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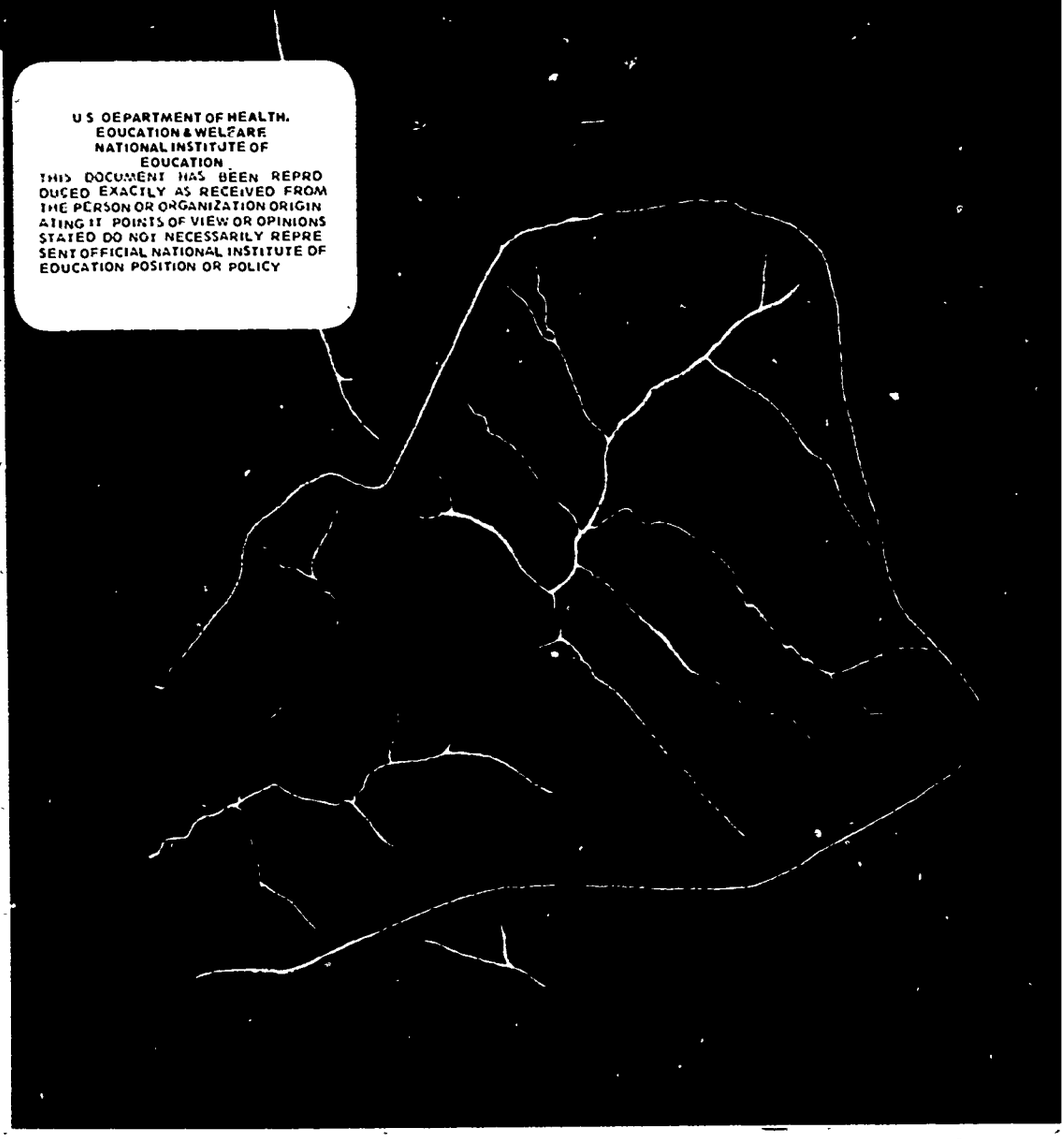
ABSTRACT

This curriculum activities guide provides the teacher with a model for a comprehensive program in watershed studies. With increased concern over water pollution, a study of the watershed is important to complete an understanding of water drainage problems. This guide includes a rationale for the study of watersheds and develops methods of implementation within the school system. An operational model for a watershed study program illustrates the data to be collected, problems to be identified, and special groups to be contacted for support. With the teaching activities in the guide, background information is included. A section in the guide explains the skills needed for the watershed study and appendices at the end include a bibliography and sample organizational information. (MA)



A Curriculum Activities Guide to

WATERSHED INVESTIGATIONS

and

ENVIRONMENTAL STUDIES

2

VOLUME SIX

Other Publications in the Series

A - The Institute for Environmental Education - history, philosophy, Guide Series rationale, federal and contract services.

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A CURRICULUM ACTIVITIES GUIDE TO WATERSHED INVESTIGATIONS AND ENVIRONMENTAL STUDIES

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First Edition, August 1974.
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CONTENTS- -

SECTION 2 - TEACHING RESOURCES WITHIN A WATERSHED - ACTIVITIES AND BACKGROUND INFORMATION

SECTION 3 - SOME OPERATIONAL AND TECHNICAL SKILLS NEEDED IN WATERSHED STUDIES

PREFACE

This publication was prepared by Dr. Peter Gail during his affiliation with the Stony Brook-Millstone Watersheds Association in New Jersey and later his directorship of the Cuyahoga Heritage Project in Northeast Ohio. Cuyahoga Heritage is a regional environmental education program of the Institute for Environmental Education. It was designated a National Demonstration Project by the U. S. Office of Environmental Education (HEW) in 1972, became the model for the pilot Ohio Water Quality Monitoring Project in 1974 and is now home base for the associated monitoring projects which in 1975 are recognized as a National Program of the American Revolution Bicentennial Administration. The book contains, therefore, a synthesis of experiences recorded during this period of evolution. It was revised shortly after the first printing and is published by the Institute for addition to the "Environmental Education Guide Series" (see inside front cover).

Volume VI describes a process for studying community concerns. It is directed primarily toward secondary school teachers and is intended as a guide. Therefore, facts are examples, hortatives are suggestions, and cross-references are open doors to related studies. The operating process is student involvement and the subjects of study are community concerns. The kind of activity described here can initiate a student's first sense of the real responsibility with which they are soon to be entrusted. That is a time when they may cease being the object of teaching and become the subjects of learning.[1]

The Institute for Environmental Education

[1]Recorded from an address by George N. Rainsford, President, Kalamazoo College. Management Forum, Vol. 3, No. 8, November 1974.

INTRODUCTION

My interest in Watershed Studies began in 1967 when Peter Buell, then Executive Director of the South Branch Watershed Association, told me of a program he had going with the Girl Scouts in Flemington, New Jersey. In this program, a troop adopted a stream and did what they could to clean it up and keep it clean. This usually meant regularly cleaning the trash and debris out of the stream or controlling the bank erosion, but this was an advancement over the conventional practice of cleaning up different streams superficially every so often, as conservation projects.

We began experimenting with the idea in Ecological Research Special Interest Explorer Post 50, North Brunswick, New Jersey, to see what high school students were capable of doing and whether they were interested in such studies. We expanded the concept to adopting watersheds instead of just streams and conducted a survey to determine if youth groups, adult service clubs and schools would support the establishment of a large scale adopt-a-watershed network. While there was interest, most felt they lacked time and expertise, and cited conflicts with other activities. The idea was resurrected in 1970, when as program director of the Stony Brook-Millstone Watersheds Association, I began exploring the possibilities of integrating watershed studies into the high school curriculum. I went to teachers, administrators, and students and suggested that we begin a study of problems in the Stony Brook and Millstone River watershed. Each school was to adopt one tributary and its watershed, and work to clean it up. The response was overwhelming. Wherever the idea was presented...faculty meetings, conferences with teachers and administrators, private schools, public schools... people got excited! Teachers said it was what they were looking for to lend meaning and purpose to their environmental units. Dr. James Kimple, Superintendent of South Brunswick Public Schools, greatly extended my visions about the potential inherent in this idea. Thus the Stony Brook-Millstone Microwatershed Program was born.

The transition from idea to implementation was difficult, however. Most teachers were not trained in how to investigate or take action on real community problems, nor was I. The only way to learn was to do it. The group of us that set out to implement this program soon narrowed down to a small band of dedicated individuals. We were committed to the ideal and dedicated to find out how to make it work under the very real constraints of the traditional school. Our goal was to develop a program that could be easily duplicated elsewhere without needing a full time coordinator to oversee affairs. To this small band of New Jersey teachers has been added another small and dedicated group of Ohio teachers who are involved in the Cuyahoga River Watershed Project, a national demonstration

model for the Office of Environmental Education (HEW). We wrote this book so that you may hopefully benefit from our experiences and not make the same mistakes.

The purpose of this book is threefold:

1. To help you, as teacher, student or administrator, initiate a watershed study in your school.
2. To assist you in involving other schools within the watershed.
3. To provide you with the tools and insights others have found valuable in conducting watershed study programs.

For this reason, this book is divided into three sections:

Section 1 - What watersheds are, why they are important, and how you and others can begin studying them.
Section 2 - Teaching resources within a watershed - Activities and background information.
Section 3 - Operational and technical skills useful in watershed programs.

This book and its companion volume, the Environmental Education Guide for Teachers[1], represent what we know now about conducting effective environmental studies in school. These books, and other related curriculum guides[2], are intended as guides only, to give you ideas that will trigger your thinking. It is up to you to adapt these suggestions to your own style, constraints, and needs of your areas and students.

ACKNOWLEDGEMENTS

The teachers, administrators and students who tested the ideas, reported their experiences, shared their insights, and helped prepare this book are:

In New Jersey:

-John Philips, formerly of Peddie School, Hightstown
-Ann Soos, Stuart Country Day School of the Sacred Heart, Princeton
-Stuart Hoverman, Pennington School, Pennington
-Sean Reilly, formerly of Crossroads Middle School, South Brunswick
-Katherine Widmer, Hopewell Valley Central High School, Pennington,

who carried on the program after I left New Jersey and authored Section 2 of this book under the Office of Environmental Education grant...

