or all of the above types of corporations and agencies with varying degrees of success. The response will vary according to letter working, time factors, number of signers of the letter and level of recycling concern by companies local to you. Some results are guaranteed and outgrowth possibilities are varied and exciting.

VI Limitations

Keep the information organized as this search moves along. Keeping a cardboard box as a data bin usually solves this problem. The size of the class and completeness of research are the only other limiting factors except those mentioned in Past Studies Section.

VII Bibliography

A Bibliography for the Layman--Selected Books and Publications

Dealing with ENVIRONMENTAL POLLUTION, The Pennsylvania Action Committee for Clean Air, Sept. 1970. This is an excellent bibliography on many facets of "Environmental Pollution" and governmental agencies involved in environmental problems. Other materials (films, questionnaires) listed in a very few spots.

G Grow Sludge Grow

I Introduction

This activity deals with a form of recycling that is currently being researched in depth by the U. S. Department of Agriculture. Students thus gain direct exposure to current research and may find that their results are of value to the research effort. The activity is suited to all age groups. Sludge is the only special equipment necessary and may be obtained free from most sewage treatment plants. The activity requires 3-4 weeks to complete though only 304 full class periods are needed. Observations and maintenance require a few minutes each day.

II Questions

1. To lead into the activity ask:
 - a. Have you ever planted a garden?
 - b. What basic needs must be met for a plant to grow and produce?
2. To initiate the activity ask:
 - a. Have you ever used fertilizer? What type?
 - b. Why is it necessary?
 - c. What makes manure a good fertilizer?
 - d. What is sludge?
 - e. How does sludge differ from manure?
3. To continue the activity ask:
 - a. In what forms is sludge used?

- b. What is digested sludge?
- c. What is meant by ultimate disposal?
4. To expand the activity ask:
 - a. What factors make sludge a poor fertilizer?
 - b. In what ways can sludge be treated to take advantage of its fertilizing qualities? Is this economically feasible?
 - c. Does sludge provide other benefits (other than as fertilizers)?
 - d. How can solid wastes be removed from sewage?
5. To evaluate the activity ask:
 - a. Did the students attempt to expand the activity by controlling other variables?
 - b. Was there a cooperative effort on the part of the students to utilize resources outside the classroom? e.g., local farmers, sewage treatment manager, letters to Department of Agriculture, etc.

III Equipment

1. Dry sludge: Prior to using the sludge place it in an oven at 300 degrees F for 30 minutes or in an autoclave for 15 minutes to destroy any pathogens that might be present.
2. Three (3) large petri dishes
3. Filter paper
4. Beaker
5. Corn or bean seeds

IV Procedure

1. Set up the petri dishes with filter paper in each.
2. Make a solution of sludge using 3-4 teaspoons of sludge to 100 ml of water.
3. In the first petri dish place 6 seeds and add enough water to saturate the filter paper.
4. In the second petri dish place 6 seeds and add enough sludge solution to saturate the filter paper.
5. Place 6 seeds in the sludge solution. Allow them to remain for a 24 hour period before putting into the petri dish.
6. Place the seeds from #5 in the petri dish and saturate the filter paper with sludge solution.
7. Observe each dish until growth occurs. Note when growth has begun and the development in each dish.
8. Compare all results. What are your findings?

V Past Studies

Students at Central Bucks West, Doylestown, Pa., grew plants to monitor air pollution. The sludge was obtained from the Doylestown Sewage Treatment Plant. They were greatly amazed by the rapid growth of the plants. One detrimental effect was noted, that was the abundance of mold growth.

VI Limitations

1. A major limitation is the attitude toward using sludge. Some students have negative feelings toward handling sewage in any form.

2. Another concern is the possibility of viable pathogens in the sludge that could lead to disease. Be sure the students follow the safety procedures listed in the appendix.

VII Bibliography

Agricultural Benefits and Environmental Changes Resulting From the Use of Digested Sewage Sludge on Field Crops, Environmental Protection Agency, U. S. Government Printing Office, Washington, D. C., 1971. A report of agronomic field studies and greenhouse studies using digested sludge. Good background for sludge usage. Readable by students of grades seven and up.

H Particulates in Air

I Introduction

The following activity examines particulate contamination using two simple but varied techniques. The lesson is designed to examine qualitatively and quantitatively the extent of particulate contamination in a given sector of the community and relate this contamination to its likely sources. The equipment used is extremely simple with many built in errors. The activities provide an opportunity to reinforce the values of accuracy and the need for controls. The activity is suitable for students from grade seven and up.

II Questions

1. To lead into the activity ask:
 - a. What constitutes air pollution?
 - b. What are the sources of air pollution?
 - c. How is solid waste considered a factor in air pollution?
2. To initiate the activity ask:
 - a. What are particles?
 - b. What is meant by particulate air contamination?
3. To continue the activity ask:
 - a. What are the sources of particulate contamination?
 - b. What sources of particulate contamination are there in your community?
4. To expand the activity ask:

- a. What is the federal allowable amount of particulate air contamination?
 - b. How do your results compare with this standard?
 - c. To what extent is particulate air contamination harmful?
 - d. What community controls do you feel are needed to limit particulate air contamination?
5. To evaluate the activity ask:
- a. What was the mortality rate on detection devices?
 - b. Were the students impressed with their findings?
 - c. What were the students' reactions to the controls and their effect on particulate air contamination?

III Equipment

Part I

Activity A

1. 15 or more 7 x 3 cards
2. Hole punch
3. 1 inch width cellophane tape

Activity B

1. 15 or more clothes hangers
2. 15 or more 3 inch glass slides
3. Petroleum jelly
4. Can
5. 1 inch width cellophane tape
6. Balance

7. Applicator sticks

Part II

Activity A

1. Microscope
2. Notebook
3. Pencil

Activity B

1. Balance
2. Conversion table (given below)

IV Procedure

Part I

1. Construction of Collector A
 - a. Fold the 7 x 3 card lengthwise as shown in the diagram.
 - b. Punch out 5 evenly spaced holes as shown using a hole punch.
 - c. Carefully place the tape over the holes from the underside.
 - d. Seal the card by placing the flap over the holes and secure with the tape ends until ready for use. Make as many cards as time allows.
2. Construction of Collector B
 - a. Bend the coat hanger into the shape shown by bending it.

around a can.

- b. Place the tape around the bottom with the sticky side out so it will hold the glass slide.
- c. Apply a thin layer of petroleum jelly to the slide. Avoid touching the jellied surface.
- d. Carefully weigh the slide and record.
- e. If more than one slide is used be sure to label the slides BEFORE applying the jelly.
- f. Slides that are not to be used right away should be placed in a box with a lid to prevent contamination or damage.

Note: The collectors are to be taken home and placed in areas that are to be examined. CAUTION: The collectors should not be placed where they are likely to be damaged by rain or direct wind. Secure them when necessary. The collectors will be left out for one week and then returned to class. Some collectors may be lost or damaged.

3. Examination of Collector A

- a. Examine the collectors under the microscopes on low power.
 - b. Describe what you see and make diagrams in your notebook.
 - c. Examine samples of other members in your group and compare to your own. Note differences and similarities.
 - d. When examination is completed, tape your collector on the sheet of white paper provided.
 - e. Get together with your group and devise a 1-5 rating of color density of the samples. Compare and relate the density of the particles and the source of the samples.
4. Examination of Collector B
- a. Weigh your slide very carefully and note any increase in weight. Record.
 - b. Using the figures you have, find the amount of particulate matter in 1 square mile in a one week period.
 $1 \text{ gram} = 1.102 \times 10^{-6} \text{ tons}$
 $1 \text{ square in.} = 2.490 \times 10^{-10} \text{ sq. miles}$
 $3 \text{ sq. in.} = 7.47 \times 10^{-10} \text{ miles (size of the slide)}$
Note: If $1 \text{ gram} = 1.102 \times 10^{-6} \text{ tons}$, your obtained weight times this number will give you the amount of particulate matter you have in tons. Divide the weight you received by the area of your slide in square miles to obtain the number of tons per square mile.
 - c. Place your results, you name and the source of the sample on the chart provided on the blackboard.

V Past Studies

An adaption of the above activity was done by students of the writer at Stamford High School, Stamford, Connecticut. The original purpose was to collect pollen grains during the hay fever season. Students were surprised to find out how much soot was in the air. Pollen grains were less numerous than soot particles.

VI Limitations

1. The collectors are not very sophisticated and may be damaged by natural forces. The more collectors available the better the results.

VII Bibliography

- Reynolds, William G. and Ward, Roger W. "Simplified Airborne Solid Sampling", The Science Teacher, Vol. 38 No. 1, Jan. 1971. p. 49-50. A description of a collector for particulates. Primarily for use by teachers. Gives procedure for use.
- Warner, Barry, "Particulates Provide Proof of the Pollution Problem", The Science Teacher, Vol. 37 No. 5, May, 1970, p. 78-79. Describes a collector for particulates and gives the procedure for use. Primarily for use by teachers or high ability senior high students.

1 Sewage Treatment

I Introduction

In this activity students learn about sewage and waste water treatment. The students learn how sewage is processed in their town and in neighboring communities. New laboratory techniques and equipment will be introduced which will enable students to determine the efficiency of various sewage treatment procedures and to appreciate, in a more precise way, the problems in an important, but often neglected or unnoticed, part of everyone's life. The time required for the activity may vary from two to four periods depending on the difficulty of the selected procedure, student interest and time and equipment available. The activity is designed for students from grade seven upward.

II Questions

1. To lead into the activity ask:
 - a. What happens to the sewage and waste waters that leave your home?
 - b. Does your community have a sewage system?
2. To initiate the activity ask:
 - a. What type (primary, secondary, or tertiary) waste water facilities does your community have? (consult local authorities, i.e., local health department or sanitary engineer)
 - b... Are different types of wastes (sewage, run-off) treated the same?

- c. How effective is the treatment?
- d. How could it be improved?
3. To continue the activity ask:
 - a. Are the methods of elimination of pollutants which you have encountered the most effective methods possible?
 - b. If not, why not?
 - c. What tests can be performed to determine the effectiveness of treatment plants?
4. To expand the activity ask:
 - a. Is the sewage treatment in your community adequate?
 - b. What factors could effect a change in the sewage load in your community?
 - c. To what extent does zoning in your community allow for residential and industrial expansion?
 - d. Would you want to drink the water coming from the final sewage treatment stage?
 - e. What factors would have to be considered in purifying this water for drinking?
 - (1) the technology required?
 - (2) the cost of processing?
 - (3) paying for the processing?
 - (4) advantages and disadvantages to you and the community?
 - (5) ecological effects on life in the stream

resulting from a change in effluent?

5. To evaluate the activity ask:
 - a. What can we as individuals or group members do to improve the sewage system in your community?
 - b. Do you feel you could explain the workings of the sewage treatment in your community to a younger student?

III Equipment

1. Sample bottles
2. Microscope slides and cover slips
3. Microscope
4. Dropper
5. A LaMotte, Hach or Delta water analysis kit
6. An identification book for identifying microorganisms.

IV Procedure

1. Make a trip to your local sewage treatment plant. Ask the plant manager to give you a tour of the plant. Discuss with him the various steps in sewage treatment. What level of treatment is used?
2. Take samples at the final sewage treatment stage.
3. Determine the nitrate level in the water using the water analysis kit. What is the significance of this level?
4. Determine the pH. Why is pH important in processing sewage?
5. Examine your samples for clarity. Is the water clear or cloudy? How would you expect the water from tertiary treatment to appear?

6. Examine a sample microscopically. Identify the organisms you find using the identification books.

V Past Studies

1. A group of students from Quincy, Mass. found their bay to be suffering from rapid biological aging (eutrophication). Also, it was being polluted by "storm" drains from a combination (storm-sewage) system. They studied the advantages and disadvantages of secondary treatment, the dangers of daily chlorination, and the problems of algae.
2. Another group of students from Quincy, Mass. made study of the effects of sludge being pumped into the bay at a rate of two million gallons a day. They concerned themselves with BOD, eutrophication and floating solids.

VI Limitations

1. If there is no treatment plant in your community, you will have to take field trips. Supplementary teaching aides may be required.
2. Samples should be drawn only at the terminal treatment stage because of the danger of disease. Hands must be washed thoroughly.

VII Bibliography

Cleaning Our Environment: The Chemical Basis for Action, A report by the Subcommittee on Environmental Improvement, Committee on Chemistry and Public Affairs, American Chemical Society,

Chapter 2 Transitional Solid Waste Activities

Draft

Washington, D. C., 1969. Deals with four major concerns: air, water, solid wastes and pesticides. For each there is an introduction to the problem, background information, a discussion of the chemical factors, control factors, the environmental effects and recommendations for change. The book is technical and best suited to the needs of secondary or college students.

J Landfills Basic

I Introduction

Students in seventh grade and below are introduced to the underlying concepts of a sanitary landfill in this activity. A drinking glass is used to enable students to observe microbial action on solid waste items in a mini landfill. The activity may be initiated in one class period and the results observed a few minutes a day as about one week passes. No special equipment is required.

I Questions

1. To lead into the activity ask:
 - a. Why do some people bury their garbage?
 - b. What's it like underground?
 - c. What happens to the garbage down there?
2. To initiate the activity ask:
 - a. What kinds of materials do people throw away?
 - b. What happens to these items in a landfill?
 - c. What kinds of things do we want in our landfill?
 - d. How long does it take for the materials to change?
3. To continue the activity ask:
 - a. Are there any empty spaces where materials have decomposed?
 - b. Are they really empty?
 - c. Is there anything at all in those spaces?
 - d. What happened to the garbage that used to be there?

- e. Is it truly "gone"?
- f. What materials did not change?
4. To expand the activity ask:
 - a. Were the physical conditions the same for each landfill?
 - b. If these conditions were changed would you expect changes in the rate of decomposition?
5. To evaluate the students ask:
 - a. Were the landfills well maintained?
 - b. Were the materials used in it representative types?
 - c. Were observations well kept?

III Equipment

Each team needs:

1. 3 or 4 see-through drinking glasses or beakers.
2. Soil - enough to fill the glasses, taken from several inches below surface.
3. Aluminum foil.
4. Various samples of litter, trash, or garbage. (The size should vary between that of a bean to a grape.)
5. Microscopes.
6. Slides.

IV Procedure

1. Have students obtain the soil and litter samples, if possible.
2. Vary the litter in the soil in the glasses at various depths - but place the litter against the inner surface of the glass

to allow the observations of microbial action.

3. Make sure the soil is firmly packed, but with an inch of air space at the top; and also the soil should be moist but not wet.
4. Cover the glasses with a piece of aluminum foil.
5. Observe daily for signs of mold and decomposition. Students may wish to perform microscopic observations as well.

V Past Studies

1. This activity was conducted by the writer to test its feasibility for classroom use. The above writing represents the variations on the basic activity.

VI Limitations

1. Do not use meat products in the landfill as they tend to produce offensive odors.

VII Bibliography

Schatz, Albert and Vivian, Teaching Science With Garbage (An Interdisciplinary Approach to Environmental Education From the Points of View of Science, Math, and Social Studies), Rodale Press, Inc., Emmaus, Pa. This activity is adapted from Teaching Science With Garbage. A delightful idea-book that lists 30 odd activities and lists facts and questions that deal with garbage and teaching. They compile a healthy interdisciplinary bundle.

Wilcomb, Maxwell J., and Hickman, H. Lanies, Jr., Sanitary Landfill

Design, Construction and Evaluation, Report (SW-88ts).

U. S. Environmental Protection Agency, Solid Waste Management Office, Superintendent of Documents, U. S. Government Printing Office, Washington, D. C., 1971. A very practical, very readable guide to the realistics of a sanitary landfill; readable from grade five upward. Cost \$.30.

K Litter 'Limination

I Introduction

This activity takes a step toward answering the provocative question - what happens to litter! By simulating biological processes in vitro, the students will become acquainted with the biodegradability status of various types of litter. This activity is suitable for any age level.

II Questions

1. To lead into the activity ask:
 - a. What can happen to litter?
 - b. What do non-natural processes do to it (e.g. cars)?
 - c. What do animals (including man) do to it?
 - d. What do natural forces (e.g. wind and rain) do to it?
2. To initiate the activity ask:
 - a. Does litter disappear?
 - b. What is meant by the term, biodegradable?
 - c. What types of litter are biodegradable?
3. To continue the activity ask:
 - a. What materials show signs of biodegrading?
 - b. What types of growths resulted?
 - c. Did sunlight affect the process?
 - d. Did moisture affect the process?
 - e. How "real" was this experiment?
 - f. Why did we use soil?

- g. What is soil?
- 4. To expand the activity ask:
 - a. Could succession be observed in the system?
 - b. In what other systems could biodegradability be observed?
- 5. To evaluate the students ask:
 - a. How logically was the experiment set up?
 - b. Did the investigation provoke further questions?
 - c. Did the students progress in terms of understanding the concept(s) of biodegradability?

III Equipment

Each team needs:

- 1. Container, glass, metal or plastic, 6-8" in diameter and 3-4" deep.
- 2. Moist but not waterlogged soil, preferably loam, from garden or under shrubbery.
- 3. Thin, clear transparent plastic.
- 4. Rubber band.
- 5. Variety of material to biodegrade or not to as the case may be - litter can be picked up from roadside, kitchen scraps, etc.

IV Procedure

- 1. Firmly pack soil an inch or so deep in the container.
- 2. Obtain litter. Do not include protein materials such as jello, meat or cheese because these may cause unpleasant odors. Make

sure someone includes materials, such as steel wool, glass, plastics, etc.

3. Place litter on surface of soil, allowing plenty of room between pieces.
4. Cover container with plastic, secured by the rubber band.
4. Observe growth of molds and subsequent decomposition - especially important is time. Watch for signs of succession.

V Past Studies

Tim Horne at George School, Newtown, Pa. set up an experiment to test the biodegradability of litter (cans, bottles, plastic, paper) as the litter is exposed to the elements out of doors.

VI Limitations

If displays are made for out-of-doors, be sure to protect them from vandalism. Occasionally, students have encountered difficulties when mounting litter because the mounting materials degraded too rapidly. The students will probably have to determine their own standards.