-Anton Lemli and Harry Brobst, Montgomery Township High School, Skillman

[1]Gail, Peter A., 1974, Environmental Education Guide for Teachers Institute for Envir. Educ., 8911 Euclid Ave., Cleveland, Ohio 44106

[2]Environmental Education Guide Series

-Ellen Watson, Princeton High School, Princeton
-Dr. Robert Simpson, Rider College, Trenton
-Dr. Mary Leck, Rider College, Trenton
-Torson Utne, Frank Cerza, Stuart Kerr, Gary Fuchs and the rest of the watershed study group members at Peddie School
-Pam Silver, Hopewell Valley Central High School
-Robert Roby and David Spiro, Hun School, Princeton
-David Dirks, Princeton University

In Ohio, the following Cuyahoga River Watershed Project members have made significant contributions to our understanding of how to incorporate watershed-oriented environmental problems studies (EPS) in all types of schools:

-Nancy Glass, St. Edwards High School, Lakewood
-Jack Arnold, Berkshire High School, Burton
-Sr. Mary Isidore, St. Wendelins School, Cleveland
-Doug Dolan and Melinda Merryfield, Cardinal High School, Middlefield
-Russ Hansen, Mike Donovan, David Livingstone and Rich Grant, Western Reserve Academy, Hudson
-Frank Jefferis, Jerry Metzler, Pete Pourzanjani, Paul Baukema, Joy Fink, George Kramer and others of the watershed study group at Lakewood High School, Lakewood
-Jim Henry, Davey Junior High School, Kent
-Bill Taylor and Al Kriz, Independence High School, Independence
-Ron McEachen, Woodridge High School, Peninsula
-Barb Kresge and Ron Yarian, Brush High School, South Euclid

I am grateful to them all.

I am also grateful to George Lowe, U.S. Office of Environmental Education (HEW) for his faith in the potential of this program, Jack Hershey (University City Science Center, Philadelphia) and Al Sexton (Project KARE, Blue Bell, Pennsylvania) for their constant encouragement, support and widespread publicity of our efforts during the formative phases of this program; Joe Chadbourne and Tom Offutt (Institute for Environmental Education) who saw the potential in this idea and gave me the opportunity to devote full time to it as director of the Cuyahoga River Watershed Project; Ian Walker (Stony Brook-Millstone Watersheds Association) for teaching me a great deal about watershed detective work; the Stony Brook-Millstone Watersheds Association, for supporting this work for the first two years; and the South Brunswick Board of Education for agreeing to sponsor the proposal which has supported this work.

Thanks are also due to Jodi Hale for editing, laying out and typing this manuscript on very short notice.

But most of all, I thank my wife, Wilma, and children, Kevin and Karin, for patiently doing without husband and father

for many hours in the past few years while I [illegible]
to make sense out of our experiences. To them, my [illegible]
this book is gratefully dedicated.

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CHAPTER 1 - WHAT ARE WATERSHEDS AND THE 'WHYS' AND 'HOWS' OF STUDYING THEM

Introduction

Lake Erie, the Atlantic Ocean and other similar large water bodies can ultimately be cleaned up. To do this, however, we must start at the headwaters of each of the feeder tributaries in the river systems feeding them, pinpoint the problems and find workable solutions for them so that the tributaries no longer contribute waste to the river system.

If everyone will clean up their own backyard (i.e., assess and work on environmental problems at the local level where the problems are generally manageable), we might be able to solve many of our major environmental problems. This can only happen, however, if the next generation of citizens understands the problems and the complexity of maintaining ecological and economic balance at the same time. They will need help to bring people together with divergent viewpoints, expertise and talent to find workable and responsible ways to solve these problems.

Today's high school students are our next generation of citizens. They are coming through school at a time when information on local problems is badly needed, but manpower and money in government agencies are often insufficient to satisfy those needs. Involving students in investigating these problems, therefore, serves a double purpose - it yields the data needed and introduces the students to valuable skills for successfully coping with environmental issues which will concern them in the future.

This book is a sequel to the Environmental Education Guide for Teachers[1], and introduces and explains specific activities that can be used by teachers employing the teaching methods described in that volume, to:

- -develop watershed awareness and a commitment to approach land use and water quality problems on a watershed basis;
- -introduce students to the skills needed to pinpoint, investigate, and work with others to find workable solutions to problems;
- -provide service to the community.

In a watershed study program, one or more schools adopt each tributary of a major river and its watershed, and take upon themselves the long-term goal of finding and trying to solve the problems in that tributary. For example - students at Park School in suburban Baltimore set up a five-year study to determine effect of development that followed completion of the Baltimore Beltway on increasing flood crests and total run-off in a stream in the area.

The Watershed Study Program provides opportunity for teachers in all fields. The emphasis is on real problems, using

[1]see page 2

tools from all disciplines to solve them. Details about how to conduct many of the activities are lacking because the procedure may be different in every situation. You and your students, working together and with knowledgeable resource people in your area, should devise the approach that works for you.

Solving environmental problems, particularly on a watershed basis, is not easy. If it were, few problems would exist, because everyone is in favor, at least in principle, of pleasant environmental conditions. Solutions to these problems require imagination, skill, knowledge, desire, patience, and time. You may not solve the problem, but the ground work you lay may help the next person who comes along know where to start, even if it is only what not to do. It is important to impress this upon students when they become discouraged by barriers they encounter, and to encourage them to find ways around the barriers. Perhaps they will need to back off, reassess, make new plans and try again.

Why Watersheds?

Streams and rivers are the plumbing system for the land - the "drain pipes" carrying water and its contents away from the area. The water that flows into this plumbing system comes from a relatively closed area bounded by the highest points encircling the stream. A house roof with rain gutters on each edge is a good example of a watershed. (Figure 1) Water falling on the sloped surface flows into the gutter at the bottom of the slope, and flows through the gutter to the ground. If two houses are connected (figure 2), the watershed of the middle gutter would be bounded by the two roof peaks or ridges. The only source of water flowing into the gutter is that which falls within the area bounded by the peaks. On the ground, each stream has a similar closed area which it drains. (Figure 3) All water falling on the area as rain or snow, except that which evaporates, is transpired or is transported into other watersheds by man or through bedrock fractures, percolates into or runs off the land and ultimately ends up in the stream.

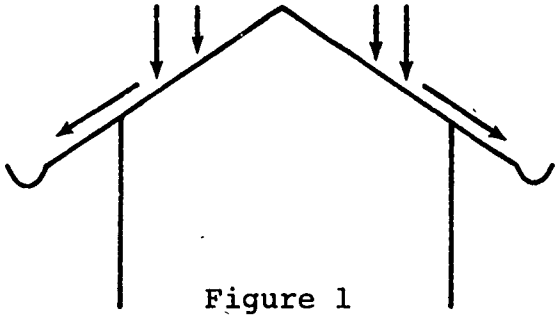


Figure 1

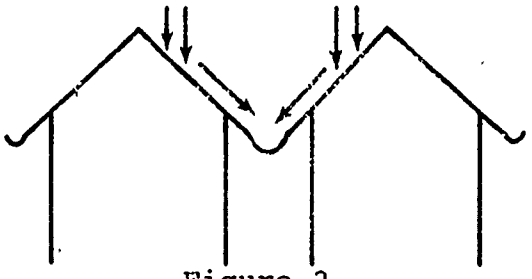


Figure 2

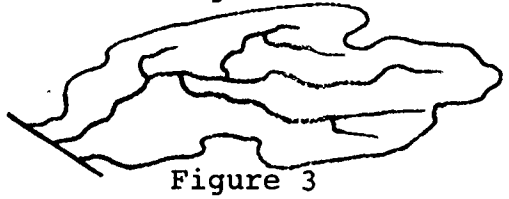


Figure 3

A house or farm or industry on the ridge a mile or two away from the stream can have as much effect on a stream as an industry along the banks. Water is the universal solvent. As it falls to earth it picks up in solution or suspension practically everything in its path and carries it to its receiver stream. These

wastes are then carried downstream, continually being increased by wastes brought in from other tributaries.

Environmental problems must be specifically identified before they can be solved. Because of the unique characteristics of water as a carrier of waste, it becomes the most encompassing factor available as an index of all other problems affecting the environment. Water quality and flow characteristics, therefore, may be used as an index of total environmental quality. This single index allows the investigator to pinpoint such diverse but interrelated problems as:

- excessive population density
- poor allocation of open space
- poor solid waste disposal practices
- improper domestic and industrial waste water treatment
- improper and harmful pesticide use
- excessive density of stray dogs in the area
- irresponsible land use and development practices
- poor flood plain management and agricultural practices

and a great many more environmental quality problems that are small, but contribute to the whole.

The Water Resources Research Institute, Rutgers University[1], reports that 2/3 of the pollution (measured as BOD loading) in the streams they studied come from small unknown sources. Only 1/3 was attributable to known domestic and industrial waste water treatment facilities. And Odum has said that[2],

> *"Recent studies on lake sediments as well as theoretical considerations have indicated that lakes can and do progress to a more oligotrophic condition when the nutrient input from the watershed slows or ceases. Thus there is hope that the troublesome cultural eutrophication of our waters can be reversed if the inflow of nutrients from the watershed can be greatly reduced. Most of all, however, this situation emphasizes that it is the entire drainage or catchment basin, not just the lake or stream that must be considered the ecosystem unit if we are to deal successfully with our water pollution problems. Ecosystematic study of entire landscape catchment units is a major goal of the American plan for the proposed International Biological Program."*

He also says, however, that,

> *"Despite the obvious logic of such a proposal, it is proving surprisingly difficult to get tradition bound scientists and granting agencies to look beyond their specialties toward the support of functional studies of large units of the landscape."*

[1]Whipple, William J., 1969 "Preliminary mass balance of B.O.D. in three New Jersey rivers", Water Resources Research Institute, Rutgers University, New Brunswick, N. J. 94 pp.

[2]Odum, Eugene, 1969, "Strategy of Ecosystem Development", Science, 164:262

What's Wrong With Using Political Units (Towns, Countries, etc.) as Study Areas

John Wesley Powell, the great statesman and explorer, exclaimed in the late 1800's that watersheds are the only logical geographical land use planning units. His wisdom had been overlooked by most planners until recently. Political boundaries cut across watershed boundaries, often dissecting a single watershed into many political units, each autonomous from the others. Counties often use major rivers as boundaries, creating a split down the middle of the watershed, in which those with authority on each side of the river have different ideas about how to use it. Development or regional planning districts often include parts of many watersheds but seldom the entire watershed of any major stream. Under these conditions, it is obvious that any attempt to clean up water in a town downstream would have, without equal commitment from all towns upstream, no chance to succeed. A watershed consciousness needs to be developed so that the next generation of government officials use watersheds and not local municipalities as their planning base.

Are Watershed Studies and Water Pollution Studies Synonomous?

Watershed studies are investigations of the use and misuse of the land which drains into a stream. Water quality in the stream draining the land is merely an index of land use quality, and as such is only part of a watershed analysis. It is important that a watershed study begin with a general overview of the entire watershed - its land use, peopel, potential problems, and stream survey, not just the latter. The watershed is a geographical region in which you begin. Once the problems are identified and understood, the search for answers may extend well beyond the boundaries of the watersheds, possibly into studies of,

- -laws and potential laws that could alleviate the problems at the local, county, state and federal level;
- -the processes in society that create the problems and alternatives available to solve them;
- -costs and benefits of alternative solutions;
- -history of the problems and peoples' attitude toward them;
- -ways of stimulating people to correct the problems;

all of which involve social sciences and none of which are concerned with water pollution per se.

Goals and Objectives of the Watershed Studies Program

The goals of the program are to

1) train students in the watershed approach to solving environmental problems by involving them in systematically gathering information about land use, water quality, and

sources of pollution and in developing plans to deal with the problems they find;
2) accumulate information that can be used by government agencies, citizens' groups, the students themselves and others to plan ways to solve environmental problems.

The specific objectives, then, of this kind of program might be stated as follows: These objectives supplement those found in Environmental Education Guide for Teachers, page 2.

Objective 1

Given a watershed area, students will be able to get information needed to understand the problems existing there, analyze this information, and communicate it to others.

Supporting Objectives:

1) Students will be able to conduct a preliminary investigation to identify problems, limit them to ones which are reasonably solvable.
2) Understand basic ecological principles as they apply to local watershed land and water use.
3) Know how to use literature to determine what work has been done on the same or similar problems, and what techniques they should use to acquire technical background.
4) Be able to choose the appropriate techniques for studying problems concerning them.
5) Be able to make or get the equipment needed to carry out research.
6) Know how to determine what technical resources are available to them locally, and how to find them.
7) They will be able to:
    a. measure stream flow and water table levels and compute water budgets;
    b. use topographic maps to map watershed boundaries;
    c. compute the area of his microwatershed or any portion of it;
    d. use soils maps to master plan a watershed area;
    e. read aerial photos;
    f. do careful water chemical analyses;
    g. make quantitative plankton and benthic invertebrate analyses and compute diversity indices;
    h. do bacteriological analyses;
    i. measure and calculate morphometric parameters for ponds, streams, etc., including measuring of pond bottom profiles and their rates of change.
8) Be able to analyze their data graphically and statistically, using simple statistical techniques.
9) Be able to prepare competent scientific reports and case histories and present them before their peers and the community generally.

Objective 2

Students will understand local, state and federal government structure and how it is organized to deal with environmental problems.

Supporting Objectives:

1) Contact the local League of Women Voters to determine what information they have on government structure and function.
2) Students will be able to find their way around local governmental headquarters.
3) Know the laws and ordinances, state, federal and local, that influence polluters in their area.
4) Know how to identify where the political power and influence resides in government and how to approach the people with this power and influence.
5) Know at least the Chairman of the Township Committee or the Mayor, the Chairman of the Conservation Commission, Planning Board, Zoning Board and Board of Health, as well as the Township manager and the Sanitarian (modify this to reflect government structure in your area).
6) Know the responsibilities of each of the Boards.
7) Be able to approach and report violations of ordinances to the appropriate Board.
8) Know the state and federal government agencies that administer environmental laws and understand their operation.

Objective 3

Students will be able to find, catalog and use resources (technical personnel and reports, citizen groups, taxpayers and self-interest in problem, maps) to help find answers to their problems.

Supporting Objectives:

1) Students will be able to use tax maps, storm drain and sewer maps to identify property ownership along streams, ponds, storm drains, and within watersheds generally.
2) Find technical reports and maps in government offices and libraries.
3) Find and recruit technical people to interpret the reports and problems.
4) Conduct surveys of residents and industry.
5) Compile accurate land use maps.
6) Build a constituency to influence government process.
7) Use the yellow pages effectively to find potential sources of funding and information.

Objective 4

Students will know how to use data gathered to get

change and solve environmental problems.

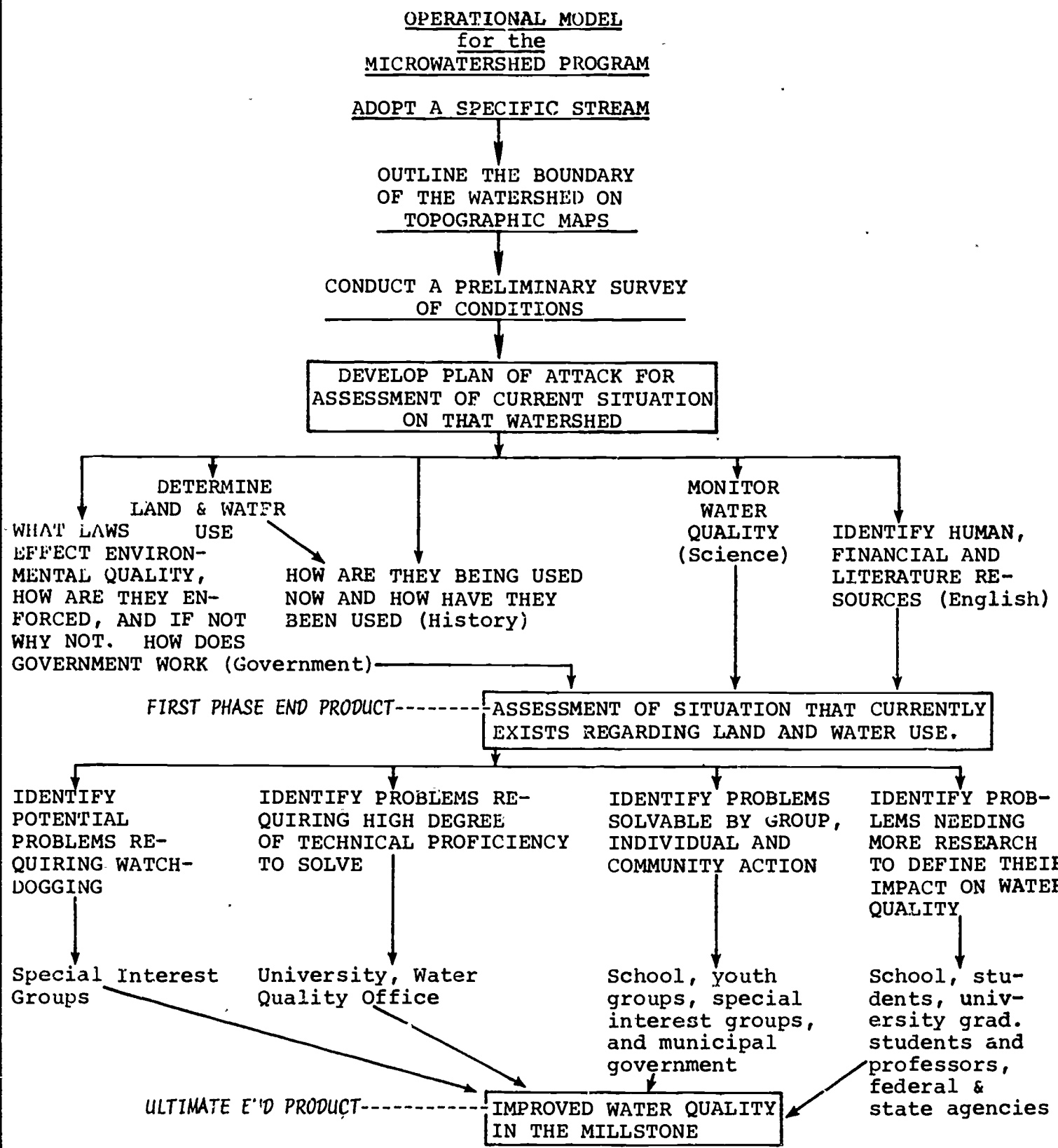
Supporting Objectives:

1) Students will know how to identify the forces helping them and those keeping them from solving the problem, and be able to develop a plan of action to take advantage of those forces.
2) Know how to make effective use of the media in their community to carry their message.
3) Know how to develop community education programs.
4) They will know how to involve others within the community in cooperative programs designed to solve the problems the community members agree they have.

These objectives are suggestions only, and may differ from study to study, but give you an idea of the scope of the skills and experience a student can expect to get through participation in this program.

Getting a Watershed Study Started in Your School

When a watershed study starts, many activities may be going on at once, often involving a number of teachers and students. The start-up activities in a watershed program can be visualized in the following operational model, which was developed for the Millstone River System in New Jersey.


OPERATIONAL MODEL
for the
MICROWATERSHED PROGRAM
ADOPT A SPECIFIC STREAM
OUTLINE THE BOUNDARY OF THE WATERSHED ON TOPOGRAPHIC MAPS
CONDUCT A PRELIMINARY SURVEY OF CONDITIONS
DEVELOP PLAN OF ATTACK FOR ASSESSMENT OF CURRENT SITUATION ON THAT WATERSHED
DETERMINE LAND & WATER USE
WHAT LAWS EFFECT ENVIRONMENTAL QUALITY, HOW ARE THEY ENFORCED, AND IF NOT WHY NOT. HOW DOES GOVERNMENT WORK (Government)
HOW ARE THEY BEING USED NOW AND HOW HAVE THEY BEEN USED (History)
MONITOR WATER QUALITY (Science)
IDENTIFY HUMAN, FINANCIAL AND LITERATURE RESOURCES (English)
FIRST PHASE END PRODUCT
ASSESSMENT OF SITUATION THAT CURRENTLY EXISTS REGARDING LAND AND WATER USE.
IDENTIFY POTENTIAL PROBLEMS REQUIRING WATCHDOGGING
IDENTIFY PROBLEMS REQUIRING HIGH DEGREE OF TECHNICAL PROFICIENCY TO SOLVE
IDENTIFY PROBLEMS SOLVABLE BY GROUP, INDIVIDUAL AND COMMUNITY ACTION
IDENTIFY PROBLEMS NEEDING MORE RESEARCH TO DEFINE THEIR IMPACT ON WATER QUALITY
Special Interest Groups
University, Water Quality Office
School, youth groups, special interest groups, and municipal government
School, students, university grad. students and professors, federal & state agencies
ULTIMATE END PRODUCT
IMPROVED WATER QUALITY IN THE MILLSTONE

In this scheme, a group of teachers and students get together, decide what information they need to adequately and objectively assess the condition of their watershed, decide which classes will be responsible for gathering which information and then begin the study.