VII Bibliography

Litter Facts, Public Affairs Dept., Glass Container Manufacturers Inst., New York, New York. Litter Facts is a short, well written pamphlet on solid waste disposal in general. The factual information is well presented and worthwhile tips are provided for those interested in starting recycling efforts.

Schatz, Albert and Vivian, Teaching Science With Garbage (An Interdisciplinary Approach to Environmental Education From the Points of View of Science, Math and Social Sciences), Rodale Press, Inc., Emmaus, Pa. A delightful idea-book that lists 30 odd activities and lists facts and questions that deal with garbage and teaching. They compile a good interdisciplinary bundle.

Scientific Experiments on Environmental Pollution, Elbert C. Weaver, Editor, Holt, Rhinehart and Wilson, New York, 1968. There is one biodegradability of solids activity in this booklet; the rest deal with air pollution and with water. A fairly technical orientation makes the activities suitable for grade nine upward.

L Landfills Advanced

I Introduction

This activity will be particularly relevant to students whose community is serviced by a sanitary landfill. Students will build a model landfill and investigate problems and controversies concerned with landfill construction and operation. Students will perform concurrent research and (with their model) shall learn material which may be shared, perhaps with younger grades.

II Questions

1. To lead into the activity ask:
 - a. Why is garbage sometimes buried?
 - b. What's it like underground?
 - c. What happens to the garbage down there?
2. To initiate the activity ask:
 - a. Is the sanitary landfill an efficient means of dealing with wastes?
 - b. How economical is it?
 - c. How efficient is it?
 - d. Does it deal effectively with the solid waste put into it?
 - e. Can a landfill be simulated?
3. To continue the activity ask:
 - a. How long does it take various materials to decompose?

- b. What stages does the decomposition process take?
 - c. What types of settling have taken place?
 - d. What can be said about organic vs. inorganic matter in landfills?
4. To expand the activity ask:
 - a. What community problems are associated with landfills?
 - b. Are landfills an acceptable way of disposing of wastes?
 - c. Compare and contrast landfills and compost piles.
 5. To evaluate the activity ask:
 - a. Is the simulation well constructed?
 - b. Does the student feel he has gained an understanding of landfills?
 - c. Was research conducted to an adequate degree?
 - d. Did the student contribute to the group work?

III Equipment

Students will probably need the following materials, most of which they should be responsible for obtaining. This may be conducted as a class or group activity.

1. Large container for landfill.
2. Soil.
3. Garbage.
4. Stones to simulate rock layers and water table.
5. Unlimited extras.

IV. Procedure

1. In your landfill box place a thin layer of soil.
2. Place about an inch of garbage over the soil.
3. Pack down the garbage.
4. Place a thin layer of soil over the garbage and pack down.
5. Continue layering garbage and soil until the box is full.
6. Work with another group of students to set up a controlled study. Leave one landfill undisturbed. Pour a cup of water into the other each day to simulate rainfall. Compare the decomposition in each landfill after a week has passed. Note the amount of settling in each landfill.

V Past Studies

The class of Mrs. Pam Gallagher at the Lower Moreland Junior High School, Pa. experimented with landfills in plastic containers. Students were involved in studying the physical conditions that were most favorable for decomposition of garbage in the landfill. Emphasis was placed on sanitary landfill as one means of waste disposal.

VI Limitations

1. A wooden box allows for viewing at only one dimension.
A pane of glass could be used in one side.
2. Odors may offer some difficulties in the controlled studies.

VII Bibliography

Cleaning Our Environment: The Chemical Basis for Action, A report by the Subcommittee on Environmental Improvement,

Committee on Chemistry and Public Affairs, American Chemical Society, Washington, D. C., 1969. Deals with four major concerns: air, water, solid wastes and pesticides. For each there is an introduction to the problem, background information, a discussion of the chemical factors, control factors, the environmental effects and recommendations for change. The book is technical and best suited to the needs of secondary or college students.

Municipal Refuse Disposal, American Public Works Association, United States Department of Health, Education and Welfare, United States Public Administration Service, Chicago, Ill., 1970. A very complete, excellent text, considering any facets of the solid waste disposal problem which students need to know. Although somewhat technical, high school students could make good use of it.

Wilcomb, Maxwell J., and Hickman, H. Lanies Jr., Sanitary Landfill Design, Construction and Evaluation, Report (SW-88ts), United States Environmental Protection Agency, Solid Waste Management Office, Superintendent of Documents, U. S. Government Printing Office, Washington, D. C., 1971. A very practical, very readable guide to the realistics of a sanitary landfill; readable from grade five upward.
Cost - \$.30.

M Particulates in Water

I Introduction

This transition activity introduces students to the problem of particulates in water. They examine water quality in terms of the amounts of suspended particles and sedimentation and consider probable sources of this form of pollution. The activity is suited for grades four through twelve. It requires no special equipment and requires from two to four class periods to complete.

II Questions

1. To lead into the activity ask:
 - a. What makes water cloudy?
 - b. What is sediment?
 - c. How can sediment be considered a pollutant?
2. To initiate the activity ask:
 - a. What are particulates in water?
 - b. Of what do these particulates consist?
 - c. What are some sources of particulates in water?
3. To continue the activity ask:
 - a. What effects does sediment have on fish and shellfish populations?
 - b. How are sediments treated in channels and harbors?
 - c. What effects do particles in water have on power turbines and pumping equipment?

- d. How does the speed of the wa' r affect the amount of sediment?
4. To expand the activity ask:
 - a. How is the cost of particulate pollution in water transmitted to you?
 - b. How could particulate pollution of water be decreased?
 - c. How can the problem of particulates in water be treated?
5. To evaluate the activity ask:
 - a. Did the students work together or separately?
 - b. Did the students compare their findings?
 - c. To what extent did the students offer suggestions for improvement of the situation?

III Equipment

1. 3,100 ml graduated cylinders
2. White 8" x 11" card or paper
3. Record sheet for data
4. Thermometer

IV Procedure

1. Locate three different sample areas along the water-way you are to examine. Each should be as different from the other as possible.
2. Collect a 100 ml water sample from each area and record its temperature.
3. Hold the sample against the white card. Rate the cloudiness

from lesser to greater (1-5).

4. Return your samples to class. Allow them to sit overnight so that the particles can settle out.
5. Measure the depth of sediment in each cylinder.
6. Examine your results. Note any relationships between the location, rate of flow, water temperature and the amount of cloudiness or sediment.

V Past Studies

Students at Germantown Academy built a check dam on the Wissahickon Creek. In the first few months, several inches of sediment collected above the dam. It was identified as the result of erosion and discharge from a factory upstream. The water below the dam was measurably clearer (JTU). They determined why these things occurred.

VI Limitations

1. Be prepared for wet clothing. Many students find it difficult to resist deep water.
2. Bring along a specimen box or container. You never know what you will find of interest.

VII Bibliography

Ruckelshaus, William D. and Dominick, David D., A Primer on Waste Water Treatment, Environmental Protection Agency, U. S. Government Printing Office, Washington, D. C., March, 1971.
An excellent introduction to sewage treatment. Deals with

types of treatment, types of pollutants and future of waste water treatment. A good background source for students from grade 7 upward.

Water Pollution, Addison Wesley, Inc. Publishing Company, Teachers Guide. A good introductory resource. It must be supplemented if detailed studies are undertaken.

N Solid Waste in Water and Its Effect on Aquatic Animals

I Introduction

This activity will test the effects of solid waste on aquatic organisms. Students will make daily observations of aquaria to which solid waste has been added. They will record their observations and evaluate them. The activity is seen as an introduction to more in-depth studies of solid waste effects on aquatic life. The activity requires a minimum of one week to complete. Aquaria that have been established prior to the activity are suggested. Students from the upper elementary grades through senior high school can benefit from this activity.

II Questions

To lead into the activity ask:

- a. How often have you passed a stream or river that was filled with debris?
- b. Why do you think people dump trash near or into waterways?

2. To initiate the activity ask:

- a. What effects do you think litter and garbage have on the animal life in these waters?
- b. Over a period of time what happens to the solid waste in these waterways?

3. To continue the activity ask:

- a. What effect does the solid waste seem to have on the

animals?

- b. What did the waste do to the water?
- c. How did the animals respond to the waste?
- d. What positive effects did the waste have on the animals, if any?

4. To expand the activity ask:

- a. How could the effects on wildlife be reversed?
- b. What economic factors have to be considered if we are to clear our waterways of solid wastes?
- c. How can we stop people from dumping wastes into our waterways?

5. To evaluate the activity ask:

- a. Did the students make in-depth observations?
- b. Was there much interaction between the various groups?
- c. Did the students speculate on the effects of the waste on the animal life?

III Equipment

1. Four aquariums, 20 gallons, with assorted animals and plants.
2. Garbage and trash items.
3. Observation sheet.

IV Procedure

1. Observe your aquarium for several days and record the behavior of the animals. Note the physical conditions in the aquarium.

2. Add a single solid waste item and again observe the animals for a few days.
3. Add another solid waste item and again observe for a few days. Continue to do this as long as time permits.
4. Make sure you record all your observations.

V Past Studies

1. The writer became involved indirectly in the above activity while teaching at Log College Jr. High School, Warminster, Pa. Someone threw some pennies in the classroom aquarium. Several fish were found dead during class. When the pennies were noticed several students wondered what really had happened to the fish. A discussion ensued on heavy metal poisoning.

VI Limitations

1. If the aquarium is not set up several weeks in advance of the activity, other factors may interfere with the results. Be sure to use a control aquarium.

VII Bibliography

Clean Water for Mid-America, Public Information Office, Great Lakes Region, FWPCA, Dept. of Interior, Chicago, Illinois, April, 1970. An introductory pamphlet on water quality. Deals with the middle states region. Concerns itself with the roles of the states, cities and industries. Good for upper elementary through senior high school.

0 Packaging Effects on Microorganisms

I Introduction

This activity shows students how packaging differences affect the microorganisms of their foods. By comparing bacteria and/or yeast concentrations of fresh, canned, and/or frozen foods, students will observe the sanitary differences that packaging affects. This activity is suitable from grade five upward.

II Questions

1. To lead into the activity ask:
 - a. What microorganisms are found on foods?
 - b. What is their source?
 - c. Are these good or bad?
 - d. Why is packaging necessary?
 - e. Is the microorganism content of foods important?
2. To initiate the activity ask:
 - a. What factors affect the microorganism content of foods?
 - b. What comparisons can be made?
3. To continue the activity ask:
 - a. How important is the sanitary quality of foods?
 - b. What laws govern this?
 - c. What common diseases are there associated with contaminated foodstuffs?
4. To expand the activity ask:
 - a. Do you think your attitudes toward buying packaged

foods have changed as a result of this activity? Explain.

- b. What factors are highlighted in the home preparation of foods as a result of this activity?
5. To evaluate the students' efforts ask:
- a. How rigorously was the procedure followed?
 - b. What happened with the results?
 - c. How did packaging play a role in the investigations?

III Equipment

1. Food samples - this may include:
 - a. canned vs. fresh vs. frozen vegetables and fruits
 - b. butcher vs. grocery store meats
 - c. bulk vs. packaged butters and cheeses
2. Millipore laboratory - set up
 - a. Sterifil unit(s)
 - b. media - total count medium, yeast and mold medium and MF-Endo medium are suggested
 - c. petri dishes
 - d. distilled water
 - e. alcohol and flame for sterilizing forceps
 - f. incubators

IV Procedure

1. Obtain the foods to be tested. Note the packaging.
2. Prepare the filters according to the Millipore instructions.
3. Place the food in sterile distilled water using sterile for-

ceps.

4. Pour into the funnel unit.
5. Rinse off the microorganisms by gently agitating the unit.
6. Remove the food with sterile forceps.
7. Filter the distilled water.
8. Use residue to streak the plates. Be sure to follow sterile technique.
9. Incubate the plates for 48-72 hours.
10. Observe the plates, determine and record your findings.

V Past Studies

This activity was conducted at the Institute for Environmental Education in Cleveland during a 1972 summer training session. Especially evident was the difference between fresh fruits in open markets vs. supermarkets who superpackage them. Studies were also done to determine the bacterial content of bulk butter, butter sold out in the open and packaged butter.

VI Limitations

Students should actually do the selecting of foods. If the students are not familiar with, say, the "farmers market" then, if possible, they should see the contrasts with supermarkets.

VII Bibliography

Hersom, A. C., Canned Foods (An Introduction to Their Microbiology), Chemical, New York, 1964. This is a fairly technical text,

although high school students could handle it. It emphasizes the rigorous laboratory analyses which can be performed, and also contains informative text.

Millipore - Experiments in Microbiology, The Millipore Corporation, Bedford, Mass. This student manual is an experiment-oriented introduction to the many procedures which can be carried out using Millipore equipment, and are basically the same type of testing done in professional laboratories. An introductory section on microorganisms provides adequate background to conduct the investigations.

Thatcher, F. S., Microorganisms in Foods (Their Significance and Methods of Enumeration), University of Toronto Press, Toronto, Ontario, 1968. A fairly technical, largely informative text. Many advanced techniques are discussed, most of which are too elaborate for the average high school student.

P The Present Tense of Soap

I Introduction

In this activity a common waste material will be used to produce a helpful product. The activity deals with the concept of recycling and points out that this is, in no way, a new concept. Because the activity involves the use of lye, students must be informed about the dangers of lye. Close supervision is suggested. The activity is suitable for students in grades seven through college. The activity requires two class periods, a week apart.

II Questions

1. To lead into the activity ask:
 - a. What do you do with left over animal and vegetable fats?
 - b. Are these wastes or by-products?
 - c. What did the early Americans do with fats?
 - d. What was fat used for during World War II?
2. To initiate the activity ask:
 - a. What is soap?
 - b. Is a detergent soap? Explain.
3. To continue the activity ask:
 - a. Is fat disposal a problem in this country?
 - b. How did our forefathers make soap?
4. To expand the activity ask:
 - a. How is soap manufactured today?

- b. How does home-made soap compare with manufactured soap?
- c. Why is water purity a consideration in making soap?
- 5. To evaluate the students' efforts ask:
 - a. How did the students respond to the activity?
 - b. To what degree did they apply the knowledge gained in performing the activity?
 - c. How well did the students work together?

III Equipment

- 1. Fats - a little over 6 lbs. or 13 cups
 - a. Kitchen grease
 - b. Tallow (beef, sheep or mutton fat)
 - c. Lard (pork and bacon fat)
 - d. Poultry fats (should not be a major source)
 - e. Vegetable oils (should not be a major source)
 - f. Candle stubs
- 2. Three enamel pots (do not use aluminum).
- 3. Cold water (rain water or distilled water is preferable).
- 4. Heat source (Bunsen burner).
- 5. Wooden stirring stick.
- 6. 2 or 3 thicknesses of cheese cloth.
- 7. Gloves or vaseline for the person working with lye.
- 8. 13 oz. container of lye.
- 9. Measuring cup or scale.
- 10. Molds (cardboard or cigar boxes, pyrex cake pan or wooden mold).

11. Cutting tool made of a strong thin wire suspended between two sticks of wood.

IV Procedure

1. Collect fats.
2. Clarify fats by boiling 1 part fat to 2 parts water. Filter through two to three thicknesses of cheesecloth.
3. Place two and a half pints of cold water in the enamel pan. Gradually add 13 oz. of lye while stirring with a wooden stick. Let the liquid mixture cool to room temperature.
4. Heat six pounds, or thirteen cups, of fat to the point that it is completely melted.
5. Gradually pour the lye solution into the fat while stirring constantly. This should be done over a 15-20 minute period.
6. Stir slowly for another half hour or until the solution begins to thicken.
7. Fill the molds with the slurry.
8. Set the molds in a warm place, undisturbed for a week.
9. When the soap has hardened, cut or flake it.
10. Be sure to wash your hands when finished!

V Past Studies

1. Soap making was done in the seventh grade classes of the writer at Log College Jr. High School, Warminster, Pa. Some of the soap was used in the classroom. The rest was taken home by the students. The students were excited about the

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activity because it was something they had heard about from their grandparents but never had done before.

2. Soap was also made by the graduate students of Dr. Albert Schatz at Temple University as an example of recycling. The interest and enthusiasm ran high. Much discussion centered around other ways of recycling in the home.

VI Limitations

1. Not all age levels will be able to conduct the entire activity.
2. Lye must be handled carefully. Should anyone get any on his clothes, skin or in his eyes, neutralize it with diluted vinegar and then wash it with water.

VII Bibliography

Cailliet, Greg, et. al., The Everyman's Guide to Ecological Living, McMillan, New York, New York, 1971. Probably one of the best references on individual and limited group environmental action activities stressing the acquisition of "ecological habits". It contains supplementary facts. Selling for \$.95, it is highly recommended. It should present no problem for the average reader, as it is not technical in presentation.

Schatz, Albert and Vivian, Teaching Science With Garbage (An Interdisciplinary Approach to Environmental Education From the Points of View of Science, Math, and Social Sciences), Rodale Press, Inc., Emmaus, Pa. A delightful idea-book that lists

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Draft

30 odd activities and lists facts and questions that deal with garbage and teaching. They compile a healthy interdisciplinary bundle.

Smith, Paul E., Revisor of text by Carpenter and Wood, Our Environment: How We adapt Ourselves To It, Allyn and Bacon, New York, 1958. This practical science textbook concerns the first half with meteorology and beyond, but the second half with health, farm and garden, and conservation. Students from grade five upward can find simplified information which includes sewage and water treatment, agricultural control, and foods. A very informative text to have on hand.

Q C.O.M.P.O.S.T.O. (Constructing Organic Matter Piles Obliterating Stagnant Throw-Outs-Outside)

I Introduction

In this activity students construct a compost pile outside the school building and assume the responsibility for its maintenance. Depending on the materials used in the compost, additives may need to be purchased because the compost pile constructed in this activity is assumed to be of considerable size. If constructed by an extracurricular group of interested students and teachers, timing would be less of a problem than if conducted by a class. Getting the compost under way might take a week's worth of class time, after which maintenance may be necessary. This activity is suitable for students from grade 3 upward.

II Questions

1. To lead into the activity ask:
 - a. What essentials are needed for plant growth?
 - b. From where do plants get what they need to grow?
 - c. What essentials are needed for animal growth?
 - d. From where do animals get what they need to grow?
 - e. What are organic wastes?
 - f. How do we dispose of these wastes?

2. To initiate the activity ask:
 - a. What is decay?
 - b. What are the by-products of decay?
 - c. What decays?
 - d. What is compost?
 - e. What goes on inside a compost pile?
3. To continue the activity ask:
 - a. Can we support a compost pile?
 - b. Where will it be located?
 - c. What materials will we want in it?
 - d. Why would we want to avoid adding some materials?
 - e. Who will contribute to it?
 - f. Who will take the responsibility for its maintenance?
 - g. What will be done with the "finished" compost?
 - h. Is a compost pile economically feasible?
4. To expand the activity ask:
 - a. What materials should be added to make a better quality material?
 - b. Do certain materials decompose better than others?
 - c. What organisms facilitate the decomposition process?
 - d. How does composting differ from landfill operations?

III Equipment

1. Supply of organic wastes. The compilation of a compost

pile is not an activity for which an exact materials list exists. For a large pile out of doors, garden wastes (leaves, grass clippings, undiseased plant refuse) are quite sufficient. If manure is available, it too is a good additive. Of course some soil is needed, as well as lime to "sweeten" the soil.

2. For the confines of the pile, a pit can be dug (which provides soil for the pile). In this case, obtain shovels. To stake out the area, have string and wooden posts. If the pile will be constructed completely above ground, have some fencing so materials don't blow all over the place (wooden staves or chicken fencing). If a wooden or cement platform is available for this, seepage can then be collected and returned to the pile for nutrient renewal purposes.
3. A supply of water should be nearby (i.e. hose).
4. Pitchforks will be needed to turn the compost.
5. Those who work with the compost pile should wear appropriate clothing.

IV Procedure

1. By going through the "continue" questions, general criteria for the pile will be determined.

2. The site should be confirmed and cleared with proper authorities. If possible, a shaded area is good so that evaporation is minimized.
3. No set procedure can be outlined below. Preparation of the area might include digging a trench and setting up confines.
4. Materials should be layered in the pile if several different ones are used. That is to say that not all leaves should be at the bottom, all manure in the middle, and all the garden scraps on top. Six inches is a good layer depth.
5. Each layer should be moistened, but not drenched.
6. The top should be flat or concave so that rain water is not repelled.
7. Materials may be continuously added to the pile.
8. The pile should be "turned" once (6-7 weeks after construction) to aerate and promote equal decomposition of matter. Make sure that the materials that were on the outside get inside. Moisten it if necessary.
9. When material is sufficiently rotted, it is ready for use.
10. Have students visit the pile periodically to make observations.

V Past Studies

1. Council Rock High School in Newtown, Pa., under the direction of Mr. Vance Bachman, established a spot on school property where the public could bring their leaves. In a three-week period the size of the pile had decreased 30-40% by the decomposition. The community was then invited to partake of the finished product.
2. Nottingham Academy in Buffalo inconspicuously maintains a compost pile for leaves and garden scraps in a shaded area of its city campus. Very few students and faculty realize that it exists!

VI Limitations

1. There is always a fear that compost piles attract flies, rats and dogs. If properly maintained (i.e. not neglected), not even an odor problem will be present.
2. Although the pile will keep through the winter, try to set up the pile so that it has some time to get going before the snow sets in.
3. If prohibited from establishing a large pile out of doors, consult the activity C.O.M.P.O.S.T.I., which directs a small pile which may be maintained indoors.

VII Bibliography

McGauley, P. H., American Composting Concepts, EPA Solid Waste Management Office, U. S. Government Printing Office,

Office, Washington, D. C., 1971. A paper reviewing the status of composting as a process for the management of municipal solid wastes. Evaluates compost in terms of economic and environmental values in long and short runs.

Breidenbach, Andrew W., Composting of Municipal Solid Wastes in the United States, U. S. Government Printing Office, Washington, D. C. Discusses large-scale composting, including case histories, somewhat technical but not too difficult for the high school student.

Dust, James O., The Compost Pile, Agricultural Extension Service of Penn State University, University Park, Pa., April, 1970. An excellent introduction and guide to composting on a home gardening scale. It discusses the practical importance of composting and the building of the pile. Directions are given for a large pile without specific directions for a very small scale attempt. Grades nine and up might find it interesting.

Rodale, J. I., and Staff, Encyclopedia of Organic Gardening, Rodale Bodes, Inc., Emmaus, Pa., 1971. An alphabetical listing of thousands of garden products, processes and plants. A virtual bible of gardening organically including excellent section on composting.

Robison, Jeanne, Making Compost Is Like Making Soup, Organic Gardening and Farming Magazine, Emmaus, Pa., May 1972.

Describes the steps and variety of materials used to rejuvenate a barren piece of property. Very interesting for any grade level.

R C.O.M.P.O.S.T.I. (Construction Organic Matter Piles Obliterating Stagnant Throw-Outs-Inside)

I Introduction

This activity is designed for classes in which an outdoor compost pile is prohibitive either because of a lack of space, time or permission. The activity allows students of any age, especially those in elementary school, to see composting in action - indoors. Students are encouraged to bring in kitchen scraps which will decompose in a trash can, facilitated by soil. Once the materials are added, they will be decomposed within a week to three weeks. An old blender is a helpful piece of equipment. Equipment requirements, however unusual, are not extraordinary.

II Questions

1. To lead into the activity ask:
 - a. From where do plants get what they need to grow?
 - b. From where do animals get what they need to grow?
 - c. What are organic wastes?
 - d. How could we dispose of these wastes?
 - e. Is there a good and a bad way to "get rid" of them?
2. To initiate the activity ask:
 - a. What is decay?
 - b. What decays?

- c. What is compost?
 - d. What goes on inside a compost pile?
 - e. What are the by-products of decay?
3. To continue the activity ask:
- a. What are good materials for decomposing?
 - b. Do certain materials decompose better than others?
 - c. What will be done with the "finished" compost?
4. To expand the activity ask:
- a. What materials, if added, would make a better quality compost?
 - b. What organisms facilitate the decomposition process?
5. To evaluate the activity ask:
- a. How cooperative were the students about bringing in materials?
 - b. What was their reaction to the project?
 - c. Did they express an enthusiasm to take the activity beyond the confines of the classroom?

III Equipment

1. Container (e.g., handled trash can) of soil - topsoil, garden soil, etc.
2. Container (e.g., handled trash can) in which to make the compost.
3. Old blender, if available.
4. Small shovel for transferring materials.

5. Slack lime for sprinkling atop mixture.
6. Thermometers.
7. Kitchen scraps the students bring in.
8. Earthworms.

IV Procedure

1. Have students collect kitchen scraps in a container which can be covered and brought to school, e.g., coffee can with plastic lid, reusable plastic storage boxes. (horrors, but . . .)
2. These wastes should consist only of materials such as vegetable and fruit scraps and peels, coffee grounds, egg shells; greasy scraps, or any meat, cheese, or egg products invite odors and pests, so stick mostly to greens.
3. If possible, run these scraps through a blender, or else instruct students to make sure the pieces are reasonably small.
4. Alternate layers of soil with layers of scraps.
5. Make sure the pile is moist. Introduce worms.
6. Sprinkle a few teaspoons of lime on every other food layer or so.
7. Take periodic temperature readings of both the inner and outer regions of the soil.

8. When soil is "done" - use it. Keep the operation going as long as enthusiasm permits.

V Past Studies

1. When kitchen scraps are put through a blender, they will decompose in about a week.
2. In a compost pile consisting of kitchen scraps, tomato seeds yielded tomato plants two feet tall. Another compost heap had to be started.

VI Limitations

1. The only limitation might be that the idea of a compost heap indoors is repulsive to some people. A properly maintained compost pile is no nuisance.

VII Bibliography

McGauley, P. H., American Composting Concepts, EPA Solid Waste Management Office, U. S. Government Printing Office, Washington, D. C., 1971. A paper reviewing the status of composting as a process for the management of municipal solid wastes. Evaluates compost in terms of economic and environmental values in long and short runs.

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including case histories somewhat technical, but not too difficult for the high school student.

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Robinson, Jeanne, Making Compost Is Like Making Soup, Organic Gardening and Farming Magazine, Emmaus, Pa., May 1972. Describes the steps and variety of materials used to rejuvenate a barren piece of property. Very interesting for any grade level.

S Compost Awareness Activity or Soiled Waste

I Introduction

The purpose of the activity is to make students aware of the soil and how composting plays a vital role in soil enrichment. Through both sensual and scientific experimentation, students will gain an increased awareness of different types of soils and composted materials. There are four different parts to this activity - they can be combined as necessary for grades K-12. Ordinary science laboratory equipment is needed to conduct this activity. It can be completed in one to three class periods.

II Questions

1. To lead into the activity ask:
 - a. Where do plants get the materials to make them grow?
 - b. What is soil?
 - c. What is compost?
2. To initiate the activity ask:
 - a. What can you see in each soil sample - i.e., identifiable matter, living, dead, or inorganic?
 - b. What does it feel like? (Do not look while doing this.)
 - c. How does it smell?
 - d. What is its color?

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3. To continue the activity ask:
 - a. What microorganisms are in the soil?
 - b. What are they doing?
 - c. What is the percentage of organic matter in the soil?
 - d. Can you distinguish the samples once they've been dried?
4. To expand the activity ask:
 - a. What is pH?
 - b. How is it important in soils?
 - c. What is the pH of the soils we are working with?
5. To evaluate the activity ask:
 - a. How exacting were the students in making clear and accurate observations?
 - b. Were they "turned on" by the activity? What interested them most/least?
 - c. What were the quality and the quantity of questions raised beyond the activity?

III Equipment

1. Soils and compost pile samples - at least four.
2. White surface on which to place samples for observation (mortars, porcelain, white glass, etc.).
3. Marking pencil for identification of samples
4. Small (50 ml or so) beakers.

5. Medicine droppers.
6. Microscopes (as most organisms are bacteria, the higher the scope can magnify the better - perhaps going into oil immersion).
7. Slides and cover glasses
8. Aluminum or other suitable drying pans.
9. Drying oven or drying lamps.
10. Soil scoops - trowels or laboratory spatulas.
11. Soil pH test kit - if desired.
12. Distilled water.
13. Scale.
14. Hand lenses.

IV Procedure

1. Make sensual observations of the soil samples provided. Hand lenses may be used. Students should collect the samples if possible.
2. Place an amount of soil in a beaker. Add distilled water to make a suspension. Swirl to mix. With medicine dropper, prepare slides. Note diversity and density (one, several, all over the place) of microorganisms. Samples can be left to propagate and daily or bi-weekly check-backs can be made on succession and change.

3. Weigh standard amounts of each sample. Place in drying oven until all moisture has been evaporated. Weigh again - evaluate results.
4. Analyze the pH of each sample. Make sure the source is known. If compost is involved, find out what material (especially if slack lime to raise pH) contributed to the compost.

V Past Studies

1. In one study (author), four samples were used: dry, trampled soil; compost from a farm; compost made mostly from leaves and garden wastes; and some from a home in which tomato plants over two feet tall had grown from seeds from contributed tomato wastes. Sensual differences were prominent especially in terms of microorganisms.
2. In the same study, one student was amazed at the concentration of bacteria from the sample of worn, trampled soil - in general, the plethora of uni-cellular bodies which didn't seem possible from some pretty worn-out looking soil.

vi Limitations

1. This activity is best tried when snow and frozen ground are not in control of circumstances.
2. High magnification (e.g., 950X) microscopes are especially good, since most microorganisms are bacteria and algae

which require higher magnification. If such are not available, the students may become discouraged and think that nothing is in the soil. Be ready to give help to frustrated students.

VII Bibliography

Bahr, Robert and Reemer, Rita, The Organic Classroom, Introduction of Environmental Education, The Organic Way. An interdisciplinary Approach, Rodale Press, Inc., Emmaus, Pennsylvania 18049, 1972. Book of classroom activities for elementary school children in particular. Organic living is a theme - growing plants, crafts, etc. Worth looking at by any science teacher.

T Learning by Burning

I Introduction

In Learning by Burning high school students investigate the combustion characteristics of commonly discarded materials. Results obtained here are then related to large scale problems concerned with municipal incinerators. Conducted using the resources of a standard high school laboratory, the activity takes place in one class period - although follow-up may extend several days.

II Questions

1. To lead into the activity ask:
 - a. Why is incineration such a popular method of refuse disposal?
 - b. What problems are there in conjunction with incineration?
2. To initiate the activity ask:
 - a. Do all materials burn the same way?
 - b. What happens when common refuse materials are burned?
3. To continue the activity ask:
 - a. Is smoke produced?
 - b. What color is it?
 - c. Are particles detached and carried away in the smoke?

- d. Does the material melt or burn?
 - e. Will the material remain ignited when removed from the flame?
 - f. How completely will it burn?
 - g. What is the consistency of all the remaining ash residue?
 - h. Are undesirable fumes or odors produced?
4. To expand the activity ask:
- a. What is pyrolysis?
 - b. Is there a difference between incineration and burning?
 - c. What is the temperature of the flame produced by the bunsen burner?
 - d. What is the temperature at which municipal waste is incinerated?
 - e. How does the ash from burned materials compare with that from an incinerator?
 - f. Can an incinerator be accurately simulated within the confines of a classroom?
5. To evaluate the activity ask:
- a. How carefully did the students conduct the investigation?
 - b. How was the quality of the data?
 - c. How much did the activity interest them?

III Equipment

1. Goggles.
2. Bunsen burners.
3. Long (at least 10") handled tongs.
4. Asbestos pads.
5. Five to ten materials per team to burn - e.g., different plastics, paper, metal, synthetic materials, rags, packaging, organic wastes, etc. Students may provide these.
6. Fume hood.
7. White paper or other surface for comparison of residue.
8. Fire extinguisher or fire blanket.
9. Burn medication.

Note: Items eight and nine are not suggestive that the activity causes devastation of the lab. However, the activity should not be conducted unless these supplies are available should the need for them arise.

10. Samples of incinerator residue from outside source.
11. Scales or balances.

IV Procedure

1. Students should elect whether or not to combust materials based on size or weight. A data sheet may be prepared.
2. In a very well ventilated room, students should place the sample in the tongs, and place them in the fire of a

bunsen burner. The time and procedure will be standardized (as students collect data) based on discussion and observations which arise as different materials are burned.

Note: Any materials, including all plastics, must be burned under a fume hood. If the suction interferes with the flame, waft the fumes into the hood. Students should never breathe vapors - waft them, but only under careful supervision by the teacher.

V Past Studies

1. One student made the mistake of inhaling some of the vapors from burning Saran Wrap. Adequate ventilation cannot be overly emphasized!
2. At a constant temperature, the differences in burning properties of common laboratory throw-outs - metal foil, plastic cover slips, powder pillows, frayed rope - fascinated the author. These properties are not considered by students and the differences are really interesting!

VI Limitations

1. The teacher's discretion will determine whether or not such an activity can be carried out by the group - here group personality and maturity become factors.
2. Excellent ventilation is a major requirement. Weather

may be a factor here - e.g., the activity would not be conducted on a hot, muggy day, or when blowing snows and open windows would pose a problem.

3. In some instances the teacher may decide to declare a particular material undesirable for burning.

VII Bibliography

Moore, H. Carlton, P. E., Honolulu's Second-Generation Incinerators, Solid Waste Plans Consider Pollution Factors and the Changes Occurring in Refuse Content, American City Magazine, May 1972. Describes the new Honolulu incinerator - the practical considerations in its design, and its operation. Grades eleven upward.

Proceeding of 1970 National Incinerator Conference, Papers Presented at 1970 National Incinerator Conference in Cincinnati, May 17-20, 1970, The American Society of Mechanical Engineers, New York, New York 10017, May 1970. Thirty-one papers cover almost any aspect of incineration. Although parts would be too technical for the average high school student, many excellent diagrams and flow charts appear.

Ostrowski, E. T., Recycling of Tin-Free Steel Cans, Tin Cans, And Scrap from Municipal Incinerator Residue, Iron and Steel Engineer, July 1971. Although the charts and

diagrams make the article look more difficult than it really is, it is comprehensible by high school students.

Weaver, Elbert C., Scientific Experiments in Environmental Pollution, Holt, Rinehart, and Winston, Inc., 1968.

Eighteen activities - all science laboratory oriented - for high school students in air, water, and solid waste pollution. The last activity deals with some problems of incineration.

Stop-Odor Incinerator Has Built-In Safeguards, Chemical Engineering, October 1971.

Take the Pressure Off the Incinerator, Stationary Packers and Transfer Trailers Absorb Peak loads of Refuse, American City Magazine, May, 1972. Case history of Dearborn Heights success. Describes daily maintenance considerations in incinerator operation. Grade seven upward.

U Packaging Patterns

I Introduction

This activity is a comparative evaluation of packaging. The students get a feeling of how present packaging trends have evolved. The activity can also be approached from the present tense - how foods and their packaging compare today throughout the world. Questions will then be modified to accommodate the time and place. Although this activity is research rather than field oriented, it will provide background knowledge for further investigations. This activity is most practical for grade five upward. Older students might present an abstraction to a younger group to give them a perspective of the situation.

II Questions

1. To lead into the activity ask:
 - a. What foods do you consume in a week?
 - b. How long have these foods been available?
 - c. How many have appeared only recently because of technological advancements?
 - d. How widely available have these foods been throughout the world?
2. To initiate the activity ask:

- a. Suppose you were living _____ in the year _____.
Of what would your food menu for one week consist?
 - b. Where would you obtain these foods?
 - c. How would they be packaged?
 - d. How would packaging affect how sanitary these foods are?
 - e. How would they be stored?
3. To continue the activity ask:
- a. How did transportation play a role in determining packaging?
 - b. What types of regulations were there regarding food packaging?
 - c. When were they introduced?
4. To expand the activity ask:
- a. What types of developments led to these laws (technical, scientific, attitudinal, etc.)?
 - b. How did the industry occupy a role at this time in terms of influencing/controlling packaging?
 - c. What can we do with what we have learned?
 - d. What connotations did the word, waste, carry?
5. To evaluate the activity ask:
- a. What was the quality of the research conducted?
 - b. How well were the findings presented?

- c. Did the students demonstrate that the activity benefitted them in some way?

III Equipment

Students may require equipment for presenting their projects.

Other than that no specific equipment is needed.