It is important that school administrators, parents, and community leaders understand what you are doing and have an opportunity to make suggestions. You may even wish to establish an advisory board comprised of representatives from each of these groups and community organizations which have an interest in your studies.

Phases in Watershed Studies

Watershed studies proceed through specific phases, each of which may take a variable length of time to complete. Some steps may not be necessary for you or you may identify steps which we have overlooked.

Phase I - Fact Finding

-Plot watershed boundaries on topographic maps. Make a reference map.
-Walk the streams and determine land use and potential or presumed problems. Make a list of these and plot them on the reference map.
-Get tax maps, soils maps, and information on geology and ground water hydrology for the watershed. Determine land use patterns and soil problem areas.
-Talk with residents, particularly old timers in the area and streamside residents. Develop a support base and get permission to work on their property. Ask if they would monitor staff gauges and rain gauges regularly if you would provide them. Establish a rainfall and stream flow monitoring network. Also, if sedimentation is a problem, ask your resident volunteers to take a gallon sediment sample for you after each rainfall at prescribed hours (during, four hours after, eight hours after, two days after, etc.), so you can get a sediment load estimate.
-Talk with potential developers or their consultants. Often a few consulting engineers who know the local government and its peculiarities will be hired by all developers trying to operate in the area.
-Talk with town, municipal and county officials for all political units in the watershed. Get their views. Get background on their ideas about environmental issues.
-Get copies of all zoning laws, sanitary code, building codes and master plans in effect in the watershed. Survey them for sediment control ordinances, flood plain and wetlands ordinances, water quality standards, steep slope protection ordinances.
-Survey water chemistry, benthic invertebrate population structure and bacteriological characteristics of the streams at selected stations from the

headwaters to the mouth.
-Determine where pending developments, shopping centers, industry, etc. are to be located.
-Get copies of minutes of zoning commissions, county commissioners and town council.
-Contact League of Women Voters to find out how government works in your state. What powers, responsibilities and limitations are there on each body. If possible get copies of state constitution, environmental statutes and enabling legislation which set powers and limitations.

Information you should have at the end of the fact finding phase of a watershed assessment includes:

-Who owns the land bordering the streams and what are their attitudes about the stream.
-Where are the critical areas in the watershed which could be most easily damaged by man's activities.
-What areas are most immediately threatened by development that should be studied first. What is the kind of potential damage.
-What land uses are now damaging the watershed and water quality, and where are they located in the watershed.
-What specific kind of damage is being done.
-What are the political attitudes in town with regard to environmental quality.
-What factions, both pro and against environmental quality, exist in the watershed.
-What laws now exist which protect flood plains, wetlands, provide for sediment control during and after construction, prevent stream encroachment, without adequate planning, for maintenance of water quality. Are they being enforced? To what extent?
-Is there a master plan for your county or town. Is zoning and planning based on soil capabilities. Have Soil Survey maps been used as the basis for planning.

Until you can answer these questions, the fact finding phase isn't complete. Get to know the reporter on the local newspaper who covers affairs in the watershed. One place to meet him/her is at local government meetings, where you can talk afterwards. The newsroom of their paper is often the worst place, because when they are trying to meet deadlines, they can't give you much time. These reporters often can give you more insight about a town and its politics than several knowledgeable residents and can give you valuable leads. They will be more helpful if you reciprocate by giving them good human interest stories. But, get to know them well before you share any pertinent information with them. They can do you a lot of damage if they misinterpret what you say or publish the information prematurely.

Phase II - Prepare preliminary report pinpointing areas of greatest potential problems and existing problems.

Write a proposal to study the most important of these. Make or get equipment needed.

Phase III - Problem investigation. Use parameters which seem important to characterize the problems and conduct thorough investigation. Involve community people in helping with this.

Phase IV - Analysis of alternatives available to solve problems. Involve community resources in helping determine all alternatives and the costs, benefits, advantages and disadvantages of each.

Phase V - Report results and recommendations, and solicit internal support for implementing solutions.

Phase VI - (optional in case Phase V is not totally effective or when the type of problem renders Phase V not applicable) - Community education, exposure of the problem to the community so they can act on it. May be slide shows, pamphlets, social gatherings with a purpose, etc.

Depending on the type of problems some of these phases may not apply or other phases may be needed. In assessing historical aspects of the watershed, it often saves a lot of time if you can find an old resident on each stream tributary you are studying. He will generally be able to give you a complete history of the stream and its problems. These older people are also often happy to have someone to talk with. When talking with residents, ask for ideas about other resources they know about which might help the class deal with the watershed's problems, such as people they know, reports they know about, etc. Find out also if they will be willing to utilize their own talents and knowledge to help your class.

Basic Resources Needed for Watershed Studies

Resources needed to conduct a successful watershed program are of three types:

-equipment and supplies[1]
-literature, and
-technical expertise

Most of the basic equipment you already have or can make easily and inexpensively. The only major expense might be for chemical and bacteriological testing equipment. If you have no money for such equipment in your budget, or don't now have this equipment, prepare a proposal (section 3) outlining your plans and the equipment needed, and after clearing it with your administration, submit the proposal to local service organizations, garden clubs, industry, or professional societies. The worst they can say is "no". Those who have done this are amazed at how much easier it is to get support from local organizations than from the school or from government grants. Those who give money, however, expect to see results. If you accept their gift, be prepared to submit a report to the organization at the end of the project period. If the report

[1]See Appendix 5

is of high quality, it may insure you of continued support from that source.

Literature

Since watershed studies programs, and EPS[1] courses generally, require no textbooks, money saved can be applied to the purchase of basic reference books (Appendix I) in sufficient quantity so that all students have access to them. You can also include books in proposal budgets. In addition to general references, the following information is available:

1) From local and county government
   a. Agenda and minutes from zoning, planning, school and health board meetings, and of city or town council meetings.
   b. Tax, topographic, highway, stormdrain, sewerage, zoning, and land use maps - available from the town or county engineer or planning boards
   c. County, town and regional master plans
   d. County and municipal ordinances
      (1) zoning ordinances
      (2) building codes
      (3) sanitary codes
      (4) whatever environmental ordinances (open space, flood plain protection, returnable bottles, etc.) have been passed by the municipality
   e. Copies of the current budgets for school, town, county
   f. Records of complaints to the county health department
2) From state governments
   a. Enabling legislation establishing each element of local and county government
   b. Copies of all permit applications developers, sewerage authorities, industry landfill operators, and others with impact on the environment must file (includes air pollution report forms, effluent report forms and stream encroachment forms available from the State Department of Natural Resources or Environmental Protection Agency) to get permission to build or operate
   c. Water quality, air quality, solid waste, water resources, health and consumer protection criteria and statutes
   d. Environmental bills pending in state legislature
   e. Enabling legislation setting up state environmental agencies (Divisions of Natural Resources, Environmental Protection, Geology, etc.)
   f. Organizational chart of state government, of all environmental agencies
   g. Names and phone numbers of all agencies and key people in them
3) From the federal government
   a. Soil Survey Information (maps, etc.) (Soil Conservation Service)
   b. Federal statutes governing air and water pollution

[1] Environmental Problem Solving (16)

c. Enabling legislation establishing the Environmental Protection Agency
d. Organizational chart on EPA
e. Climatological data for the area, historical and present (NOAA, U.S. Weather Bureau)
f. Geology and groundwater resources for the area (U.S. Geological Survey or State Department of Geology)
g. Stream flow data for the watershed, historical and present, including location of gauging stations (U.S. Geological Survey)
h. Full sets of U.S.G.S. topographic maps for watersheds served by the library, piece together and mount on a conspicuous wall
i. Guidelines for environmental impact statements and river basin plans (Environmental Protection Agency)

4) From other sources
a. Master plan guidelines (regional plan commissions, development districts)
b. Aerial photographs of the area - U.S.G.S. Map Information Office, Washington, D.C. 20204
c. Reports of local problems by League of Women Voters, Regional Planning Commission, watershed districts or associations, colleges and universities
d. Publication of local government structure (League of Women Voters)
e. Examples of model master plans and environmental ordinances from various states and communities

It is important to know which of the above materials are not available for your area (i.e., soil surveys have not been made for Cuyahoga County, Ohio) as it is to have the information that is available.

A library can also keep a resource file listing people who are willing and able to provide technical assistance to students working on environmental problems in the community.

Students can record names and addresses of people who appear in the newspaper that might provide these services in particular fields.

Getting Other Schools into the Study

The ultimate goal of the Watershed Study Program is to clean up entire river systems which feed into oceans and lakes, not just isolated tributaries. Therefore, each Watershed Study, whil it may start with just one school, must soon incorporate many other schools if it is to meet this goal. Generally, the procedure is as follows:

1. Teachers and students in the school initiating the study secure maps of their entire river basin, and deliniate the boundaries of that basin.
2. Using the State Department of Education Directory of schools or other similar resource, they identify all the schools, private or public secondary, within the basin and plot the location of these schools on the map.

3. Appropriate people (e.g., department chairman, principal, curriculum supervisor, etc.) are contacted in each school, and the program is explained to them. A faculty meeting is arranged to present the program to all secondary teachers in the district.
4. Teachers recruited through these faculty meetings are invited to participate in a series of organizational meetings in which the group

a. decides on its goals and objectives
b. determines and assigns watersheds to each school
c. determines what training is needed to get the studies started on each watershed, and schedules workshops to provide that training
d. develops a schedule for meeting the objectives
e. assigns committees to be responsible for meeting the objectives

If the basin is large, regional subgroups may be established for convenience.

Generally, watershed study programs have two working groups:

1) A consortium of teachers, who meet together regularly to discuss implementation problems and develop training programs for themselves and new recruits. In Cleveland, teachers involved in this consortium may, at their option, receive graduate credit for their participation.
2) A cluster comprised of student and teacher representatives from each school who meet together monthly to discuss their studies, share resources and ideas, design needed training programs, and in general coordinate the watershed program. It is this group which is responsible for setting watershed-wide goals and forming committees responsible for achieving them. This may include:
   - -preparation of annual environmental quality reports for the entire river basin
   - -designing and conducting seminars and workshops
   - -publication of a newsletter
   - -arrangment of agenda and program for monthly meetings
   - -establishing a technical resource advisory committee to help with design of investigations, interpretation and analysis of data.

Programs for seminars and training workshops as well as agenda, minutes and records of other cluster affairs will be found in Appendix I.

In summary, the consortium is concerned with the practical problems of incorporating the Watershed Study into the curriculum; the cluster is concerned with the problems involved in

the watershed study itself.