IV Procedure

1. Having gone through the questions, help students select a specific time and place to research. Also, use discretion to determine whether the activity is best conducted individually or in groups.
2. Sources may range from interviews to books, magazines and newspapers of the times, if available.
3. Research may be presented in ways ranging from a simple oral presentation, to preparation of a sample meal, including packaging, to some type of skit. Encourage creativity!

V Past Studies

1. Students in a project such as this may take a genuine interest in knowing the way that people do things differently from the way they do. Others may take a "so what" attitude.
2. Looking through books on current packaging trends - international as well as our evolution - really "turns some people on". Several references of this type are in the Bibliography.

3. Occasionally, one runs into students who do not have an appreciation of history, whether they are excited about the present or not. In an activity such as this, they are apt to see history's relevance to a real, present problem.

VI Limitations

1. Accessibility of adequate research materials may be prohibitive. Check local universities! Assisting in this activity may be history teachers. Involve as many people as possible to make it truly interdisciplinary.
2. Time may be a limitation. Perhaps the activity will not be good to conduct during class periods, except the introduction and the presentation.

VII Bibliography

Cronwel, William and Weidemann, Kurt, Packaging, An International Survey, Frederick A. Praeger, New York, New York, 10003, 1968. Quadrilingually presented (English, German, French and Spanish), the entire book consists of glossy black and white pictures of packaging around the world - and packaging is a very broad term. There is much shown, however, about foodstuff packaging. Any student can look through the pictures. The introduction is only two pages long.

Guss, Leonard M., Packaging Is Marketing, American Management Association, 1967. Contains excellent bibliography of

books, articles, and reports: American Management Association Publication, Public documents, unpublished material and miscellaneous. It starts out, "We live in a world of packaging", and covers I the Nature and Scope of Packaging, II Packaging and the Function of Protection, III Packaging and the Functions of Physical Supply, IV Packaging and the Functions of Exchange, V Packaging and the Law, VI The Social Values of Packaging, VII The Determinants of Packaging, VIII Packaging, and the Ultimate Consumer, and IX Company Organization for Packaging.

Grades seven and up - excellent reference.

Little, Arthur D., The Role of Packaging in the U. S.

Economy, Report to the American Foundation of Management, Research, Inc., American Management Association, 1966. Considers packaging from the business point of view. Especially good are flow charts of metal, glass and plastic packaging materials. Not too technical for grades seven and up - very readable.

V Magic Holes

I Introduction

This transitional activity begins with increasing the students' awareness of waste disposal routes and capitalizes on their interest to allow exploration into the treatment of waste products. The activity may be carried out by students from grade four upward. A 40-60 minute discussion period should be allowed before the students group for the projects, which grow out of the discussion. The project time is variable depending on the degree of community involvement.

II Questions

1. To lead to the activity ask:
 - a. Where do things go when you are finished with them?
 - b. Who provides the services for this?
 - c. What are some magic holes which you use?
 - d. What magic holes did our forefathers have?
2. To initiate the activity ask:
 - a. What magic holes are there in your classroom?
 - b. Is the wastebasket a magic hole?
 - c. What are some of the magic holes in the school?
In your home?

3. To continue the activity ask:
 - a. How can we show the flow of wastes as they move from the magic holes to their ultimate end?
 - b. What happens to the waste as it moves along?
 - c. How does it move along?
 - d. Where can it get lost?
4. To expand the activity ask:
 - a. How would you diagram the flow of wastes?
 - b. Is your community tied together by waste disposal services? Is it anything like a road map?
 - c. How could you tag solid waste for periodic recovery if you were to examine its flow through the system?
 - d. How can we measure how much and how many waste products are processed?
5. To evaluate the activity ask:
 - a. Did the students think of new ways to process waste products?
 - b. What level of involvement was noted?
 - c. Did they want to go to processing centers?
 - d. Did they work with their parents?

III Equipment

1. Construction materials:
 - a. Boxes
 - b. Straws

- c. Cans
- d. Paste
- e. Tape
- f. Paper
- g. Paint
- h. Thumb tacks

2. Community map

IV Procedures

1. In class, pursue the sequence of questions and get the students to focus on how to tell others what they have learned.
2. Let students group to carry out projects which illustrate their findings. Some suggested projects include: making a model of a sewage treatment plant and diagramming waste flow; mapping trash removal or sewage routes; comparing of waste management systems.
3. Let the students tell others of their findings. Encourage peer education in and out of the classroom.

V Past Studies

1. Excitement runs high as more and more discoveries are made. In Norristown, Pennsylvania, elementary school students were investigating how the classroom sink worked. A few students noticed a water tower on

a nearby hill and there was a rush to the windows. Through discussion the students related the tower to the workings of the sink and soon understood the gravity feed water supply and the sewage system. They also explored the storm drainage system. One idea that emerged was a message system to find out "how far" the storm run off went.

2. A middle school student, attending a Tilton School summer workshop in Tilton, New Hampshire, constructed a non-working model of a secondary treatment plant. His explanation of how it worked was a fine demonstration of the knowledge he acquired in constructing the model.

VI Limitations

Occasionally it is difficult to obtain information from local government service employees. If you explain fully what you are doing with a positive orientation, in all probability the workers will be helpful. One of the outgrowths of this activity will be a desire to go to see what is going on. Arrangements may be difficult to make.

VII Bibliography

Clean Water for Mid-America, Public Information Office, Great Lakes Region, FWPCA, Department of Interior, Chicago, Illinois 60605, April 1970. An introductory pamphlet on water quality. Deals with the middle

states region. Concerns itself with the roles of the states, cities and industries. Good for upper elementary through senior high school.

Municipal Refuse Disposal, United States Public Administration Service, Chicago, Illinois, 1970. A very complete, excellent text, considering any facets of the solid waste disposal problem which students need to know. Although somewhat technical, high school students could make good use of it.

Ruckelshaus, William D., and Dominick, David D., A Primer on Waste Water Treatment, Environmental Protection Agency, Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, March 1971. An excellent introduction to sewage treatment. Deals with types of treatment, types of pollutants and future of waste water treatment. A good background source for students grade 7 and up.

Small, William E., Third Pollution, The National Problem of Solid Waste Disposal, Praeger, New York, N.Y., 1971. A general reference for most students from grade 5 upward.

W Managing Plastic Wastes

I Introduction

This transitional activity deals with the decomposition rates of plastics and introduces the recycling potential of plastics. Once students realize the difficulty involved in degrading plastics naturally, they are encouraged to examine chemical degradability, incineration and the recycling of plastics as potential means of management. The activity may be completed by students of any age and requires no special equipment.

II Questions

1. To lead into the activity ask:
 - a. How many foods are packaged in plastic containers?
 - b. How else is plastic used in packaging?
 - c. What happens to the plastics you discard?
2. To initiate the activity ask:
 - a. Is the burning of plastic ecologically sound?
 - b. What happens to plastic when you bury it?
3. To continue the activity ask:
 - a. What necessary factors need be present for natural degradation of substances such as leaves or food products?
 - b. How can we increase the rate of decomposition of plastics?

- c. What is the basic problem in the slow degradability of plastics?
4. To expand the activity ask:
 - a. What research is being conducted to reduce the problem of plastic wastes?
 - b. How can you recycle plastics in your own home?
 - c. How can plastics be recycled on a national level?
5. To evaluate the activity ask:
 - a. Were the students able to relate the problem of plastics to their own environment?
 - b. Did they engage in meaningful discussions?

III Equipment

The equipment used is variable. The main intent is to bury various types of plastic material and observe periodically for degradability.

IV Procedure

1. Select a wide range of plastic materials.
2. Bury the materials in designated plots so that they can be identified and unearthed for examination.
3. Some classes have used large glass bottles such as pickle bottles and buried their plastics indoors.
 - a. If the indoor approach is used, the soil in the containers must be kept moist to approximate that

which would be outside.

- b. Some classes have used plastic containers for the activity. The logical flaw here is often not apparent at first.
4. The plastics should be examined each week for as long as the activity continues.
5. Note any changes in the materials buried.

V Past Studies

The degradability of plastics was examined in a class conducted at Temple University for a graduate course in environmental science. The plastics were weighed before and after they had been buried.

VI Limitations

The main limitation is losing the items buried because of inadequate marking of outdoor sites.

VII Bibliography

- Don't Incinerate Plastic Bottles; Make Concrete Bridges With Them, American City Magazine, May 1972.
- Connolly, Hugh H., Plastic Wastes in the Coming Decade, EPA Solid Waste Management Office, 1970. A statement by the Solid Waste Management Office determining the need to examine packaging practices and recycling possibilities for plastic.

Plastics in Refuse No Incinerator Hazard, American City Magazine, January 1972. Tells that the study of the effect of plastics, especially polyethylene, in incinerators, points out that plastics are not detrimental to incinerator operation. It suggests that copies of the report can be obtained from its sponsors: The Society of the Plastics Industry, 250 Park Avenue, New York, N.Y. 10017.

X The Ultimate in Waste Disposal

I Introduction

This activity is a tool which can be used to evaluate the students' work on solid waste. By using it at the end of the unit, they will incorporate knowledge and skills they have acquired and apply them to their problem. This involves the use of the questioning approach by the students. In designing the ultimate, they must present a series of questions to which they need answers to solve the problem. In this way, teachers can evaluate the questioning approach's affect on the students' way of thinking. Hopefully, in pursuit of the solution to the problem, the students will have an opportunity to interact with their community.

II Questions

1. To lead into, initiate, continue, and expand the activity state:
 - a. You are a consulting engineer called upon by our city (town, etc., or whatever) to design the ultimate in waste disposal to the year 2020. You must consider the present problems in pursuing the solution.
2. To evaluate the activity ask:
 - a. How much knowledge and understanding of solid waste problems did the students demonstrate?

- b. How did their questions work?
- c. What was the quality of the recommendations?
- d. Did the activity reveal a lot about the affect of
of the block on the students?

III Equipment

1. Unless students will attempt to design a scientific
ultimate, no equipment is needed.

IV Procedure

1. Present the problem to the students.
2. Let them know that in seeking the solution they must plot
out a series of questions which will be their investigation
guide.
3. They may split into factions (e.g. industrial, commer-
cial, domestic); or each group may concentrate on the
design of the ultimate and then compare results.
4. This is an excellent place for simulation exercises.
5. Whether or not anything written is required is decided
by the teacher.

V Present Studies

1. The questioning approach is a logical means of dealing
with the investigation of a problem. A high school senior
in Buffalo is presently conducting a feasibility study for
paper recycling in her town. The outline prepared with the

questioning approach was formulated easier than with mere notations, because questioning leads to other questions (consequently a more thorough view).

VI Bibliography

Goldstein, Jerome, Garbage As You Like It, A Plan to Stop Pollution, Rodale Books, Inc., Emmaus, Pennsylvania, 1969. A wonderful approach to the uses of garbage. It contains 21 chapters of ideas, facts, formulas and possibilities. An appendix, "Technical and Mechanical Aspects of Composting," is simply presented. Suitable for grade seven upward.

CHAPTER 3

The operational activities section is essentially an outgrowth of the first two levels. The students function individually or in groups to perform certain environmental actions, or investigate, in depth, specific environmental concerns. They gain direct experience in carrying through investigations in which they are responsible for decision-making regarding (1) the recognition and definition of the problem, (2) analysis of the problem, (3) data processing, and (5) data evaluation, as well as the utilization of the data. The teachers' roles are primarily those of resource persons and guides to learning.

Four approaches are presented as initiators for action. The teacher is encouraged to examine each approach and select one or more which he feels is appropriate for his class. Each approach deals with problem solving in a somewhat different manner. These are merely guidelines with some suggestions to start the students. The interests and abilities of your students may necessitate a variety of changes. Feel free to make any additions or modifications necessary to meet these needs.

Each approach requires a certain investigative level in which students are required to examine their findings and determine what potential impact these findings might have on community action. If recommendations for action are called for, the

student(s) must consider the action and the alternatives to this action as they relate to a variety of political, economic, legal, social and technological factors.

Through these activities the students realize that they have a definite role as community members. They become aware of the complexity of both natural and man-made systems, and they have a responsibility that extends beyond their own interests and needs. Outgrowths of these activities include a greater concern for social responsibility, a consideration of environmental ethics and a greater awareness of potential career opportunities.

A Realistic Environmental Problem Simulation (REPS)

REPS allows a group of students to realistically simulate a probable sequence of events related to an environmental problem a year or more into the future. The simulation is based on a real problem in the students' environment, and the students play the roles of all the important people involved in the problem. During the simulation time passes relatively quickly, thus allowing the students to speed up the normally slow ecological, economic, political, and social processes.

Before moving to the details of REPS, the differences between REPS and other simulations and games will be discussed. There is a continuum of types of games and simulations; some games closely resemble simulations and vice versa, whereas others are very different. The following paragraphs highlight some of the differences and similarities.

Both games and simulations have rules. Rules provide for timing, actions, the evaluation of actions, a record of actions, and final results. The devices necessary to carry out the rules are often very different; however, essentially they are there. A second similarity exists in that control personnel are required to manage effective games or role simulations. These similarities are the major ones of such enterprises.

The differences deal with more detailed aspects of games or role simulations. Most simulations are hypothetical in nature, while REPS is real. The dealings which are carried out among players vary also. Usually the dealings are carried out indirectly, that is to say, the record of player actions is usually something such as a board or wall chart or a physical entity of some sort. The players, therefore, deal with the physical entity and through it, each other. In REPS, all action is taken through communications, which provide for a direct dealing with other players. The record of dealings is maintained as a subsidiary concern. Therefore, the status of a role simulation may be in doubt at a given time because a physical entity such as a board or chart may not be observed readily to determine the relative positions of all players or teams. This in itself is closer to reality than a chart or board. The timing in games and REPS also is in contrast. In games, the amount of time required for moves or between moves is not usually considered to be of great importance. In contrast, in REPS, the timing relative to real life is in a particular ratio; for example, one month in real time may be simulated as ten minutes or fifteen minutes during REPS. Another area of contrast is in the preparation to participate in the game or REPS. In playing games, the background, hypothetical in nature, is easily assimu-

lated. A brief description and the rules of the game determine how a player plays. In contrast, a great deal of research is required to play a role in REPS.

PEPS has many educational merits. These merits are not exclusive to REPS, but they certainly do provide an exciting combination. The merits are expressed from the students' points of view. One of the things that impresses and motivates the students most readily is the fact that they are participating in a study of something that is real. A corollary to this is that they have helped determine what it is that they are going to study, and the study is inter-disciplinary in nature. In fact, the various subject headings that a student is pursuing at a given time cannot be defined because the combinations found in real problems are very complex. Another merit of the program is that the teacher can learn along with the students. Very often teachers are handicapped by the notion that they must know everything that the students are to learn. Experiences related to REPS indicate that perhaps this notion is neither desirable nor necessary. One of the greatest examples that can be provided for students is the teacher in the process of learning. The students are allowed to work under a variety of conditions and circumstances while pursuing the various aspects of a REPS. They, of course, do a lot of their research as individuals. However, when they

are participating in the simulation they work as teams, and as their ability and confidence increases with their teams, they learn how to listen to other people while motivated by a desire to contribute. In this process of interaction, the students also learn to compromise. They spend a great deal of time doing this to establish a position for their team. Since the simulation is carried out by sending and receiving messages, communication is emphasized. At first, messages are sent at a very brisk pace, the communicators concentrating on what they want others to know and do. Usually, they pay very little attention to those messages which they are receiving. In 30 minutes of unlimited message sending and receiving, students quickly realize that others do not understand what they (the students) wish to have them understand. At this point, the students develop a very serious and purposeful attitude toward helping others to understand. During the research phase, the students become aware of the many skills required to solve problems. As the simulation progresses, they understand the importance of having the skills. Perhaps one of the most important outgrowths of REPS is that the students are allowed to determine that they have to acquire skills to solve problems. Once a student has determined that he has a need to develop skills to deal with the realities of life, his capacity for growth is greatly enhanced. He is very willing

to amplify his own powers by pursuing broad and diverse cultural objectives.

An interesting by-product of the simulation which was not originally envisioned is the understanding of cognitive and affective domains and their relationships. A great deal of emphasis in education today persists in the cognitive area while the affective areas are somewhat shortchanged. Once the student has a significant exposure to REPS, he perceives the importance of considering objectives in the affective domain, that is, he sees the significance of many aspects of his life style as it is developing and as it is being modified.

The REPS is divided into sequential sections. Each section involves a process and product. The first section describes the selection of the REPS, and how the background is developed for that REPS. The second section contains the rules for the simulation and descriptive material on the control and participation roles. A broad variety of circumstances may be dealt with effectively. REPS have been completed in as little time as one day; on the other hand they may take as long as a month and a half.

I Selection

The REPS depends on the selection of a proper subject. Many factors enter into the selection process, but the most im-

portant single factor is the interest of the participants. Therefore, the subject or problem to be considered for the REPS must be something that interests the participants. At this point, we have not had any REPS that have failed because of a poor subject or problem selection. The problem usually enlarges itself to fit the number and the maturity of the participants. Selection of a problem which could be simulated by less than 15 students would be difficult if the problem is to be covered satisfactorily. To choose a problem that is too small would be difficult. Because the selection process requires compromise on the part of all individuals involved, you should consider the selection over a period of time. To introduce the subject with a few moments notice would be unwise if the participants did not have a basic awareness of their environment. That is to say, you can't spring a problem on a relatively unsophisticated audience.

From the following two examples, the reader should be able to get a feeling for the selection. A land use problem which was to be studied for approximately two weeks on a full-time basis by 20 people was selected over a period of about three days. Only four or five people participated in the selection

process; however, those doing the selection had broad experience. Students and teachers were both represented. The most rapid selection process experience thus far took approximately 20 minutes. Ten teachers in a one day in-service program selected an environmental problem for study. It was a focal point in the local press. The selection of this particular problem was a natural for the group. These examples represent two approaches to the selection process. One that might occur more frequently would be to briefly (in a matter of minutes) introduce the idea that people can play roles to simulate an actual problem, and then ask the students to spend some time discussing with their parents a problem that might be important to the community in the area in which they reside. The following day, a class period could be devoted to discussing the types of problems which were brought out by the parents and students the previous evening. Those items which the students are most enthusiastic about would be the items to pursue. Often, the items brought up in discussion represent facets of a larger problem. Usually the items discussed are symptoms of the real problem or are phenomena that may be readily observed at very low levels of awareness. If the topics can be narrowed down in

a day's discussion, additional time might be devoted to the problem at the next class meeting after the students have had an opportunity to further discuss the selection with their parents.

There appears to be a risk factor at this point on the part of the teachers. Whenever discussions not based on lesson plans or text books develop in classrooms, the teacher runs the risk of not having very much information on the subject at hand. A teacher might feel this is risky business, however, it represents one of the best opportunities for students to see someone "thinking on his feet" or better still, it represents an opportunity for teachers to learn from students. This occurs more effectively when teachers are listening.

The selection process continues as the symptoms are translated into a set of causes which begin to define an environmental problem. At this point, the discussion should turn to causes of the problems. An effective way to handle this is to simply list those people or functions which are causing the problem. If a person or organization is allowing a problem to develop or to continue to exist, then the group should look to see who allows that person to continue doing the wrong thing.

As the discussion continues, more and more names of people, jobs that people perform, and organizations that control the things that people can and cannot do will appear.

When more names or descriptions are not forthcoming, let the discussion turn to classifying those items which appear on the list. Usually four or five major classifications emerge. These major classifications represent the teams that will participate in the REPS.

II Scenario

The scenario is a background statement which acts as a source document for the research phase of the REPS. The scenario is divided into parts which correspond to the four or five teams identified in the problem selection process. The scenario is completed as a two step process: (1) the gathering of all pertinent data and (2) compiling and publishing.

The data are gathered by temporarily assigning the participants to study groups. For a class of 35, five teams of 5 to 8 students could be formed. Let the participants work in study groups for several hours or class periods to define the scope of the simulation teams. Typical teams representing local government, state government, federal government,

agencies, citizens' organizations, business, industry, etc., will be formed. The group should determine the names and positions of many important people. The relationships of these people to the problem should be blocked out also.

Once the study groups have roughed out the list of names and relationships, participants should rotate to other teams. At this point interviews, phone calls and letters may be written to secure basic information about the important people. More names and agencies will be added to the list. After some progress has been made the relationships should be refined through group discussion. The groups should rotate through all teams so the participants have some experience in each team area. Don't worry about the complications of receiving mail and delayed interviews. The participants can pass the mail along and appointments may be kept by future group members. All that is needed is a log or bulletin board which notes future commitments for action relative to each simulation team.

The scenario may be written when the last study group rotation occurs. Each study group assembles the materials (those which have been written from interviews, letters, pamphlets, and other documents) into a background package.

Thirty students at Germantown Friends carried out the above procedure in 1 1/2 weeks (full-time effort) and assembled a five-section, 320 page document. Three days were needed to print, collate, and bind. Usually the document is under 100 pages and is dittoed by hand. There is little need to number pages consecutively but it is handy to use section oriented paging such as II-3 or C-15.

III Research

The participants choose individual (or agency) roles and group into the simulation teams. Then each researches his role using the scenario as a starting point. The scenario is most helpful for him when he wishes to learn of his relationship to others. The research phase is an in-depth study and requires a detective-like attitude.

IV Simulation

The basic organization is shown in the figure below. Five functions are performed by a control group in association with the simulation teams. The control group consists of an umpire, a recorder, a conference coordinator, a media simulator, and a team of messengers.

All communication during the simulation takes place via written messages. Messages originate from the teams and are carried by messenger to the umpire.

of some sort is needed, the umpire can stop the simulation to effect the necessary repairs.

The recorder keeps a running log of the messages and the order in which the messages are dispersed. When the recorder gets the message from the umpire who has validated it, he will put a number on it indicating the order in which the message was received by him. He will also, for further reference, put the time at which he received the message to the nearest minute. Then he will deliver the message to a messenger who will distribute it to the various teams.

Under certain circumstances, a team may wish to communicate with another team secretly. Under these circumstances, the team originating the message should write "secret" next to the word subject on the message form so that the recorder will know it's a secret message. When the recorder receives the message, he will distribute it immediately through the messengers to the indicated recipient. The recorder will hold the remaining copies of the message for a period of fifteen minutes and then have the messengers distribute the remaining copies to the remaining teams.

The media controller simulates the manner in which the media would cover the particular events transpiring. The principal function would be to combine the effects of several individual messages on a situation and comment on them in an editorial way. If the simulation fails to become dynamic and active, the media can stimulate it by introducing messages that would throw new light on situations which should be developing.

The conference coordinator accepts requests from various teams when they wish to meet with other teams. A conference may be held between two teams. The time limit on a conference is five minutes. The coordinator will send a message indicating when and where it will be held. The time he indicates as the beginning of the conference determines the end of the conference, i.e. five minutes later. The participants must arrive on time (with a spokesman) in order that the conference will move swiftly under the direction of the conference coordinator. The short duration of the conference precludes many topics being discussed; therefore, the conference should be for a particular purpose.

The messengers continually circulate and act as extensions of the umpire in many cases. They carry messages back and forth and try to clarify the game situation for the various teams. The particular emphasis is on the rules and how to interpret the rules.

The rules for REPS are as follows:

1. During the simulation the members of the teams must stay in the rooms designated for the teams. No communication among teams may take place directly except in cases of conferences which are prearranged.
2. During the simulation, the period of time representing one month transpires in ten minutes. That is to say, during every hour of the simulation, one half year has transpired.
3. Conferences may be called by sending a message to the conference coordinator. The conference coordinator will reply to the message with another message indicating the time and the place of the conference. The conference may last no longer than five minutes; therefore, do not try to take on too many things in a five minute period. Conferences are limited to discussions between two teams.

4. If teams have press releases which they wish the media simulator to handle, they should fill out the message form with the material to be covered by the press and direct it to the media simulator.
5. All messages will be sent to all teams at the same time, unless the messages are marked "secret". If the message is marked "secret" in the box marked "subject" by spelling out in capital letters "secret", then the recorder will only send that message to the team designated; however, after a fifteen minute delay, that message will be sent to the remaining participating teams. When teams receive copies of the messages that they have sent, they will know that everyone is in possession of the secret information.

V Recapitulation and Outgrowths

After the simulation is over, a thorough discussion of what happened will take place. This happens informally because the participants cannot prevent it from happening. Almost without exception the students will wish to repeat the simulation from a certain point in the simulation. They will also wish to do more research before a repeat. If possible, plan for and allow this to happen. Other things also happen. Usually students discuss the rationality of the simulation

and they also wish to take actions they feel are necessary to deal with the problem they simulated. The teacher should consider these action-oriented outgrowths as powerful potential learning experiences.

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B Contract Projects for Community Action

A contract approach is suggested for classes in which there is a wide diversity of interest and ability. The contract approach described below is somewhat more flexible than most described in the literature. The activities are listed according to degree of complexity. Competence criteria are set as parameters for successful completion. Each project activity is school or community oriented and emphasizes problem-solving.

Teachers are asked to avoid failing students who do not complete an activity or who show little or no initiative to perform an activity. If possible use an incomplete grade rather than a failing grade. Low ability students will require additional help and direction. The teacher functions as a facilitator and should help guide the students toward completion of their projects. The grading system set up below includes grades A,B,C and F. The grade of D is used for those students who fall short of the expectations set forth in the grading categories. If the student fails to meet his contract but completes some of it, his grade is then a D. The C grade is stated as the minimum because many low achievers will strive to complete the activity. The students should not be told a D grade is available.

A contract approach is often set up as a do or fail approach. This is done to establish initiative for achievement. The activities are broad and allow the students to select the activity that best suits their interests and abilities. The learning process is then almost totally placed in the hands of the student thus mitigating the threat of failure by the teacher. The student can no longer say the teacher failed me. He must admit he failed himself. If the approach seems a bit hardnosed to the student, he might be reminded that contracts in business must be met or the company could be penalized or even go out of business.

For a grade of C you must complete, to the satisfaction of the teacher, one of the activities listed below. Once you have selected the activity you must submit a statement to your teacher which includes the following information: name, date, activity selected, a step-by-step listing of what you are going to do and an estimated date of completion.

1. Make 4-6 posters (2 feet by 3 feet approximately) which illustrate the problems of solid waste. You may look at the problem locally or nationally. The posters should be aimed for elementary school age children. Once you have completed the posters present them to your teacher for approval. Then, present the posters to a teacher or the principal of an

elementary school. Your posters will be used to illustrate the problems of solid waste and solid waste management to students in that school. Ask the teacher involved or the principal to write you a letter stating the reactions of the students to your posters so you can have some feedback.

2. Volunteer your services to one of your local agencies involved in recycling.

What are their needs?

How can other people help?

What is their function?

Where are the foods recycled?

How much are their management costs?

What are their profits?

How do they use these profits?

3. Visit a sewage treatment plant. S-e Transitional Activity I.
4. Make a list of all the industries in your community. What products do they make? Visit one of the industries. Find the answers to the following questions:
 - a. What raw materials do they use in processing?
 - b. Where do these materials come from?
 - c. At what level of efficiency do they operate?
 - d. What factors go into the final cost of the product?
 - e. What is their profit margin on single items?

- f. What are their waste products?
- g. Are these waste products discarded?
- h. Are there any attempts to re-use the waste in some form?

For a grade of B you must complete one of the activities listed below. In order to meet the contract you must complete the activity to the satisfaction of the teacher. Once you have selected the activity you must submit a statement to your teacher which includes the following information: name, date, activity selected, a step-by-step listing of what you are going to do and an estimated date of completion.

1. Examine the biodegradability of a variety of substances in a landfill operation. For help see activities J. Landfills Basic, and L. Landfills Advanced. Be sure to keep a record of each step you take in this activity. Use the following guide as the basis for your report.
 - a. What are you trying to do?
 - b. How did you set up your experiment? List each step.
 - c. What observations did you make?
 - d. What do these observations indicate?
 - e. Answer the questions in the activities, J. & L.
2. How can you get trash barrels put on the main streets in town? Find out who is responsible for the trash cans. How

do you see to get additional cans put out? Find a way (legally) to add one more trash can to your community. In order to do this you must be able to present a case for having it in the location you select. Present a report of your work and findings to your teacher when the task is completed.

3. Is the air in your community polluted with particles? Complete Activity H.
4. Examine your school library. Find out what materials the school has on the environment. Write to at least five industries or agencies for free materials. Find out from the Librarian how books are ordered. Who is responsible for ordering the books desired in the library? Does the Librarian have access to government publications? Can the school get government publications free? How can you receive a list of these publications that come out of the government printing office? Write to the Environmental Protection Agency for free materials. Use this as one of your five letters. Another suggestion is to write to Anheuser-Busch, Inc., 721 Pestalozzi Street, St. Louis, Missouri 63118, and ask them for their book, A Pledge and A Promise.

For a grade of A you must complete one of the following activities to the satisfaction of your teacher. Remember, in order to meet the contract the activity must be completed. If you wish to modify the activity you may do so with the approval of your teacher.

REV:A:1

In any case you are required to submit a statement to your teacher with the following information: name, date, activity selected, a step-by-step listing of what you are going to do and an estimated date of completion.

1. Investigate the waste disposal system of your school. Find out how the school disposes of its wastes. How much waste in pounds is discarded each week? What is the cost/year of the disposal method in use? What are the relative advantages or disadvantages of switching to a shredder-compactor? Can this waste be recycled and save the school money? Would the manufacturer of such a system buy the waste from the school? Ecologically how does the system now in use compare with a shredder-compactor?
2. Examine your school library and your community library. Find out what materials are available on the environment in each. Make a bibliography of available materials. Find out how more environmental materials can be added to each library. To what extent, if any, is there a duplication of effort and materials in each library? Write to 10 agencies or industries requesting free materials. Make a copy of each letter sent and give to your teacher. Some suggested sources of materials include: Anheuser-Busch, Inc.; Scott Paper Company; Environmental Protection Agency; HEW's Office of Environmental

Education: Sun Oil Company; the American Chemical Society.
For additional information, see the listing of addresses in the Appendix, pages A-30, A-31.

3. Make a litter survey of your community. Find out how much litter is discarded on a major street in town. Calculate the weight discarded. Categorize the amounts of various items discarded. Use the following categories: paper, glass, cans, plastics and miscellaneous. Since the activity requires that you pick up the litter in one section of your community, be sure you do a thorough job of it. Come back a week later and note how much waste is discarded; weigh it and again categorize the items. How much waste is discarded on this street per week? Are the items recyclable? Calculate from your findings how much money the trash is worth in terms of recycling. You will need to find out the going rates for paper, glass and cans. Calculate how many miles of roads there are in your community. If the section of road you investigated is representative of the community as a whole, figure out approximately how much money in recyclable trash is discarded/month in your town. Write up your findings using the following guidelines:
 - a. What are you trying to do?
 - b. How did you set out to do it?
 - c. What are your findings? Use graphs, charts and all calculations necessary.

- d. What do your findings mean?
4. Take the activity H. Ecologically Yours. Make a survey to find out how many people in your community do any of the suggestions listed. Ask them what other ecological activities they perform and add them to your list. Tabulate all your findings. How can you make people respond to doing the suggested activities? Make at least 3 suggestions. When you make a survey you must use as a base 100 families. Find out the number of families living in your community so that you can get a picture of the entire community. When you do the survey be sure to talk with people from different parts of town. One way of gathering a random sample is to ask the questions on your list to people shopping at a major store in town or to stand on a street corner. Try to get permission from a store manager to set up a table either in or in front of the store. Be sure you find out if a person actually lives in town before asking him to fill out the questionnaire. You may want to use your questionnaire in more than one part of town. The more information you collect the better your results. Ask your teacher for help in making multiple copies of the questionnaire.

The above listing is a partial one. Some students may have ideas of their own. The teacher should allow those students with special interests to write up their own

contract for approval. If students wish to work in groups, then the suggested activity should be expanded somewhat. When a contract is written for a group of students the role of each student should be designated. A contract is essentially written for each group member. This is done to protect the group from a student who might not meet his part of the contract.

C. Debating

Debates are often used to help students focus on the issues in a problem situation. For this reason they have been extensively used in social studies classes. Until recently, debates have been relatively uncommon in science courses. With the growing emphasis on multidisciplinary education, social-scientific issues such as those of solid waste management are becoming far more common in science courses. As such, debating of these issues is seen as a viable approach toward problem-solving.

In setting up a debate certain guidelines need to be followed. First, the students should decide what they want to debate. If they have difficulty in selecting a topic area, then a list of suggested topics might be provided. Do not assign an affirmative or negative position until the topic has been researched.

In order to achieve total involvement more than one topic should be selected. Each student should be provided several days to research his topic. Make sure the students are familiar with the resources available to them, most notably the Readers Guide to Periodic Literature.

Provide a class period to become familiar with the various

resources.

On the day of the debate write the proposition clearly on the chalk board and indicate clearly which students are supporting the proposition and which are not. Each group should have an opening statement to support its stand. No more than four students should be in a group. Large numbers of students tend to address themselves to one another rather than the whole class.

Students are to follow the following guidelines:

1. Show respect for your opponents.
2. Show respect for your opponents' views.
3. Avoid argumentation without logical defense.
4. Do not interrupt. You must wait your turn.
5. You must take notes on your opponents' statements so you have a basis for defense or logical argument.
6. Cross-examination techniques may be used. You may question your opponents' stand rather than support your own if this is necessary.
7. Ten to fifteen minutes should be allowed for class questions at the end of the debate. Do not entertain any question from the class during the debate.

Debates provide students with an opportunity for self-expression and rational thought in a courteous atmosphere. In researching a topic the student gains competence in an area and thus feels more confident in being able to substantiate his stand. Debating provides for a gaming atmosphere which is more acceptable and interesting to students than a project report or lecture. In a gaming atmosphere more total involvement by class members occurs. When related topics are researched by the entire class overlaps are seen in class discussions after each debate. Each person has a role to play and is reinforced in his position through exposure to the various views presented.

Suggested solid waste issues include:

- Resolved: Every family in this community should be required to recycle its newspapers, bottles and cans.
- Resolved: Disposable bottles should be banned.
- Resolved: Automobile manufacturers should be required to make automobiles that are guaranteed to last a minimum of five years.
- Resolved: Open dumps are a health hazard and thus should be banned.
- Resolved: Styrofoam use should be banned because of its inability to degrade.

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D Modeling

Modeling utilizes several educational methods, including creative dramatics, role playing and gaming. A model of an environment or an environmental situation is established either by the students or the teacher. The environmental situation deals with one or more concepts in which is developed through problem solving techniques. The students are called upon to listen, discuss, consider opinions and judgments, and make decisions related to the problems inherent in the situations as expressed.

Skits provide a modeling approach which is convenient and easy to implement and interesting to most students. Skits allow for the creative development of concepts and provides for behavior directed toward environmental ethics. Students who have difficulty writing generally find they can express themselves better through dialogue. Dialogue tends to illuminate subtleties of thought which are often missed in prose. The skit also provides a non-threatening means of evaluating the students' understanding of the problem situation.

Students who wish to write their own skit should, first, decide which problem they are to deal with. They should examine the problem in terms of the factors that cause it, the attitudes of society towards the problem and possible corrective measures to deal with

the problem. Students should briefly outline the above factors and use these to help structure their skit. An environment or environmental situation is then selected. Action and roles are established and the script is then written. Each group of students should be allowed the opportunity to run through their skit before the class so that class input may be solicited before the final copy is written.

Gaming techniques provide an added dimension to modeling. Games are difficult for most students to develop on their own unless they have a prototype they can use to expand on. One game which is available free to teachers is Man In His Environment. The game was put out by the Coca Cola Bottling Company and is free on request to teachers. The game centers around the fact that all elements of the environment are interrelated and interdependent. The game requires students to examine the advantages and disadvantages of making changes in an environment. Decisions are made to include or exclude these changes by the representative groups. The game is suggested primarily because it examines many of the factors studied earlier by the students and because it has a problem focus.

APPENDICES

Bibliography

During this age of the "information explosion" students as well as teachers must learn to use the resource materials available to them. The following books and pamphlets were found to be particularly useful in developing this guidebook. The list is in no way complete. Teachers are encouraged to write to many of the industries, agencies and associations listed in part L of the Bibliography for additional materials.