Each school determines, based on faculty and student interest, how it will approach the problems it uncovers in the survey of its watershed. Consortia and clusters exist solely to support teachers and students in what they want to do. They do not dictate what needs to be done.

Establishing a Technical Advisory Committee

You may want to create a formal technical advisory committee, comprised of scientists, planners, economists, sociologists, lawyers and others interested in the watershed study and willing to help when needed. Maintaining a list of resources you have found, or inviting these people to participate in periodic seminars and workshops may serve your purposes as well or better than having a formal committee. Some schools and clusters arrange certain nights each week when technical resource people are available to work with students who need help.

Involving Youth and Citizen Groups in the Watershed Study.

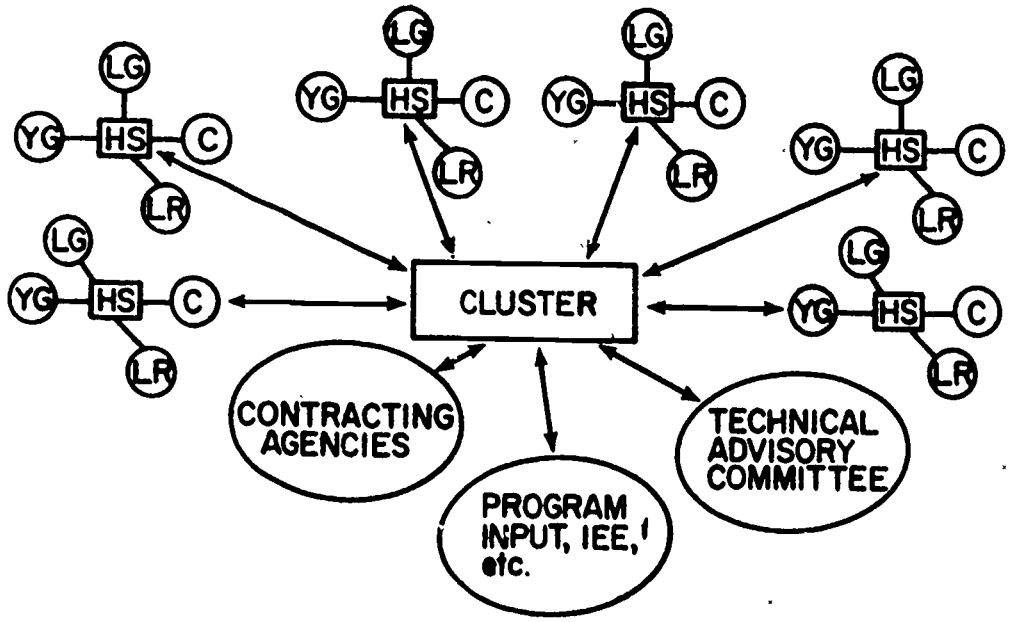
The most important time for monitoring stream quality is during low flow periods. These usually come in late summer when school is out. 4-H clubs, scout troops, explorer posts, or adult groups can provide a real service during these periods, but their work should be supervised by a member of the watershed study team. These groups may also provide valuable service in walking or canoeing the stream, mapping pipes, erosion and other potential pollution problems, as well as land use. The school study team can then investigate these problems further.

In 1971, youth groups contributed valuable data to several projects in the Stony Brook-Millstone Microwatershed Study. Fifty 4-H members, along with students from the schools involved in the project, spent the summer sampling streams in five counties in Central New Jersey to determine baseline water quality during the low flow seasons. They then published a report which was sent to all schools whose streams were included in the survey[1]. Another group, Scout Troop 58 of Hightstown, gathered data for and under the direction of the Peddie School Watershed Study Team during the same period[2].

An organizational model that shows the relationship of all these groups to one another might be visualized as follows:

[1]Gail, Peter, 1972, Water Quality in Rantan and Millstone River Tributaries - A 4-H Summer Program, Institute for Environmental Education, Item F.

[2]See Appendix 4



These are suggestions. They may, or may not, work for you. One of the first jobs necessary for the cluster committee will be to answer the following questions:

-What organizational framework is best for our microwatershed program?
-How large should a cluster or consortium of participating schools be? How will we communicate within the cluster and between clusters working on the same watershed?
-How will we organize the equipment and replacement of supplies within the watershed? Is there need for a quartermaster?
-How will we perpetuate the skills needed in the program?
-How will we get other teachers and students involved?
-How will we insure dependable transportation to support sampling?
-Who are the principal resource people who will support a microwatershed program in our community? How will we identify them? Where will we get the technical support needed to interpret the information we gather?
-What kinds of home-made tools can we make?[1]
-How can we pool expensive, seldom used specialty equipment so all schools benefit from it.

[1]Institute for Environmental Education, 8911 Euclid Avenue, Cleveland, Ohio, Support Agency

[2]Kriebel, D.(ed), 1974, Curriculum Activities Guide to Water Pollution Equipment, Institute for Environmental Education. Vol. III, Environmental Education Guide Series.

CHAPTER 2 - INTEGRATING WATERSHED STUDIES INTO YOUR CLASSES

Introduction

Watershed studies can be integrated into science or social science classes, and/or be subject of new courses in either department. Often students are introduced to the concept in 9th or 10th grade core courses and pursue their studies in advanced elective courses, or through independent study.

Some Possible Start-Up Strategies for Watershed Studies

Some startup strategies for environmental studies programs are presented in the Environmental Education Guide for Teachers[1]. Teachers who initiate their course with watershed studies, find that a structured sequence of startup activities, including discussions on watershed concepts and some skill development exercises, are most successful.

A general schema for starting a watershed unit might be as follows:

1. Discuss the hydrological cycle and the importance of watersheds in land use planning (lecture and discussion).
2. Watershed mapping activities - students identify the streams near school or their homes on a topographic map, and mark the boundaries of the watershed. They then make a watershed reference map (page 70), (small groups).
3. Discussion of ways to get information about the watershed (small and large group discussions).
4. Assignment of information gathering tasks to class members either individually or in small groups. This can be done using task cards[1] or by having groups decide on what they need to study. Teacher works with each group as they plan how they will get the information. Interviews are dry run, etc.
5. Information is compiled into reports by each group and given orally and in writing.
6. Specific problems are identified by the students who then choose what they want to work on, plan their study and carry it out.

Skills training sessions, either individually with slide cassette training materials[2], through seminars, or by students training other students, can be integrated into this schema

[1]Environmental Education Guide for Teachers, Chapter 2.

[2]Institute for Environmental Education has student produced training units composed of a series of slides and a cassette tape

where needed.

One example of such an approach was developed by Drs. Robert Simpson and Mary Leck for a Water Pollution Problems class at Rider College, Trenton, New Jersey. It is equally adaptable for use in high school. Their objective was to get the class off to a fast start, so that plenty of time would be available for the study.

The topic was introduced with approximately four hours of lecture which covered the hydrological cycle, what watersheds are, why it is important to study them, and some of the features (natural, social, political and economic) of the watershed they were assigned to study. Then, using topographic maps, they determine the boundaries of the watershed and went into the field to get first-hand impressions. With this background, they began the following series of exercises. Each exercise was typed on a separate card. After students had finished the first exercise, they were given the second and so on, until the sequence was completed. You will notice that Exercise 6 requires the use of the force field problem solving scheme presented on page 87, Section 3. This procedure worked well for Drs. Leck and Simpson. You might want to try it.

EXERCISE ONE - Divide into small groups - each group consider the following questions:

1. What factors must you consider if you are to adequately assess the extent and causes of the problem you are investigating?
2. Why is each factor important?
3. How does each factor affect man and/or other organisms?

List the factors on a piece of paper and be prepared to explain the importance of each factor and how it affects man and/or other organisms.

EXERCISE TWO - Large group meeting

Now that each small group has presented the factors they feel should be considered, compile a master list of factors.

EXERCISE THREE - Small group sessions

You have a set period of time from today (specified by your instructor) to deal with the factors the class has listed. Consider the following questions:

1. What order of importance would you ascribe to the master list of factors?
2. Why have you selected this ranking?
3. How are you going to get the information you need to determine the actual extent and importance of each factor?
4. What obvious resources will you need for each factor? List those needed and those available. This is one means of assessing feasibility of dealing with the problem.

Record your ranking on a piece of paper and be prepared to defend your ranking and the procedures you would use to determine the actual extent and importance of each factor.

EXERCISE FOUR - Large group

Now that each group has presented their rankings and the procedures they would use to assess each factor, decide what factors the group will actually research during the month.

EXERCISE FIVE - Individual

Choose the factor you would like to emphasize and investigate in depth.
(Note: You will have a chance to explore other factors of interest during the month, but not in the same depth as the factor you choose for in-depth analysis.)

Here are some guidelines for selecting the problem:

1. Is it something you really care about? Select a problem you want to work on.
2. Is it something in which you are personally involved?
3. Do you have some possibility for influencing the situation?
4. DESCRIBE THE PROBLEM AS YOU SEE IT.

Just in case no one else wants to work on this, have a second choice in mind.

EXERCISE SIX - Project groups of people with similiar interests.

Now that you have selected your area of concentration, and described the problem as you see it, you and other members of your work group will use the problem solving program provided to you to clearly define the problem and plan a course of action to solve it. (Force Field Problem solving techniques, page 87). Be prepared to present a brief discussion of your problem area and how you plan to attack it to the other project groups.

EXERCISE SEVEN - Large or small group discussions

Now that you have a general idea of what each group is going to do, consider the following questions:

1. How are you going to maintain adequate communications between groups?
2. How are you going to compile data, exchange information, and ask for each other's assistance?
3. How are you going to have a well-written report summarizing your findings completed at the end of the work period?

Once these plans were completed and approved by the teacher, the student teams began their study. The report produced by students in the 1971-72 course is available[1].

Another approach is to start the students with a series of assignments that get them into the watershed. This does three things, 1) accumulates some of the information needed for the assessment; 2) builds an awareness of the diverse activities and resources within the watershed; and 3) develops information finding and sharing skills. A weekly rap session in which each student team shares what it has found with others, broadens everyone's experience with the watershed.

In a social studies, government, economics, or history class you might start, after identifying the watershed area and making a reference map (page), with such assignments as:

-What kinds of problems do people have who own houses on flood plains or in other wet soil areas? Would they buy another home on a flood plain?

[1]Simpson, R. , Leck, M., et al, 1972, A Preliminary Study of the Rocky Brook Watershed, Environmental Education Institute, Item F.