<u>Section</u>	<u>Title</u>	<u>Page</u>
A	Core References	A-2
B	General References on Solid Waste Management	A-6
C	Composting	A-10
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F	Landfills	A-12
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H	Scientific Investigations	A-16
I	State Planning	A-19
J	Systems Analysis	A-22
K	Miscellaneous	A-24
L	Directory of Source Materials	A-31

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A Pledge and A Promise, Aneuser-Busch, Inc., St. Louis, Missouri, 1970. Defines solid waste. Describes the problem, discusses the complexity and some possibilities for alleviating the problem. An excellent introductory pamphlet for students from grade 6 upward.

Litter Facts, Public Affairs Department, Glass Container Manufacturers Institute, Inc., New York, New York. Litter Facts is a short, well written pamphlet on solid waste disposal in general. The factual information is well presented and worthwhile tips are provided for those interested in starting recycling efforts.

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Committee on Chemistry and Public Affairs, American Chemical Society, Washington, D.C., 1969. Deals with 4 major concerns: air, water, solid wastes and pesticides. For each there is an introduction to the problem, background information, a discussion of the chemical factors, control factors, the environmental effects and recommendations for change. The book is technical and best suited for secondary or college students.

Citizen Handbook on Recycling (A How-to-do-it Guide for Individuals and Groups), Tuberculosis, Health, Respiratory Disease and Clean Air Organizations, Unpublished, 1970-1971. Excellent guidelines for recycling projects and several past community experiences. Also, there is a list of "Hints on Sound Ecological Living" and an invaluable appendix of recycling agencies in the Philadelphia-Camden and surrounding areas.

Cailliet, Greg, et.al., The Everyman's Guide to Ecological Living. MacMillan, New York, New York, 1971. Probably one of the best references on individual and limited group environmental action activities stressing the acquisition of "ecological" habits. It contains supplementary facts. Selling for \$.95, it is highly recommended. It should present no problem for the average reader and is not technical in presentation.

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American Society for Engineering Education
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ABANDONED MOTOR VEHICLE - A motor vehicle that applicable State laws deem to have been abandoned.

ABANDONED VEHICLES - Passenger automobiles, trucks and trailers that are no longer useful as such which have been abandoned on streets, highways and other public places.

ABRASION - Wearing away of surface material, such as refractories

Glossary

in an incinerator or parts of solid waste handling equipment, by the scouring action of moving solids, liquids, or gases.

ACTIVATED SLUDGE - Process removes organic matter from sewage by saturating it with air and adding biologically active sludge.

ADSORPTION - An advanced way of treating wastes in which activated carbon removes organic matter from waste water.

AERATION TANK - Serves as a chamber for injecting air into water.

AGGREGATE - Crushed rock or gravel screened to sizes for use in road surfaces, concrete, or bituminous mixes.

ALGAE - Plants which grow in sunlit waters. They are a food for fish and small aquatic animals and, like all plants, put oxygen in the water.

ASH - The incombustible material that remains after a fuel or solid waste has been burned.

ASH-FREE BASIS - The method whereby the weight of ash in a fuel sample is subtracted from its total weight and the adjusted weight is used to calculate the percent of certain constituents present. For example, the percent of fixed carbon (F C) on an ash-free basis is computed as follows:

$$\frac{\text{F C (weight)} \times 100}{\text{Fuel Sample (weight)} - \text{Ash (weight)}} = \% \text{ ash-free F C}$$

ASH PIT - A pit or hopper located below a furnace where residue is accumulated and from which it is removed.

Glossary

ASH SLUICE - A trench or channel in which water transports residue from an ash pit to a disposal or collection point.

BACKFILL - The material used to refill a ditch or other excavation, or the process of doing so.

BACTERIA - Small living organisms which often consume the organic constituents of sewage.

BAGASSE - The fibrous residue that remains after juice is extracted from sugar cane or sugar beets.

BALER - A machine used to compress and bind solid waste or other materials.

BEARING CAPACITY - The maximum load that a material can support before failing.

BECCARI PROCESS - A composting process developed by Dr. Giovanni Beccari in 1922. Anaerobic fermentation is followed by a final stage in which decomposition proceeds under partially aerobic conditions; the process was later modified by Verdier and Bordas.

BIODEGRADABLE - The significant breaking down by microorganisms of the physical and/or chemical structure of a compound.

BLADE

Earth - A heavy broad plate that is connected to the front of a tractor and is used to push and spread soil or other material.

Landfill - A U-blade with an extension on top that increases

Glossary

the volume of solid wastes that can be pushed and spread, and protects the operator from any debris thrown out of the solid waste.

U-Blade - A dozer blade with an extension on each side; they protrude forward at an obtuse angle to the blade and enable it to handle a larger volume of solid waste than a regular blade.

BOD - Or biochemical oxygen demand, is the dissolved oxygen required by organisms for the aerobic decomposition of organic matter present in water. It is used as a measure in determining the efficiency of a sewage treatment plant.

BRIQUETTER - A machine that compresses a material, such as metal turnings or coal dust, into small pellets.

BUCKET - An open container affixed to the movable arms of a wheeled or tracked vehicle to spread solid waste and cover material, and to excavate soil.

BULKY WASTE - Large items of refuse such as appliances, furniture, large auto parts, trees and branches, stumps, and similar large items not easily crushed or reduced in volume using light landfilling equipment.

BULL CLAM - A tracked vehicle that has a hinged, curved bowl on the top of the front of the blade.

BURNER

Conical - A hollow, cone-shaped combustion chamber that has

Glossary

an exhaust vent at its point and a door at its base through which waste materials are charged; air is delivered to the burning solid waste inside the cone. Also called a teepee burner.

Primary - A burner that dries out and ignites materials in the primary combustion chamber.

Refuse - A device for either central or on-site volume reduction of solid waste by burning; it is of simple construction and all the factors of combustion cannot be controlled.

Residential - A device used to burn the solid wastes generated in an individual dwelling.

Secondary - A burner installed in the secondary combustion chamber of an incinerator to maintain a minimum temperature and to complete the combustion of incompletely burned gases. Sometimes referred to as an afterburner.

BURNING RATE - The quantity of solid waste incinerated or the amount of heat released during incineration. The rate is usually expressed in pounds of solid waste per square foot of burning area per hour or in BTU'S per square foot of burning area per hour.

CAPACITY (INCINERATOR)

Design - The number of tons of solid waste that a designer anticipates his incinerator will be able to process in a 24-hour period if specified criteria are met.

Glossary

Firm - The processing capacity of an incinerator when its largest independent unit is not operating.

Rated - The number of tons of solid waste that can be processed at an incinerator per 24-hour period when specified criteria prevail.

CARBONACEOUS MATTER - Pure carbon or carbon compounds present in the fuel or residue of a combustion process.

CARBON DIOXIDE (CO₂) - A colorless, odorless, non-poisonous gas that forms carbonic acid when dissolved in water; it is produced during the thermal degradation and microbial decomposition of solid wastes.

CARRY-CLOTH - A large piece of canvas or burlap used to transfer solid waste from a residential solid waste storage area to a collection vehicle.

CELL - Compacted solid wastes that are enclosed by natural soil or cover material in a sanitary landfill.

CENTRAL GARBAGE GRINDER - A conveniently located facility that mechanically pulverizes food wastes collected from many sources in a community.

CHARGE - The quantity of solid waste introduced into a furnace at one time.

CHARGING CHUTE - An overhead passage through which waste materials drop into an incinerator.

Appendix B

Glossary

CHARGING CUTOFF GATE - A modified charging gate used in continuous-feed furnaces that do not have high temperatures near the charging hopper. A sliding steel plate at the bottom of the charging hopper closed on a machined seat at the top of the charging chute.

CHARGING GATE - A horizontal, movable cover that closes the opening on a top-charging furnace.

CHARGING HOPPER - An enlarged opening at the top of a charging chute.

CHLORINATOR - A device for adding chlorine gas to sewage to kill infectious germs.

CLINKERS - Hard, sintered, or fused pieces of residue formed in a fire by the agglomeration of ash, metals, glass, and ceramics.

COAGULATION - The act of removing solid waste from the central storage point of a primary source.

Alley - The picking up of solid waste from containers placed adjacent to an alley.

Carryout - Crew collection of solid waste from an on-premises storage area using a carrying container, carry-cloth, or a mechanical method.

Glossary

Contract - The collection of solid waste carried out in accordance with a written agreement in which the rights and duties of the contractual parties are set forth.

Curb - Collection of solid waste from containers placed adjacent to a thoroughfare.

Franchise - Collection made by a private firm that is given exclusive right to collect for a fee paid by customers in a specific territory or from specific types of customers.

Municipal - The collection of solid waste by individuals or companies from residential, commercial, or industrial premises: the arrangements for the service are made directly between the owner or occupier of the premises and the collector.

Setout/Setback - The removal of full and the return of empty containers between the on-premises storage point and the curb by a collection crew.

COLLECTOR (INCINERATOR)

Bag-Type - A filter in which the filtering medium is a fabric cylindrical bag.

Cyclone - A collector in which an inlet gas stream is made to move vortically; its centrifugal forces tend to drive suspended particles to the wall of the cyclone.

Glossary

Dust - Any device used to remove dust from exhaust gas.

Fly Ash - Equipment used to remove fly ash from
combustion gases.

Mechanical - A device in which inertial and gravitational
forces separate dry dust from gas.

Multicyclone - A dust collector consisting of a number
of cyclone collectors that operate in parallel; the
volume and velocity of combustion gas can be
regulated by dampers to maintain efficiency over a
given load range.

COMBINED SEWER - Carries both sewage and storm water run-off.

COMMERCIAL WASTE - All solid waste originated in commercial
establishments.

COMMINUTOR - A device for the catching and shredding of heavy
solid matter in the primary stage of waste treatment.

COMPACTOR

Mobile - A vehicle with an enclosed body containing
mechanical devices that convey solid waste into the
main compartment of the body and compress it.

Sanitary Landfill - A vehicle equipped with a blade and
with rubber tires sheathed in steel or hollow steel
cores; both types of wheels are equipped with load
concentrations to provide compaction and a crushing
effect.

Glossary

Stationary - A machine that reduces the volume of solid waste by forcing it into a container.

COMPOST - Relatively stable decomposed organic material.

COMPOSTING - A process for biological decomposition of organic waste in a nuisance-free manner through controlled environment either aerobic or anaerobic, producing a stable residue which may be used as a soil conditioner. A controlled process of degrading organic matter by microorganisms.

Mechanical - A method in which the compost is continuously and mechanically mixed and aerated.

Ventilated Cell - A composting method in which the compost is mixed and aerated by being dropped through a vertical series of ventilated cells.

Windrow - An open-air method in which compostable material is placed in windrows, piles, or ventilated bins or pits and is occasionally turned or mixed. The process may be anaerobic or aerobic.

CONSTRUCTION AND DEMOLITION WASTES - Waste building materials and rubble resulting from construction, remodeling, repair, and demolition operations on houses, commercial buildings, pavements and other structures.

CONTAINER TRAIN - Small trailers, hitched in series that are pulled by a motor vehicle; they are utilized to collect and transport solid waste.

Glossary

CONVEYOR

Apron - One or more continuous chains that are supported and moved by a system of sprockets and rollers; they carry overlapping or interlocking plates that move bulk materials on their upper surface.

Drag - A conveyor that uses vertical steel plates fastened between two continuous chains to drag material across a smooth surface.

Flight - A drag conveyor that has rollers interspersed in its pull chains to reduce friction.

Inclined Plate - A separating device that operates by feeding material onto an inclined steel plate belt conveyor so that heavy and resilient materials, such as glass, bounce down the conveyor, and light and inelastic materials are carried upward by the motion of the belt.

Residue - A conveyor, usually a drag- or flight-type, used to remove incinerator residue from a quench trough to a discharge point.

Screw - A rotating helical shaft that moves material, such as incinerator siftings, along a trough or tube.

COOLING SPRAYS - Water sprays directed into flue gases to cool them and, in most cases, to remove some fly ash.

CORES - Are the wood, metal, paper or other sorts of cores on which cord, fabrics, wire and other raw materials are

Glossary

supplied to the fabricated rubber products industry.

They are usually returnable and reusable, but if damaged in the rubber plant they are disposed of with the other solid wastes at that location.

COUNTER STOCK - The stiff board-like material made of rubber, textile, and paper fiber and used as protection and stiffening of shoe toes, heels, and uppers. Since it is concealed, much plant scrap is used in its production.

CULLET - Clean, color-sorted, crushed glass that is used in glassmaking to speed up the melting of silica sand.

CURING BAG - A tire-like structure of rubber compound and some fabric which is inserted inside an uncured tire when it is placed in the curing mold to provide pressure and internal heat. The curing bag is expendable after several hundred uses.

CURED STOCK - Any rubber compound, with or without fabric, which has been subjected to heat and is no longer thermoplastic.

CUT - Portion of a land surface or an area from which earth or rock has been or will be excavated. The distance between an original ground surface and an excavated surface.

CUT AND COVER (CUT AND FILL) - An infrequently and incorrectly used term referring to the trench method of sanitary landfilling.

Glossary

CUT-OFF TRENCH - A trench that is filled with material that is impermeable or very permeable to the flow of gas or water. The barrier is used to prevent the movement of gas or water or to intercept them and to direct them to another location. See GAS BARRIER.

DAMAGED STOCK - In-process material which has been made useless for its intended purpose by accidental semi-curing, by color change, by errors in preparation, by water or steam damage, or other processing accidents. Usually such materials can be blended off in small amounts with fresh material, but some cannot be utilized or sold to others for some value and become solid waste.

DAMPER - A manually or automatically controlled valve or plate in a breeching, duct, or stack, that is used to regulate a draft or the rate of flow of air or other gases.

Barometric - A hinged or pivoted plate that automatically regulates the amount of air entering a duct, breeching, flue connection, or stack; it thereby maintains a constant draft in the incinerator.

Butterfly - A plate or blade installed in a duct, breeching, flue connection, or stack that rotates on an axis to regulate the flow of gases.

Guillotine - An adjustable plate, utilized to regulate the flow of gases, installed vertically in a breeching.

Sliding - A plate normally installed perpendicularly to

Glossary

flow of gas in a breeching and arranged to slide across it to regulate the flow.

DANO BIOSTABILIZER SYSTEM - An aerobic, thermophilic composting process in which optimum conditions of moisture, air, and temperature are maintained in a single, slowly revolving cylinder that retains the compostable solid waste for one to five days. The material is later windrowed.

DECOMPOSITION - The reduction of the net energy level and change in chemical composition of organic matter, as by microorganisms.

DEGRADABLE WASTES - Substances which are changed in form and/or reduced in quantity by the biological, chemical, and physical phenomena characteristic of natural waters.

DENSITY

Sanitary Landfill - The ratio of the combined weight of solid waste and the soil cover to the combined volume of the solid waste and the soil cover.

$$(W_{sw} + W_{soil}/V_{sw} + V_{soil})$$

Solid Waste - The number obtained by dividing the weight of solid waste by its volume.

DESTRUCTIVE DISTILLATION - The airless heating of organic matter that results in the evolution of volatile substances and produces a solid char consisting of fixed carbon and ash. See LANTZ PROCESS.

DIFFUSED AIR - A technique by which air under pressure is forced into sewage in an aeration tank. The air is

Glossary

pumped down into the sewage through a pipe and escapes out through holes in the side of the pipe.

DIGESTION - Digestion of sludge takes place in tanks when the materials decompose, resulting in partial gasification, liquefaction, and mineralization of pollutants.

DIRECT-DUMP TRANSFER SYSTEM - The unloading of solid waste directly from a collection vehicle into an open-top transfer trailer or container.

DISPERSION - The dilution or removal of a substance by diffusion, turbulence, etc. Technically, a two-phase system involving two substances, the first of which is uniformly distributed in a finely divided state through the second (the dispersion medium).

DISPOSAL

Ocean - The deposition of waste into an ocean or estuarine body of water.

On-Site - The utilization of methods or processes to eliminate or reduce the volume or weight of solid waste on the property of the generator.

Waste - The orderly process of discarding useless or unwanted material.

DISPOSAL AREA - A site, location, tract of land, area, building, structures, or premises used or intended to be used for partial and/or total refuse disposal.

Glossary

DISSOLVED OXYGEN - Refers to oxygen which is dissolved in water.

Dissolved oxygen is essential for aerobic decomposition of organic matter and for fish and other aquatic life.

DISSOLVED SOLIDS - Organic and inorganic matter which often renders water unpalatable.

DISTILLATION - In waste treatment consists of heating the effluent and then removing the vapor or steam. When the steam is returned to a liquid it is almost pure water. The pollutants remain in the concentrated residue.

DOMESTIC WASTE - All types of refuse which normally originate in the residential household or apartment house.

DULONG'S FORMULA - A formula for calculating the approximate heating value of a solid fuel based on its ultimate analysis.

DUMP - A land site where solid waste is disposed of in a manner that does not protect the environment.

DUMP, OPEN - The consolidation of waste from one or more sources at a central out-of-doors disposal area, which has little or no management and which does not conform to the requirements of a landfill or sanitary landfill.

DUMP, OPEN BURNING - An open dump where burning is permitted in an uncontrolled manner.

DUMP, CONTROLLED OPEN BURNING - An open dump where burning is controlled by some responsible person. Burning is not confined to an incinerator but is practiced in the open on the ground.

Glossary

- DUMPING** - An indiscriminate method of disposing of solid waste.
Meaning the unloading or emptying of a container.
- DUNNAGE** - Wood, cardboard, or paper which is used to secure raw materials or equipment in rail cars or trucks. There is a strong trend to returnable dunnage, but there is still much that must be disposed of at the receiving point as solid waste.
- DUST** - Fine-grain particulate matter that is capable of being suspended in air.
- DUST-LOADING** - The amount of dust in a gas; usually expressed in grains per cubic foot or pounds per thousand pounds of gas.
- ECOLOGY** - The science that deals with the interrelationships of organisms and their living and non-living surroundings.
- ECOSYSTEM** - The interdependence of organisms and their surroundings.
- EFFLUENT** - The substances that flow out of a designated source.
An outflow of water such as from a septic tank or a waste treatment plant. Liquid that comes out of a treatment plant after completion of the treatment process.
- EFFLUENT SEEPAGE** - Diffuse discharge onto the ground of liquids that have percolated through solid waste or another medium; they contain dissolved or suspended materials.
- ELASTOMER** - An elastomer is a substance which is capable of being altered by curing to a condition in which if stretched to a limited degree at room temperature it will return to sub-

Glossary

stantially its original dimensions in a short time when released. All of the so-called rubbers and a few other organic substances are elastomers.

ELECTRODIALYSIS - A process which utilizes direct current and an arrangement of permeable-active membranes to achieve separation of the soluble materials from the water.

ELECTROSTATIC PRECIPITATOR - A device that collects particulates by placing an electrical charge on them and attracting them onto a collecting electrode.

ELUTRIATION - Separation of solid waste into heavy and light fractions by washing.

ENVIRONMENT - The conditions, circumstances, and influences surrounding and affecting the development of an organism or group of organisms.

EROSION

Accelerated - Erosion of soil material at a faster than natural rate. Accelerated erosion occurs when vegetal cover is destroyed or is affected by some activity of man.

Refractory - The wearing away of refractory surfaces by the washing action of moving liquids, such as molten slags or metals, or the action of moving gases.

EXTRUSION - A process by which a thermoplastic material is forced through a forming die to produce continuous lengths of pipe, tubes, and a variety of profiles. Extrusion is applied to uncured rubber, to many plastics, to metals, and many other thermoplastic materials.

Glossary

FABRIC - Fabric for the purposes of this report means any sheet goods made of natural or man-made textile fibers by weaving, knitting, braiding, or non-woven processes. It includes fabrics laid in place of tire cord.

FABRICATOR - For the purposes of this report a fabricator is any installation which receives raw materials or semi-processed goods from others and converts them into complex finished products for consumer or industrial sale.

FACULTATIVE - Able to live and grow with or without free oxygen.

FAIRFIELD-HARDY DIGESTER (COMPOSTING) - A patented product of Fairfield Engineering Company, Marion, Ohio, which decomposes garbage, sewage sludge, industrial, and other organic wastes by a controlled continuous aerobic-thermophilic process.

FARM TIRES - Includes all off-the-road tires which are used in agriculture ranging from those on garden tractors to those on massive specialized ploughing and harvesting rigs. The heavily lugged tires used on standard size farm tractors account for the largest share of the total weight. Farm tires seldom wear out in the usual sense, but are destroyed by irreparable damage from stones or roots or environmental degradation.

FIELD CAPACITY (OF SOLID WASTE) - The amount of water retained in solid waste after it has been saturated and has drained freely. Also known as moisture-holding capacity.

Glossary

FITTINGS - Those ferrous, non-ferrous, or plastic parts which are purchased from others and made an integral part of fabricated rubber products. Examples would be brass hose couplings, inner tube valves, metal or plastic zippers for footwear, shoe eyelets, and buckles for arctics.

FLAPS - A tape used to protect casings and inner tubes from abrasion of damaged metal wheels.

FLAREBACK - A burst of flame from a furnace in a direction opposed to the normal gas flow; it usually occurs when accumulated combustible gases ignite.

FLOC - A clump of solids formed in sewage by biological or chemical action.

FLOCCULATION - The process by which clumps of solids in sewage are made to increase in size by ~~chemical~~, physical, or biological action.

FLUE - Any passage designed to carry combustion gases and entrained particulates.

FLUE GAS - Waste gas from a combustion process.

FLUE GAS SCRUBBER OR WASHER - A type of equipment that removes fly ash and other objectionable materials from flue gas by the use of sprays, wet baffles, or other means that require water as the primary separation mechanism.

FLUIDIZED BED TECHNIQUE - A combustion process in which heat is transferred from finely divided particles, such as sand, to combustible materials in a combustion chamber. The materials

Glossary

are supported and fluidized by a column of moving air.

FLUXING - Dissolving or melting of a substance by chemical action.

FLY ASH - All solids, including ash, charred paper, cinders, dust, soot, or other partially incinerated matter, that are carried in a gas stream.

FOOD PROCESSING WASTE - Waste resulting from operations that alter the form or composition of agriculture products for marketing purposes.

FOOD WASTE - Animal and vegetable waste resulting from the handling, storage, sale, preparation, cooking and serving of foods; commonly called garbage.

FOULING - The impedance to the flow of gas or heat that results when material accumulates in gas passages or on heat absorbing surfaces in an incinerator.

FUEL BED - The layer of solid fuel or solid waste on a furnace grate or hearth.

FUNGI - Simple plants that lack a photosynthetic pigment. The individual cells have a nucleus surrounded by a membrane, and they may be linked together in long filaments called hyphae, which may grow together to form a visible body. Simpler fungi are involved in the stabilization of solid waste and sewage. Small non-chlorophyll-bearing plants which may play a useful role in trickling filter treatment operations.

GARBAGE - Garbage is the solid or semi-solid animal and

Glossary

vegetable waste resulting from the handling, preparation, cooking and serving of foods, including cans, bottles and cartons in which it was received and wrappings in which it may be placed for disposal. Garbage does not include commercial and industrial waste from meat packing plants, food processing plants such as canneries and crop wastes from farms, nor market wastes which originate in wholesale and retail stores or markets engaged in the storage, processing and selling of food products.

GARCHEY SYSTEM - A patented system in which residential waste is temporarily stored in a water-filled flushing device mounted under a sink; it is conveyed through tubes to a central holding tank.

GAS BARRIER - Any device or material used to divert the flow of gases produced in a sanitary landfill or by other land disposal techniques. See CUT-OFF TRENCH.

GENERATION - The act or process of producing solid waste.

GRAVEL - Rock fragments from 2 mm to 64 mm (.08 to 2.5 inches) in diameter; gravel mixed with sand, cobbles, boulders, and containing no more than 15 percent of fines.

GRINDING - The mechanical pulverization of solid waste.

HAMMERMILL - A broad category of high-speed equipment that uses pivoted or fixed hammers or cutters to crush, grind, chip, or shred solid wastes.

Glossary

HARDPAN - A hardened, compacted, or cemented soil layer.

HEARTH

Burning - A solid surface to support the solid fuel or solid waste in a furnace during drying, ignition, or combustion, without air openings in it. The surface upon which material is placed for combustion.

Cold Drying - A surface upon which unheated waste material is placed to dry or burn; hot combustion gases are then passed over the material.

Drying - A solid surface in an incinerator upon which wet waste materials or liquid or waste matter that may turn to liquid before burning are placed to dry or burn with the help of hot combustion gases.

Hot Drying - A surface upon which waste material is placed to dry or burn; hot combustion gases first pass over the wastes and then under the hearth.

HEAVY MEDIA SEPARATION - Separation of solid wastes into heavy and light fractions, in a fluid medium whose density lies between theirs.

HYDROLOGY - Science dealing with the properties, distribution, and flow of water on or in the earth.

IGNITION TEMPERATURE - Lowest temperature of a fuel at which combustion becomes self-sustaining.

IMPACT MILL - A machine that grinds material by throwing it against heavy metal projections rigidly attached to a rapidly rotating shaft.

Glossary

INCINERATION - The controlled process by which solid, liquid, or gaseous combustible wastes are burned and changed into gases and the residue produced contains little or no combustible material. Consists of burning the sludge to remove the water and reduce the remaining residues to a safe, non-burnable ash. The ash can then be disposed of safely on land, in some waters, or in caves or other underground locations. The controlled process of burning solid, semi-solid, liquid or gaseous combustible wastes in an enclosed device, producing an inoffensive gas and a sterile residue containing little or no combustible material. The process is used to reduce the volume or weight of waste material or to change the characteristics of hazardous wastes to a safer form.

INCINERATOR - An engineered apparatus used to burn waste substances and in which all the factors of combustion-- temperature, retention time, turbulence, and combustion air-- can be controlled.

Batch Fed - An incinerator that is periodically charged with solid waste; one charge is allowed to burn down or burn out before another is added.

Cell-type - An incinerator whose grate areas are divided into cells, each of which has its own ash drop, underfire air control, and ash grate.

Glossary

Central - A conveniently located facility that burns solid waste collected from many different sources.

Chute Fed - An incinerator that is charged through a chute that extends two or more floors above it.

Continuous Feed - An incinerator into which solid waste is charged almost continuously to maintain a steady rate of burning.

Controlled-Air - An incinerator with two or more combustion areas in which the amounts and distribution of air are controlled. Partial combustion takes place in the first zone, and gases are burned in a subsequent zone or zones.

Direct Fed - An incinerator that accepts solid waste directly into its combustion chamber.

Flue Fed - An incinerator that is charged through a shaft that functions as a chute for charging waste and has a flue to carry the products of combustion.

Industrial - An incinerator designed to burn a particular industrial waste.

Multiple Chamber - An incinerator consisting of two or more chambers, arranged as in-line or retort types; interconnected by gas passage ports or ducts.

Municipal - A privately or publicly owned incinerator primarily designed and used to burn residential and commercial solid wastes.

Glossary

On-Site - An incinerator that burns solid waste on the property utilized by the generator thereof.

Open-Pit - A burning device that has an open top and a system of closely spaced nozzles that place a stream of high-velocity air over the burning zone.

Retort-type - A multiple-chamber incinerator in which the gases travel from the end of the ignition chamber, then pass through the mixing and combustion chamber.

INDORE PROCESS - An anaerobic composting method that originated in India; it is similar to the Bangalore process and was modified by Van Maanen. Organic wastes are placed in alternate layers with human or animal excreta in a pit or pile. The piles are turned twice in six months and drainage is used to keep the compost moist.

INFILTRATION AIR - Air that leaks into the chambers or ducts of an incinerator.

INOCULUM - Microorganisms placed in a culture medium, soil, compost, etc.

INTERCEPTOR - Sewers in a combined system control the flow of the sewage to the treatment plant. In a storm, they allow some of the sewage to flow directly into a receiving stream. This protects the treatment plant from being overloaded in case of a sudden surge of water into the sewers. Interceptors are used in separate sanitation systems to collect flows from main and trunk sewers and carry them

Glossary

to the points of treatment.

INTERFLOW - That portion of precipitation that infiltrates into the soil and moves laterally under its surface until intercepted by a stream channel or until it resurfaces down a slope from its point of infiltration.

ION - An electrically charged atom or group of atoms which can be drawn from waste water during the electro dialysis process.

JUNK - Unprocessed materials suitable for reuse or recycling.

LAGOONS - Ponds, usually man-made to rigid specifications, in which sunlight, algae, and oxygen interact to restore water to a reasonable state of purity.

LANDFILL - Same as a sanitary landfill, except, cover material is applied from time to time as required, instead of daily or more frequently. To be acceptable, landfills must be restricted in inert, non-combustible, non-putrescible solid waste materials.

LANTZ PROCESS - A destructive distillation technique, in which the combustible components of solid waste are converted into combustible gases, charcoal, and a variety of distillates.

LATERAL - Lateral sewers are the pipes that run under the streets of a city and into which empty the sewers from homes or businesses.

LATEX - A suspension of very small solid rubber particles in a water solution. Natural rubber exudes from the tree in this form and most synthetic rubbers are produced in this form or

Glossary

easily converted to a latex. Latex is used in the manufacture of foam, dipped goods, carpet backings, and other coatings and adhesives. They are distinguished from cements which are solvent solution.

LEACHATE - Liquid that has percolated through solid waste or other medium and has extracted dissolved or suspended materials from it.

LEDGE PLATE - A plate that is adjacent to or overlaps the edge of a stoker.

LIFT - In a sanitary landfill, a compacted layer of solid wastes and the top layer of cover material.

LITTER - Wantonly discarded material.

LOAM - A soft, easily worked soil containing sand, silt, and clay.

LYSIMETER - A device used to measure the quantity or rate of water movement through or from a block of soil or other material, such as solid waste, or used to collect percolated water for quality analysis.

MANURE - Primarily the excreta of animals; may contain some spilled feed or bedding.

MECHANICAL AERATION - Uses mechanical energy to inject air into water, causing the waste stream to absorb oxygen from the atmosphere.

MICROBES - Minute plant, animal, or protist life. Some microbes which may cause disease exist in sewage.

4

Glossary

MICRON - A measure of dust-particle diameter equal to 1/1,000 of a millimeter (1/25,400 of an inch).

MILLED REFUSE - Solid waste that has been mechanically reduced in size.

MINERAL FILLERS - Fine ground mineral powders which are added to rubber compounds to improve properties, to increase density or decrease cost. Common ones are clays, whiting, magnesia, zinc oxide, asbestos, and lead compounds.

MIXED LIQUOR - A mixture of activated sludge and waters containing organic matter undergoing activated sludge treatment in the aeration tank.

MOISTURE CONTENT (SOLID WASTE) - The weight loss (expressed in percent) when a sample of solid waste is dried to a constant weight at a temperature of 100°C to 105°C.

MOLDING - The process of forming rubber products with heat and pressure in precision formed molds. Various forms of molding are compression, transfer, injection, slush, rotational, and open mold. Compression molding is the traditional process for rubber products, but injection molding is becoming more common because of greater efficiency. Plastics are molded by very similar processes.

MOLDING WASTE - The overflow from the molding process including that from the air release channels built into the mold. Mold waste is always cured so it cannot be conveniently re-mixed.

Glossary

MUNGO - The waste of milled wool that is combined with other fibers to make low-quality cloth.

NATURAL RUBBER - Rubber originating from natural sources, almost entirely the cultivated rubber tree of Southeast Asia, Indonesia, Ceylon, West Africa, and a few minor tropical sources. It is marketed as either solid rubber or the concentrated latex.

NONDEGRADABLE WASTES - Substances that are not changed in form and/or reduced in quantity by the biological, chemical, and physical phenomena characteristic of natural waters. Although nondegradable wastes may be diluted by receiving water, they are not reduced in quantity.

OFFAL - Intestines and discarded parts, including paunch manure, of slaughtered animals.

OPACITY RATING - The apparent obscuration of an observer's vision that equals the apparent obscuration of smoke of a given rating on the Ringelmann Chart.

ORGANIC CONTENT - Synonymous with volatile solids, except for small traces of some inorganic materials such as calcium carbonate, that lose weight at temperatures used in determining volatile solids.

ORGANIC MATTER - The carbonaceous waste contained in plant or animal matter and originating from domestic or industrial sources.

ORSAT - An apparatus used to analyze flue gases volumetrically by measuring the amounts of carbon dioxide, oxygen, and carbon

Glossary

monoxide present.

OSBORNE SEPARATOR - A device that utilizes a pulsed, rising column of air to separate small particles of glass, metal, and other dense items from composc.

OXIDATION - The addition of oxygen which breaks down organic wastes or chemicals in sewage by bacterial and chemical means.

OXIDATION POND - A man-made lake or body of water in which wastes are consumed by bacteria. It is used most frequently with other waste treatment processes. An oxidation pond is basically the same as a sewage lagoon.

PALLETS - Wood, paper, or plastic supports for piles of bags, bales, or rolls of raw material to facilitate semi-automatic handling. They may be either disposable or returnable. One-trip pallets or damaged returnable pallets become solid waste at the point of delivery.

PATHOGEN - An organism capable of producing disease.

PEAT - Partially decomposed organic material.

PERCENT MOISTURE CONTENT (SOLID WASTE) - The percent of moisture contained in solid waste; it can be calculated on a dry or wet basis.

$$1. \text{ Wet} = \frac{100 (\text{water content of sample})}{\text{Dry weight of sample \& water content of sample}}$$

$$2. \text{ Dry} = \frac{100 (\text{water content of sample})}{\text{Dry weight of sample}}$$

Glossary

PERCOLATION - A qualitative term that refers to the downward movement of water through soil, solid waste, or other porous medium.

PERMEABILITY - The capacity of a porous medium to conduct or transmit fluids.

PIGMENTS - Pigments are organic or inorganic powders used to color products. They include many mineral products such as titanium oxide or zinc oxide which make white products. The terms, pigment and mineral filler, are often used interchangeably.

PNEUMATIC TIRES - Tires containing an enclosed air space and having an elastic and resilient body, the combination giving a smooth, jolt-free motion to vehicle on rough road-beds.

POLLUTION - The condition caused by the presence in the environment of substances of such character and in such quantities that the quality of the environment is impaired or rendered offensive to life. Pollution results when animal, vegetable, mineral or heat wastes or discharges reach water, making it less desirable for domestic, recreation, industry, or wildlife uses. Pollution is the contamination of any air, water or land so as to create a nuisance or render such air, water or land unclean or noxious, or impure so as to be actually or potentially harmful or detrimental or injurious to public health, safety, or welfare, to domestic, commercial, industrial or recreational use, or to livestock, wild animals,

Glossary

birds, fish, or other aquatic life or to plant life.

POLYELECTROLYTES - Synthetic chemicals used to speed the removal of solids from sewage. The chemicals cause the solids to flocculate or clump together more rapidly than chemicals like alum or lime.

POLYMER - A high molecular weight material made up of similar repeated units of simple structure. All rubbers are polymers but the term includes most plastics and many biological materials.

POLYVINYL CHLORIDE (PVC) - A common plastic material that can release hydrochloric acid and phosgene when burned.

PRIMARY TREATMENT - Removes the material that floats or will settle in sewage. It is accomplished by using screens to catch the floating objects and tanks for the heavy matter to settle in.

PRODUCT PACKAGE - Most consumer items and many industrial products are marketed in some type of package for protection, identification, or customer appeal. The package may be a cardboard box, a paper jacket, paper wrapping, or a multitude of other types. Sometimes boxed items are shipped together in an outer case. This material becomes solid waste at the point of ultimate consumption.

PULVERIZATION - The crushing or grinding of material into small pieces.

Glossary

PUSH PIT - A storage system sometimes used in stationary compactor transfer systems. A hydraulically powered bulkhead that traverses the length of the pit periodically pushes the stored waste into the hopper of a compactor.

PUTREFACTION - The decomposition of organic matter by microorganisms and oxidation, resulting in odors.

PUTRESCIBLE - Organic matter capable of being decomposed by microorganisms.

PYROLYSIS - The chemical decomposition of a material by heat in the absence of oxygen.

PYROMETER - An instrument for measuring or recording temperatures.

Optical - A temperature-measuring instrument that matches the intensity of radiation at a single wavelength from a tungsten filament with the intensity of the radiation at the same wavelength emitted by a heat source.