-What restrictions are there on land use within the boundaries of our watershed? Who restricts it, and why?
-How is local government financed? Does this have any effect on town politics?
-What laws would a developer have to comply with if he wanted to build a house in our town?
-How are people selected for appointed boards? Who selects them? What is the criteria for the appointment? What are the qualifications of the people who now serve on the boards?
-What are the duties of the Board of Health? Where would you look for this information? Is the Board of Health fulfilling its responsibility?
-What criteria are used to establish a zoning ordinance?
-What money does our town get from the federal and state governments? What is it used for?
-Do local planning officials know what watersheds are?
-Are township zoning ordinances based, at least in part, on soils survey information? Do we have a master plan in this town?
-How are new laws introduced to council? What would a citizen have to do to get a law introduced into council?
-In what ways do our elected officials try to influence our thinking?
-What are the attitudes of local officials about environmental quality in the town? Is anything being done now to improve it?
-What resources are available in the local offices of government agencies which can help us better understand our area?
-Who owns the property along all the streams in the watershed?
-Are the existing laws protecting public health and environmental quality being enforced? What are the laws? Who is responsible for enforcing them? If they are not being enforced, why not?
-How does a politician build a constituency?
-How can the public influence what politicians do? Design a questionnaire to find out what people consider to be their environmental problems that yields usable information rather than just attitude or opinion.
-Trace the genealogy of the town's oldest families. What influence do these families have on our town now? How did that influence develop? What effect have their business activities had on the current environmental problems in our town?
-How responsive is our government to the needs and wishes of the people? Who are they responsive to and why? (This might be determined by students taking a specific issue identified by citizens as a problem, e.g., road salting, and try to resolve it going through government channels. This activity could occupy a large part of the school year.

In a science class you would also make a reference map and start with questions such as:

-What is the relative abundance of animals in the stream bottom at the headwaters, mid-region and mouth of _____ ____creeks. (Or upstream and downstream from a specific sewage plant, industry, farm or housing development.)
-How is the land used on all areas that could possibly affect _____Creek?
-How much water falls into the area drained by _____ Creek per year, and of that, how much do you suspect drains off? Justify your estimates. (see Water Budget Activities, page 114).
-Given a piece of a soils map and an interpretation sheet, place a house with basement, a septic tank, farm pond, a Christmas tree farm and a cornfield on it so the land will be used in the most ecologically sound manner.
-How do people who have been living along _____ Creek for ten years feel about their homes? What problems have they had that they didn't anticipate when they bought the home and what would they look for in buying a new home?
-What agencies, businesses, or people would you go to to obtain information on how to best use a piece of land you plan to buy? What kinds of information or help would you expect to get from each?
-Determine, by using appropriate tests, whether the sewage treatment plant at _____ affects the bacterial count of water in _____ Creek. (To be determined by experimentation, not from literature or interviews.)
-Determine, by testing and reviewing the literature, whether the river upstream from _____ can support trout. If not, why not? Could anything be done to it to make it a trout stream?
-Determine all possible sources of pollution between _____ Road and _____ Road and map them.
-What kinds of effects could the farm at _____ and _____ Roads have on water quality on _____ Creek?
-Does the township have a master plan, and if so, is it built on a base of soils information?
-What are the responsibilities of the Board of Health?
-What should the quality of our stream be? Find the baseline (without man-induced pollutants) water quality for our watershed. Where would you go to get this data?
-What happens to water that goes down your storm drain? What goes into the water before it enters the storm drain?
-Make a list of all the different types of wastes produced in this town. Where do they go? What effects do they have on others?

These watershed awareness tasks are written on numbered slips of paper. Students, in teams of two, choose tasks, work on them and report their findings at the end of a specified period of time, usually 1-3 weeks. You will very quickly spot

skills deficiencies and be able to plan skills training sessions (Section 3) to correct them.

Science oriented tasks may be used in social science classes or vice versa if no teacher in the opposite discipline is working with you. However, try to involve as many other teachers from all disciplines in the project as you can. Divide the tasks listed above among the science and social science teachers. The arts, English, industrial arts, math and home economics departments can make equipment, analyze data, and communicate with the public. All students and teachers participating in the project would schedule periodic symposia to share their findings.

A more structured approach to watershed studies might be conceived as follows:

PHASE 1 - Training in Watershed Study Skills (Sept.-Oct.)

1. The hydrologic cycle and watershed concepts are discussed.
2. Students map watershed boundaries on topographic maps, make a reference map, plot where they live, and establish preliminary survey teams made up of people who live relatively close to one another.
3. Each preliminary survey team makes an enlarged map of the area for which it is responsible.
4. Student survey teams make land use analysis as homework.
5. During class, students are trained in: a. water chemical sampling and analysis; b. bacterial sampling techniques; c. measurement of flow and sedimentation; d. identification, ecology, sampling for invertebrates, fish, plankton and other aquatic organisms.

While being trained in these skills and concepts, students conduct studies using the skills within their assigned area, (e.g., after the student has been trained to use membrane filtration equipment to determine fecal coliform concentrations, he chooses an appropriate site near his home, designs a simple research plan to determine bacterial contamination, and carries out the research.) In addition to gaining experience conducting simple research, the student gathers information useful in pinpointing problems for later study.

PHASE 2 - Social Survey Skills (Oct.-Nov.)

1. Class prepares report on their Phase 1 findings.
2. Students are trained to use the library (including a field trip to a local university library), write study plans, group dynamics

and other operational skills (Section 3).

3. Students are trained to use tax and soils maps, develop questionnaires and conduct interviews. They then apply these tools to an assessment of land use and resident attitude in their watersheds.

PHASE 3 - Independent Team Studies (end of first semester, entire second semester)

1. Students identify problems that they have found in their preliminary studies, form teams according to their interest, plan research, and have the remainder of the year to study problems they choose. Weekly progress reports can keep everyone informed about what the rest are doing.

Each training session can include readings, seminars, and lectures as appropriate. Lectures on plankton can lead into traditional academic concepts, such as photosynthesis, those on bacteria into microbial genetics, etc. Phase 3 is done mostly on the student's homework time, giving you the rest of the year to cover other concepts you normally include in your class.

What do You do After the Study is Well Underway?

The watershed assessment may occupy, with all the other material you must cover, the better part of the first year. A written report on your findings will be valuable not only to town and government agencies, but to your students as well. The problems unearthed and directions identified provide a basis for studies in succeeding years.

Second year students can be introduced to previous studies through slide-cassette presentations prepared by students at the end of the first year, by reading reports prepared the preceding year, they can choose from the list of problems found by earlier students, or continue with a long term project started by those students. Often experienced students can help younger students doing environmental studies for the first time. This work may take the form of the Park School study[1] which chronicled what happens to storm water runoff as an area develops from rural to urban over five years, or of the Peddie School Rocky Brook study, in which students during the first year identified siltation, inadequate enforcement of existing health laws, and poor communication on environmental issues as the major problems in their watershed. Using the first year's report as a guide, second year students did the following--in part, in their social studies, biology, chemistry, and English classes; and in part as senior projects:

-interviewed Board of Health members and found that most didn't fully understand their responsibilities and opportunities.

[1]Howard, James, III, 1971, Studying the Impact of Urban Encroachment, American Biology Teacher, 33:342-349.

-studied the enabling legislation establishing Boards of Health, and shared their findings with the Board in an informal meeting.
-helped the Board find a competent health officer for the town.
-contracted with the Board of Health, for $1,250.00, to do research on siltation and allied water quality problems and submit reports on their findings with recommendations[1].
-established a hot-line between city hall and the school so they could receive and immediately follow-up on reports of fish kills or other stream abnormalities while the evidence was still fresh.
-helped a town upstream use soil survey information to re-zone land within the watershed so that proposed development would cause the least environmental damage.
-worked with local government, conservation commissions, and citizen groups within the watershed for the passage of an erosion control ordinance which would protect the local lake from further sedimentation.
-prepared a series of slide-cassette training programs on how to conduct watershed studies which could be loaned to teachers in area schools for the training of their students.

This was all coordinated by one English-social studies teacher, John Philips, with the help of other teachers as resource people.

When and How do You Invite Others Schools to Join in Your Watershed Study?

When your study is well underway, and your best students are trained in technical and operational skills, you might suggest to your student leaders that they invite other schools to join the study. A presentation to an assembly or faculty meeting at schools you select might be the first step, followed by training sessions. Programs for such training sessions conducted in New Jersey and Ohio are in Appendix 2. One of your experienced students may be assigned to advise the recruited school during their startup period. Participation in regular cluster meetings will help the new school overcome any initial problems.

How Watershed Studies Can be Used to Initiate Traditional Academic Units

An oft-heard argument against incorporating watershed studies is that the teacher has too much to cover now and not enough time to do it. To the contrary, watershed studies can help you more effectively teach what you now teach. Certain types of watershed study activities can serve as a springboard into concepts and have the students more interested in

[1]Burne, Torson, 1972, A Comprehensive Study of Siltation in [illegible]ky Brook, Inst. for Environ. Educ., Item F.

and enthusiastic about learning them than ever before.

For example, in biology:

-a survey of photosynthetic productivity in a pond can lead into a unit on photosynthesis.
-a detailed analysis of distribution of aquatic invertebrates in different microhabitats can lead to a unit on physiology and genetics of adaption.

In chemistry:

-"Would dissolved oxygen content be higher in riffle areas or in pools?" might lead to a discussion of the gas law.
-analysis of well water led to a discussion of solubility constants in a class at Montgomery Township High School.
-an exploration of the effects of chlorination on water upstream and downstream from a sewage treatment plant led to a discussion on acid-base balance and buffer systems.

In earth science:

-"Why does grass grow in some places and not others in your backyard?" led into a study of soil and its properties.

You will undoubtedly find many other similar activities that can start units more interestingly than the standard lab exercises.

Tips for Teachers and Miscellany Not Covered Elsewhere.

All of us seek peer approval. In any class or company, most employees or students without positive direction will work at low productive levels. A few are ambitious and a few are completely non-productive. Every teacher or manager enteres his class or job facing this situation. A good teacher or manager inspires those working with him/her to do their best. Teachers in Ohio characterized people they know that fit this description. According to these teachers, they are:

1. Patient and willing to teach student or worker how to succeed on his own. Criticism is constructive and designed to build morale.
2. Enthusiastic about their work.
3. Sincere and friendly.
4. Competent; they can do all the jobs they require of those under them.
5. Well-organized.
6. A good example; they never ask someone to do what they wouldn't do themselves.
7. Quick to show how each person is important in the success of the group and recognize accomplishments, no matter how small.
8. Firm but forgiving; they expect the job to be of

high quality and to be done on time; they express disappointment when it is not, but work to help the person succeed the next time.