Radiation - A device that determines temperature by measuring the intensity of radiation at all wavelengths emitted by a material having a high temperature.

PYROMETRIC CONE EQUIVALENT (PCE) - An index to the refractoriness of a material; it is obtained by a test that provides the number of a standard pyrometric cone that is closest in its bending behavior to that of a pyrometric cone made of the material when both are heated in accordance with the ASTM Standard Method of Test for Pyrometric Cone Equivalent of Refractory Materials.

Glossary

QUALITY CONTROL - This incorporates all physical, chemical, or service testing of raw materials, in-process material, and finished product to insure that products meet the desired or required test specification. It would include all research and development products where this work is associated with a producing facility. Much of the raw material and in-process material could be returned to process, but much would be subjected to curing for test purposes and this, together with spoiled finished product, would be disposed of as solid waste.

QUENCH TROUGH - A water-filled trough into which burning residue drops from an incinerator furnace.

RASPER - A grinding machine in the form of a large vertical drum containing heavy hinged arms that rotate horizontally over a rasp-and-sieve floor.

RATED LOAD - The maximum load that a crane is designed to handle safely.

RECEIVING WATERS - Rivers, lakes, oceans, or other water courses that receive treated or untreated waste waters.

RECLAMATION - The restoration to a better or more useful state, such as land reclamation by sanitary landfilling, or the obtaining of useful materials from solid waste.

RECOVERABLE RESOURCES - Materials that still have useful physical or chemical properties after serving a specific purpose and

Glossary

can, therefore, be reused or recycled for the same or other purposes.

RECOVERY - The process of obtaining materials or energy resources from solid waste. Synonyms: Extraction, Reclamation, Salvage.

Energy - Energy available from the heat generated when solid wastes are incinerated.

RECYCLING - The process by which waste materials are transformed into new products in such a manner that the original products may lose their identity.

REFRACTORY - Nonmetallic substances used to line furnaces because they can endure high temperatures. In addition, they should normally be able to resist one or more of the following destructive influences: abrasion, pressure, chemical attack, and rapid changes in temperature.

Castable - A hydraulic-setting refractory, suitable for casting or being pneumatically formed into heat-resistant shapes or walls.

High Alumina - A refractory product containing 47.5 percent more alumina than regular refractories.

Plastic - A blend of ground fireclay materials in a plastic form, that is suitable for ramming into place to form monolithic linings or special shapes. It may be air-setting or heat-setting and is available in different qualities of heat resistance.

Glossary

REFUSE CHUTE - A pipe, duct, or trough through which solid waste is conveyed pneumatically or by gravity to a central storage area.

REINJECTION - Reintroduction of fly ash into a furnace to burn out all the combustibles.

REJECTS - Finished product which is judged by test to not conform to established quality standards. In some cases a reject can be repaired (belting and hose), or sold commercially as second or third quality (footwear), or reprocessed (heels and soles). In many cases repair or sale as off-quality cannot be tolerated and the item must be made unserviceable and disposed of as solid waste (tires, inner tubes, hose).

RETREADING - The process by which sound tire carcasses which have had the tread worn beyond safe levels by normal operation are rejuvenated by molding on a new tread equivalent in safety performance to the original.

REUSE - The reintroduction of a commodity into the economic stream without any change.

RINGELMANN CHART - Printed or photographically reproduced illustrations of four shades of gray, that an observer can use to estimate the density of smoke emitted from an incinerator. A clear stack is recorded as 0, and 100 percent black smoke as 5. Number 1 has a 20 percent density, and 2 through 4 are progressively 20 percent more dense.

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RIPARIAN RIGHTS - Rights of the landowner to water on or bordering his property; they include his right to prevent upstream water from being diverted or misused.

RUBBER - An unfortunately vague word having many different common and technical meanings. Originally meaning the crude natural product. It now covers all the synthetic elastomers, compounds of them, and fabricated products. It also refers to the "rubbery" properties of things that may not be elastomers at all. Then specifically it may refer to such things as waterproof footwear, prophylactics, and many other items.

RUBBER COMPOUND - Intimate mixtures of elastomers, oils, mineral fillers, pigments, chemicals, sulfur, and other modifying materials. It usually refers to uncured material.

RUBBER MILL - An open mixer for making rubber compounds consisting of two powered rolls operating in opposite or the same directions, at various rotational ratios, and either smooth or grooved in various ways.

RUBBISH - A general term for solid waste--excluding food waste and ashes--taken from residences, commercial establishments, and institutions. Non-putrescible wastes, such as cardboard, paper, tin cans, wood, glass, bedding, crockery or litter of any kind.

RUBBLE - Broken pieces of masonry and concrete.

RUNOFF - That portion of precipitation or irrigation water that drains from an area as surface flow.

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SALTS - Are the minerals that water picks up as it passes through the air, over and under the ground, and through household and industrial uses.

SALVAGE - The utilization of waste materials.

SALVAGE, METAL - A commercial enterprise engaged in the purchase of salvaged metals for resale, or processing and resale of these metals to metal consuming industry.

SALVAGING - The controlled removal of waste materials for utilization. The controlled removal of reusable materials. Not to be confused with scavenging.

SAND - A coarse-grained soil, the greater portion of which passes through a No. 4 sieve, according to the Unified Soil Classification System.

SAND FILTERS - Remove some suspended solids from sewage. Air and bacteria decompose additional wastes filtering through the sand. Cleaner water drains from the bed. The sludge accumulating at the surface must be removed from the bed periodically.

SANDY LOAM - A soft, easily worked soil containing 0 to 20 percent clay, 0 to 50 percent silt, and 43 to 85 percent sand, according to the U. S. Department of Agriculture classification code.

SANITARY LANDFILL - A site where solid waste is disposed using sanitary landfilling techniques. A controlled method of disposing of refuse on land without creating air, land or water pollution or nuisances or hazards to public health or

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safety, by utilizing the principles of engineering to confine the refuse to the smallest practical volume, and to cover it with a layer of earth at the conclusion of each day's operation, or at such more frequent intervals as may be necessary.

SANITARY LANDFILLING - An engineered method of disposing of solid waste on land in a manner that protects the environment, by spreading the waste in thin layers, compacting it to the smallest practical volume, and covering it with soil by the end of each working day.

SANITARY LANDFILLING METHOD

Area - A method in which the wastes are spread and compacted on the surface of the ground and cover material is spread and compacted over them.

Quarry - A variation of the area method in which the wastes are spread and compacted in a depression; cover material is generally obtained elsewhere.

Ramp - Another variation of the area method in which a cover material is obtained by excavating in front of the working face. A variation of this method is known as the progressive slope sanitary landfilling method.

Trench - A method in which the waste is spread and compacted in a trench. The excavated soil is spread and compacted over the waste to form the basic cell structure.

Wet Area - A method used in a swampy area where precautions

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are taken to avoid water pollution before proceedings with the area landfill technique.

SANITARY SEWERS - Sanitary sewers, in a separate system, are pipes in a city that carry only domestic waste water. The storm water runoff is taken care of by a separate system of pipes.

SANITATION - The control of all the factors in man's physical environment that exercise or can exercise a deleterious effect on his physical development, health, and survival.

SATELLITE VEHICLE - A small collection vehicle that transfers its loads into a larger vehicle operating in conjunction with it.

SCAVENGER - One who participates in the uncontrolled removal of materials at any point in the solid waste stream.

SCRAP - Discarded or rejected material or parts of material that result from manufacturing or fabricating operations and are suitable for reprocessing.

Home - Scrap that never leaves the manufacturing plant and is reprocessed there. Also known as revert scrap.

Obsolete - Scrap that results when material becomes worn or otherwise unusable for its original purpose.

Prompt Industrial - Scrap that is left over from the fabrication of iron and steel products.

SECATOR - A separating device that throws mixed material onto a rotating shaft; heavy and resilient materials bounce off one

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side of the shaft, while light and inelastic materials land on the other and are cast in the opposite direction.

SECONDARY MATERIAL - A material that is utilized in place of a primary or raw material in manufacturing a product.

SECONDARY TREATMENT - The second step in most waste treatment systems in which bacteria consume the organic parts of the wastes. It is accomplished by bringing the sewage and bacteria together in trickling filters or in the activated sludge process.

SEDIMENT - The material that settles to the bottom of a lake.

SEDIMENTATION TANKS - Help remove solids from sewage. The waste water is pumped to the tanks where the solids settle to the bottom or float on the top as scum. The scum is skimmed off the top, and solids on the bottom are pumped to incineration, digestion, filtration or other means of final disposal.

SEEPAGE - Movement of water or gas through soil without forming definite channels.

SEMI-PNEUMATIC - A tire of heavy construction having an air space within it usually at atmospheric pressure. They provide much less cushioning than pneumatic tires and are used on light weight equipment or industrial units.

SEPARATORS - Sheets of plastic, paper, or treated fabric which are used to temporarily separate prepared pieces of tacky uncured rubber prior to assembly. The trend is to plastic

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film which can be recovered after use and reprocessed in the fabricating plant as many as six or eight times. Treated paper and fabric can be used over several times, unless they have been cut, and then must be discarded as solid waste.

Ballistic - A device that drops mixed materials having different physical characteristics onto a high-speed rotary impeller; they are hurled off at different velocities and land in separate collecting bins.

Inertial - A material separation device that relies on ballistic or gravity separation of materials having different physical characteristics.

Magnetic - Any device that removes ferrous metals by means of magnets.

SEPTIC TANKS - Used for domestic wastes when a sewer line is not available to carry them to a treatment plant. The wastes are piped to underground tanks directly from the home or homes. The bacteria in the wastes decompose the organic waste and the sludge settles on the bottom of the tank. The effluent flows out of the tank into the ground through drains. The sludge is pumped out of the tanks, usually by commercial firms, at regular intervals.

SETTLING VELOCITY - The velocity at which a given dust will fall out of dust-laden gas under the influence of gravity only.

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SEWAGE SLUDGE - A semiliquid substance consisting of settled sewage solids combined with varying amounts of water and dissolved materials.

SEWAGE TREATMENT RESIDUES - Coarse screenings, grit, or sludge from wastewater treatment units.

SEWERS - A system of pipes that collect and deliver waste water to treatment plants or receiving streams.

SHREDDER - A machine that reduces discarded automobiles and other low-grade sheet and coated metal in a continuous operation to fist-size pieces.

SIFTINGS - The fine materials that fall from a fuel bed through its grate openings during incineration.

SILICA (SiO_2) - The oxide of silicon, a major constituent of fireclay refractories, alone or in chemical combinations.

SILT - Mineral soil grains intermediate between clay and sand (0.05 to 0.002 mm in diameter). Waterborne sediment whose individual grains have diameters approaching those of silt. Soil material that contains at least 80 percent silt, less than 12 percent clay, and less than 20 percent sand. A fine-grain soil having liquid limits and plasticity indexes that plot below the "A" line on the Unified Soil Classification System plasticity chart.

SINTERING - A heat treatment that causes adjacent particles of a material to cohere below a temperature that would cause them to melt.

Glossary

SLAG - A mineral substance formed by chemical action and fusion at furnace operating temperatures.

SLAGGING OF REFRACTORIES - Destructive chemical action that forms slag on refractories subjected to high temperatures. Also a molten or viscous coating produced on refractories by ash particles.

SLUDGE - A semi-liquid sediment. The solid matter that settles to the bottom, floats, or becomes suspended in the sedimentation tanks and must be disposed of by filtration and incineration or by transport to appropriate disposal sites.

SOIL - The unconsolidated natural surface material present above bedrock; it is either residual in origin (formed by the in-place weathering of bedrock) or has been transported by wind, water, or gravity.

SOLID TIRES - A solid mass of rubber built up on the rim of a metal wheel with no substantial air space. Usually limited now to small heavily loaded wheels and rollers such as aircraft tail wheels, industrial tractors, and conveyor rolls and casters.

SOLID WASTE - Useless, unwanted or discarded material with insufficient liquid content to be free flowing. Unwanted waste or discarded materials resulting from commercial, industrial and agricultural operations and normal community activities.

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Wastes include solids, liquids and gases. Wastes which are solids, or semi-solids containing insufficient liquid to be free-flowing are classed as solid waste. Solid waste is refuse and includes in part the following: garbage; rubbish; ashes and other residue after burning; street refuse; dead animals; animal waste; abandoned vehicles; agricultural, commercial and industrial waste; construction and demolition waste; sewage treatment residue. See also WASTE.

Agricultural - The solid waste that results from the rearing and slaughtering of animals and the processing of animal products and orchard and field crops.

Commercial - Solid waste generated by stores, offices and other activities that do not actually turn out a product.

Industrial - Solid waste that results from industrial processes and manufacturing.

Institutional - Solid wastes originating from educational, health care, and research facilities.

Municipal - Normally, residential and commercial solid waste generated within a community.

Pesticide - The residue resulting from the manufacturing, handling, or use of chemicals for killing plant and animal pests.

Residential - All solid waste that normally originates in a residential environment. Sometimes called domestic solid waste.

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SOLID WASTE MANAGEMENT - The purposeful, systematic control of the generation, storage, collection, transport, separation processing, recycling, recovery and disposal of solid wastes.

SOOT - Agglomerations of tar-impregnated carbon particles that form when carbonaceous-material does not undergo complete combustion.

SPECIAL WASTES - Hazardous wastes by reason of their pathological, explosive, radioactive, or toxic nature; or wastes which require special treatment prior to disposal in ordinary disposal facilities, or special facilities.

SPOIL - Soil or rock that has been removed from its original location.

SPONGE - Cellular rubber products made from softened solid rubber products containing chemical agents which decompose to gases during the curing process.

STERILIZATION - The destruction, by chemical or physical means, of a microorganism's ability to reproduce; to render something barren. The destruction of all living organisms. In contrast, disinfection is the destruction of most of the living organisms.

STOKER - A mechanical device to feed solid fuel or solid waste to a furnace.

Chain Grate - A stoker that has a moving chain as a grate surface; the grate consists of links mounted on rods to

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form a continuous surface that is generally driven by a shaft with sprockets.

Incinerator - A mechanically operable moving grate arrangement for supporting, burning, and transporting solid waste in a furnace and discharging the residue.

Inertial Grate - A stoker consisting of a fixed bed of plates that is carried on rollers and activated by an electrically driven mechanism; it draws the bed slowly back against a spring and then releases it so that the entire bed moves forward until stopped abruptly by another spring. The inertia of the solid waste carries it a small distance forward along the stoker surface, and then the cycle is repeated.

Oscillating Grate - A stoker in which the entire grate surface oscillates to move the solid waste and residue over the grate surface.

Reciprocating Grate - A stoker consisting of a bed of bars or plates arranged so that alternate pieces, or rows of pieces, reciprocate slowly in a horizontal sliding mode and act to push the solid waste along the stoker surface.

Rocking Grate - A stoker consisting of a bed of bars or plates on axles. When the axles are rocked in a coordinated manner, the solid waste is lifted and advanced along the surface of the grate

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Rotary Kiln - A cylindrical inclined device that rotates, thus causing the solid waste to move in a slow cascading and forward motion.

Traveling Grate - A stoker that is essentially a moving chain belt carried on sprockets and covered with separated small metal pieces called keys. The entire top surface can act as a grate while moving through the furnace but can flex over the sprocket wheels at the end of the furnace, return under the furnace, and re-enter the furnace over sprocket wheels at the front.

STORAGE - The interim containment of solid waste, in an approved manner, after generation and prior to ultimate disposal.

STORM SEWERS - Storm sewers are a separate system of pipes that carry only runoff from buildings and land.

STREET REFUSE - Material picked up when streets and sidewalks are swept manually and mechanically. Litter from public receptacles, and dirt removed from catch basins.

SURFACE CRACKING - Discontinuities that develop in the cover material at a sanitary landfill due to the surface drying or settlement of the solid waste. (These discontinuities may result in the exposure of solid waste, entrance or egress of vectors, intrusion of water, and venting of decomposition gases.)

SUSPENDED SOLIDS - The small particles of solid pollutants which

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are present in sewage and which resist separation from the water by conventional means.

TOPSOIL - The topmost layer of soil; usually refers to soil that contains humus and is capable of supporting good plant growth.

TOPOGRAPHIC MAP - A map indicating surface elevations and slopes.

TREAD - That part of the tire casing which comes in contact with the road. It contains no fabric and is especially designed for abrasion resistance and maximum skid resistance under all driving conditions. This part of a sound tire can be effectively replaced by retreading.

TRICKLING FILTER - A support medium for bacterial growth, usually a bed of rocks or stones. The sewage is trickled over the bed so that bacteria and other organisms can break down the organic wastes. The organisms collect on the stones through repeated use of the filter.

TRIMMINGS - Almost all fabricated rubber products are assembled from sheet or strip rubber compound, fabric or metal by hand or semi-automatic operations. This requires much hand or machine trimming of excess material to make the final shapes required. Many of these trimmings may be reprocessed but the remainder is discarded as solid waste.

VIRUS - The smallest form of microorganism capable of causing disease.

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WASTE - See also SOLID WASTE.

Bulky Waste - Items whose large size precludes or complicates their handling by normal collection, processing, or disposal methods.

Construction and Demolition Waste - Building materials and rubble resulting from construction, remodeling, repair, and demolition operations.

Hazardous Waste - Those wastes that require special handling to avoid illness or injury to persons or damage to property.

Wood Pulp Waste - Wood or paper fiber residue resulting from a manufacturing process.

Special Waste - Those wastes that require extraordinary management.

Yard Waste - Plant clippings, prunings, and other discarded material from yards and gardens. Also known as yard rubbish.

WASTE PROCESSING - An operation such as shredding, compaction, composting, and incineration, in which the physical or chemical properties of wastes are changed.

WASTE SOURCES - Agricultural, residential, commercial, industrial activities that generate wastes.

WASTE TREATMENT PLANT - A series of tanks, screens, filters, and other processes by which pollutants are removed from water.

Glossary

WATERSHED - Total land area above a given point on a stream or waterway that contributes runoff to that point.

WET DIGESTION - A solid waste stabilization process in which mixed solid organic wastes are placed in an open digestion pond to decompose anaerobically.

WET MILLING - The mechanical size reduction of solid wastes that have been wetted to soften the paper and cardboard constituents.

YARD RUBBISH - Prunings, grass clippings, weeds, leaves, and general yard and garden wastes.