9. Selfless; they go out of their way to help others.
10. Humble; they admit their errors and mistakes. They seek and utilize counsel from those working with them. They aren't afraid to say, "I don't know, let's find out together" or "What do you think?"

The teachers agreed that a person with these traits inspires the confidence, respect and love of his/her class or employees.

Many times class members look to one of their peers as their real leader, regardless of who is elected or appointed the "official leader" (teacher, class president, etc.). If that person is ignored or treated as an equal by the teacher, hy may compete with the teacher for the attention of the class members. One way to deal with this is to acknowledge his/her role and make him/her responsible for some of the class activities. You may put him/her in charge of a team assigned to find information or accomplish a task, or ask him/her to teach some skill that you have previously trained him/her in to others.

This tact is the same one you would use in designing a community or watershed assessment. Your study has a greater chance of succeeding if through subtle questioning of citizens, you find out who the real leaders of the community are (the mayor, or township trustees may be figureheads), and share your ideas with them, seeking their help in your project.

Students may become biased. One of your jobs is to help them remain objective. Encourage them to look at all sides of an issue before coming to conclusions. The following advice might be transmitted to students in a form which best suits your style.

1. Be truthful about your project when speaking to residents, town officials and industry representatives. Remember that our interest is not in condemning suspected polluters, but in getting facts about how land and water in the watershed is being used. We are trying to assess the current situation. Don't be trapped into commenting on someone without having built all the facts from both sides.

2. We got to the moon by being unified. If we are going to solve pollution problems, we will do so by getting everyone together--government, industry, individuals--to work on the problems, each sharing his particular experience and expertise. Attack and condemnation breeds defense, and nothing gets done. In every case, try to bring people together. Don't become emotional

and don't make enemies, especially in the information gathering stages of the project. If, after you build your case history, you find non-cooperative officials or industries, then may be the time to present the case before enforcement agencies.

3. Don't encourage too much press coverage until you have solid, verified data that will not embarrass you later. If you call someone a polluter, you better be able to support that with quantitative data, as well as with information showing you understand his problems, how his operation works to cause pollution, and what alternatives he has to correct the problem.

4. Don't advertise your moves to the extent that you dry up sources of information. Don't be classified as activists out to get polluters. Make it clear that you realize that our problems will be solved only when everyone recognizes the problems, brings them out into the open and works cooperatively to find answers.

CHAPTER 3 - DEVELOPING A PUBLIC RELATIONS PROGRAM TO BUILD SUPPORT FOR YOUR ACTIVITIES[1]

Introduction

A good public relations program may determine how well your class activities are supported by administration, community, parents, students and colleagues. Simply stated, public relations is "doing good and telling people about it".

Your media outlets might be newspapers, magazine articles, radio, television, your own class newsletter, public presentations at PTA meetings, workshops, local government meetings, school board, or even testimony at hearings on environmental issues that concern you. It is important that you know how to capitalize on each opportunity to build additional support.

Public relations should start right within your class and school. No money is needed to start. You simply need someone, preferably with a little experience on the school newspaper or elsewhere, who has a "nose for news" and is interested in communicating what you are doing to others.

Your PR effort should:

-keep the community correctly informed of your activities that affect them and which they can participate in.
-share information students have gathered on which they can act to prevent or correct environmental damage.
-build a solid relationship between you and the community.

Qualifications of the PR Person

Look over your class. See if you have anyone with the attitude for PR work. He/she should thoroughly understand the program and be able to articulate clearly in speaking and writing. He/she should also be:

-sincere, while fair and tolerant of the views of others, able to stand by his convictions.
-a friend maker who likes people and is able to get along with them.
-honest and dependable
-capable of using the soft-sell approach rather than being pushy and persistent.
-able to act quickly to get stories in. Time is a vital factor. Today's news today is what is wanted; tomorrow may be too late.

If you find no one who meets these qualifications, you may:

-do the job yourself, or consult with the journalism or English teacher to see if he has someone who would like

[1]Adapted from: How to Conduct a Public Relations Program for Your Ward or Stake, Church of Jesus Christ of Latter Day Saints, Salt Lake City, Utah.

to function in the position.

Who Wants News?

All news media need news--reports on what is happening in their areas of influence. Generally they will welcome news leads and stories from any reliable source. Your PR person's job is to let them know that you exist and that information coming from him is reliable.

Before you start your own PR program, though, let your principal or other appropriate administrator know and approve. Make sure they also approve all PR copy that goes to the public. Some schools have a PR department or person. If yours does, you will want to coordinate your activities with them.

What is News?

News comes in many forms. Here is a check list of just a few possibilities:

-students publish water quality report.
-students do a survey of local public transportation and want to share their findings.
-students, with help of community planners, construct a master plan for the town which takes environmental values into account.
-a brochure explaining city zoning laws has been produced by students and is now available to the public.
-a hot-line has been established between city hall and the watershed study group to report fish kills and other water pollution problems immediately.
-students are working with Board of Health or planning board to draft new ordinance designed to protect environmental values.
-your class is sponsoring an environmental symposium for the public.
-members of the watershed study group will do soil and/or well-water testing for the public.
-students receive awards for community service.
-students testify at Congressional, Corps of Engineers or other hearings.
-students present results of their study to city council.
-exhibit planned for fair, library, etc.
-presentation given to service groups, school board, etc.
-special workshop, conference or symposia for member schools.
-feature on the variety of studies being conducted in your class and school.
-students receive scholarship based on work in the program.

Six Steps to Organize a PR Program.

Step 1. Select the best person for the job.
Step 2. Work with that person to survey and list the people he will be working with in the media.

a. Research the news media. List all key news media people, with addresses, phone numbers, names of owners and publishers, news directors, environmental reporters, radio and TV stations, news wire services, etc. It is vital for effective coverage that the list be as complete as possible. The list should also contain names, phone numbers and data about important influence makers in the area. Key elected officials, civic leaders, educational groups, government agencies heads, citizen environmental groups. Make sure the list includes free circulation papers and other special publications. A sample public relations work sheet for the press might look like this:

WORKSHEET FOR PUBLIC RELATIONS SURVEY-WORKING PRESS

Media	Address	Phone	Administrative Head	News Editor	Reporter
Daily Newspapers:					

Weekly Newspapers:					

Television Stations:					

Radio Stations:					

Wire Services:					

Other:					

b. Radio and TV stations are required by FCC regulations to devote a portion of their broadcast time to public service. Public broadcasting will often do feature stories on an interesting program if they are approached properly.

Step 3. Start to work immediately. After the survey is is completed, the PR person should visit each medium personally as soon as possible. In calling on the press, he should keep each visit short and try not to intrude during pressure hours--deadline periods or newscast times. He should leave

his name, phone number and address, and a brief explanation of what makes the program newsworthy, or better yet, a press release on the program and what is currently happening. Reliability is the key. If the PR man doesn't know the answer to a question, he should say so, and that he will find out and call back.

Tips

1. The PR person should always try to know personally the press members with whom he is dealing. If he is only a signature on a press release, the story can be dropped. It's not so easy to throw his release away, however, if they know him.

2. Don't pressure news sources. Most media get ten times as much copy as they can utilize. If the story is not used the PR person should not get upset. He can call to see if it arrived, or if they need more information, but should never hound the media or express disappointment if the release was not used.

3. Saturday or Sunday magazine people are always looking for good features. Have your PR man get to know the feature editor of these magazines, and keep them informed about what you are doing.

4. Make notes about how the various media want stories submitted. Some may want stories phoned in as soon as possible, rather than mailed or carried in.

5. Learn the deadlines of the various media; which day the weeklies want copy and which hour in the day the morning and afternoon dailies want material. Adhere to these deadlines.

Step 4. Set up an internal PR program, also, covering the school, community and parents. Keep them all informed through newsletters, articles in the school newspaper, bulletins, presentations, etc.

Step 5. Involve others. Invite good artists, writers, and speakers to fulfill specific assignments. Give them a deadline and hold them accountable. Make friends with the school photographer, art teacher, good typists, school newspaper editor and reporters and others with special skills which might dovetail well in the PR program. By spreading the assignments, the PR person does not get over-burdened to the degree that his or her school work suffers.

Step 6. Follow correct journalistic form for your newspaper news releases. The following is an example of how this is done. Pay particular attention to form as well as content.

NEWS RELEASE

"Environmental Studies" Newspaper Writing

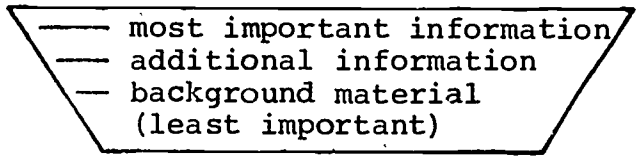
for further information, call, Peter Gail, day or night: 421-0028

FOR RELEASE AFTER NOVEMBER 1

A news release is a fact story which may consist of three parts: the opening paragraph briefly tells the main point of the story; the second gives additional information; the third tells the background.

The first paragraph may include a brief statement of any of the following: who, what, where, when, why, or how, depending upon the subject of the release. A concise first paragraph should not exceed 35 words, and the average is 21 words. Additional information and background material then follow in order of importance to the reader. This style of writing is referred to as the "inverted pyramid", and is followed because editors often must cut the story from the bottom without fear of deleting the most important facts. The editor, and the reader, get the most essential facts without reading the entire news release.

The Inverted Pyramid:



News releases should be double-spaced on a 60-space line with five-space indentation for each new paragraph. To indicate conclusion of a news release, place "-30-" at end of the material. If more than one page is necessary, write "MORE" at the bottom of the material. Place release subject name (example: "Environmental Studies" - Newspaper Writing) directly above "FOR RELEASE..." on the first page. Repeat subject name at the top of second page, with "ADD 1" placed directly under the topic. "ADD 2" is placed at the top left of the third page, etc.

-30-

Sample Press Release

NEWS RELEASE

for further information,
call: John Philips, 428-7361

ENVIRONMENTAL CONFERENCE PLANNED
FOR AREA HIGH SCHOOLS

FOR IMMEDIATE RELEASE (or date you specify)

SOUTH BRUNSWICK, N. J.--Feb. 24-- Students and teachers from ten area high schools will meet this Saturday, Feb. 27, to learn how to pinpoint pollution problems in Millstone River tributaries and work with adults to solve these problems.

The conference will begin at 9:00 a.m. in the Science Bldg. Lecture Hall at Rider College, Trenton, N.J. Speakers will be Mr. Ian Walker, Executive Director of the Stony Brook Millstone Watersheds Assocation; Mr. George Pence, Chief of Simulation and Forecasting, Federal Environmental Protection Agency; and Mr. John T. Hershey, Science Dept. Chairman at Germantown Academy, Ft. Washington, Pa. Mr. Walker will discuss environmental problems of the Millstone watershed and Mr. Pence will explain the relationship between the student program and studies being conducted by his office. Mr. Hershey will discuss a case history of a similar program at Germantown Academy and present a film produced by students at the Tilton School in New Hampshire.

In the afternoon, social, political, economic and technical aspects of the study will be discussed by students and representatives of public agencies and industry.

-MORE-

ENVIRONMENTAL CONFERENCE
PLANNED FOR AREA HIGH SCHOOLS

FOR IMMEDIATE RELEASE

ADD 1

Joining the morning speakers in these discussions will be Mr. David Beeker, Assistant Manager-Process Engineering, Johnson and Johnson, Inc.; Dr. Don Derr, Asst. Professor of Agricultural Economics and Dr. Ronald Raschke, Asst. Professor of Botany, Rutgers University; and Dr. Robert Simpson, Asst. Professor of Biology, Rider College.

Participating schools include South Brunswick, Hopewell, Montgomery, and Princeton High Schools, and Peddie, Hun, Lawrenceville, Pennington, Princeton Day and Stuart Schools. Several youth groups will also be represented. Others interested in the program are invited to attend.

-30-

NEWS RELEASE

for more information,
call: Russ Hansen, 653-9524

$800.00 GOODYEAR GRANT
AIDS WRA STUDY

FOR IMMEDIATE RELEASE

HUDSON, --March 13-- An $800.00 grant from the Goodyear Tire and Rubber Company has enabled a group of Western Reserve Academy students to continue a 1972-3 study of the water quality in Brandywine Creek, which originates in Hudson and runs through Northfield and Macedonia before emptying into the Cuyahoga River.

Last year's study was initiated by Rich Grant, son of Mr. and Mrs. George Grant, of Hudson (58 Habden Dr., 653-6077), who was concerned with the effect pollution has had on the Cuyahoga River and the ecosystems surrounding it. Local interest groups, such as the Cleveland Health Museum, the Cleveland Institute for Environmental Education, and Cleveland State University helped support the project along with funds from the Goodyear Company.

Three Academy juniors, Jonathan Hardee of Hudson (7543 Sugarbush Trail, 653-9472), Michael Donovan of Hudson (333 Simon Dr., 653-2281), and David Livingstone, of Brecksville (12916 Parkview Rd., 526-4107), are heading the current study which is a continuation of Grant's work. These students along with 15 others, are concentrating on measuring the impact of three sewage dis-

-MORE-

$800.00 GOODYEAR GRANT
AIDS WRA STUDY

FOR IMMEDIATE RELEASE

ADD 1

posal plants on the water quality in Brandywine Creek. They also hope to gather rough preliminary data on effects of salt runoff from roads and highways on the creek.

A special laboratory at the Academy for the analysis of water samples and other specimens was built last spring with the help of Goodyear funds.

The students involved find it a stimulating and valuable experience to work in the field rather than encounter simulated problems in the laboratory. They feel they are learning how one goes about studying environmental questions and helping to solve them in a realistic way. Overseeing the study is WRA's Biology Master, Russel F. Hansen.

-30-

Photographs

Generally, a good photograph makes the written news release more appealing. The photograph should be submitted with the release. However, space will be a major factor when the editor decides to use it or not. Don't be disappointed if it doesn't get run.

When submitting photographs, be sure to write the cutline (caption) and tape it directly to the back of the picture. Photographs should show good contrast and be glossy rather than matte finished. Make sure to have names, addresses, and phone numbers of all people in the picture listed in the caption.

Writing for and Utilizing Radio and Television

The same basic journalistic format used for newspaper releases should be applied to radio writing. Note in the text of the following release the difference in content.

NEWS RELEASE

for further information call: William Haws, day or night: 345-6759

"ENVIRONMENTAL STUDIES"

RADIO WRITING

FOR IMMEDIATE RELEASE

A radio release follows the same format as a newspaper release. But when a person hears a news broadcast, he cannot re-read the story. He must understand what the newscaster says the first time.

If the listener fails to understand the newscaster, the message is gone. The listener is left dissatisfied, wondering, confused.

In writing news for radio, in the interest of clarity:

1. Avoid long or complex sentences or phrases.
2. Numbers usually cause a problem for the

-MORE-

"ENVIRONMENTAL STUDIES"

RADIO WRITING

FOR IMMEDIATE RELEASE

ADD 1

radio broadcaster; avoid addresses, ages, etc., unless they are important to the story. When numbers must be used, write them smoothly into the story. (Example: "Fourteen-year-old David Evans of Cambridge" sounds smoother than "David Evans, 14, of 11456 Kinsman Blvd., in Cambridge").

3. Details for news articles written for broadcasting should be kept to a minimum. Tell the entire story but avoid uninteresting details. Only in a "feature" are the details important in electronic journalism.

4. Be certain to proofread carefully and read aloud all news releases before distributing them.

-30-

While many stations are network affiliates and subscribe to various audio services, they have large news gathering staffs and hence have no major difficulty obtaining personal interviews with the news maker (actualities); smaller stations have relatively few sources for actualities.

Nearly all stations would be pleased to receive 30-second statements. The average actuality length should be approximately 25 seconds, never longer than 45 seconds.

If the actualities must reach the radio station within a reasonable period of time after they occur, pre-record some for advance release.

Provide television news directors with copies of news releases sent out to radio or newspapers, and suggest ideas for adaption of news release material to television.

Watch for human-interest ideas adaptable to visual presentation. These ideas should be continually suggested to electronic media people, especially those in public broadcasting.

Exercise care in releasing material to radio and television stations and to newspapers; see that preferential treatment (because of deadlines, etc.) is not given to one station or newspaper over another. When special consideration seems given-because of staggered deadlines-care should be taken to see that another receives it next time. Great effort is exercised by all media to be "first" to release a story, especially one of importance. Be careful here.

Publishing Your Own Class or Watershed Newsletter

If you, or your cluster, publishes your own watershed newsletter for parents or community, and want to make it look professional, the following checklist may give you some guidelines.

CHECKLIST for PUBLICATIONS

1. Determine philosophy of publication.
2. Determine departments. How much space will be devoted to features, each department, ads, etc.?
3. Put dummy (work sheets with department headings in their proper places) on wall. Assign features, departments, etc. to proper places.
4. Develop list of articles and materials needed for each department.
5. Assign staff responsibilities; features, departments, art, layout, copy, subscription, and advertising (if any).
6. Assign articles to authors. Give them article length. Discuss illustrative material and how that will cut down on article length.
7. On submission of article, appropriate editor sets file

folder for it.
8. Submit to art editor who makes format and illustrative decisions on the article.
9. Copy editor reviews content and grammar for accuracy, readability, pacing, etc.
10. Art director and layout man prepare layout sheets.
11. Typist types articles to fit spaces in layout sheets designated for them.
12. Camera-ready copy is sent.

Public relations will be a crucial factor in how effective you are in getting environmental improvement in your community. Many people are interested in helping on projects others initiate, but don't want to do the organizing themselves. Your Public Relations program can recruit these people into your service, and win more passive support from others for your watershed studies.

SECTION 2 -- TEACHING RESOURCES WITHIN A WATERSHED ACTIVITIES AND BACKGROUND INFORMATION

Introduction

Many new ideas for studies will occur to both you and your students as you progress through the year. Take advantage of these ideas by being flexible. Many times both you and your students will learn more by following your intuition and interests rather than sticking with a predetermined plan. Some of these studies may seem unrelated to watersheds, but there is no rule that states that you must concentrate on watersheds alone. The watershed and its problems are points to start from, not a prison from which you can't escape when something more interesting arises.

The activities in this section are representative of the kinds of watershed studies students have conducted during the past three years. They are divided into two chapters:

-Critical areas and resources in watersheds
-The influence of man's activities on watersheds

You will note a lack of specific style and consistency in the following presentation. After long discussion, we decided at the risk of seeming unprofessional, that this is what we wanted. Each activity has unique attributes that the author appreciates and which resist being hammered into any standard format. What you are reading, therefore, is each of the six of us communicating to you what we think is important. We hope you will find this diversity refreshing. If not, you will at least know that we did it to you on purpose. We would appreciate your comments and criticism.

Each activity contains a few starter questions. The students should really come up with their own questions, with the questions given used as a last resort, or to every now and then inject new life into a project. As long as the student is generating questions, even if they are unsophisticated, let him pursue answers to them. The question he is asking is where he's at. If he is really interested, his questions will become more sophisticated as he digs deeper into the project. Imposition of the questions at the wrong time and in the wrong way may stifle his interest. They may be too sophisticated for his skill level and he will become frustrated because of his inability to find answers for them. On the other hand his questions may be too sophisticated for him to handle successfully in which case you may have to help him restructure them into feasible units.

Another resource for supplemental ideas along this line is: Wurman, R.T., Yellow Pages of Learning Resources, MIT Press, Cambridge, Mass., available in most bookstores.

-Stuart Hoverman
-John Philips
-Peter Gail
-Katherine Widmer
-Ann Soos
-Sean Reilly

CHAPTER 4 - CRITICAL AREAS AND RESOURCES IN WATERSHEDS

Headwaters of Tributary Streams

Headwaters are the beginning trickles of water that seep out of soil and rock crevices to form streams. Some of the questions you may ask about headwaters include:

-how can springs in the headwaters produce clean, clear water if the water comes out of the ground?

-is all water which comes out of the ground clean and pure?

-why does water come out of the ground as springs or seepage swamps?

-what determines how much water will come out of the ground in headwater areas?

After asking these questions, you might take your class to the headwaters of your local stream to survey the area and determine conditions existing there. Have students record their observations and questions. Questions they might want to consider while at the headwaters might include: how deep is the water table? how deep is it to bedrock? how much water enters the tributary each day? how clean is the water? how does the quality of the ground water influence what lives in the stream? what kinds of living things are in the water, and is this an indication of good or poor quality water? how is the land surrounding the headwaters being used? does the land use have any effect on the quality of water in the stream?

You may also want to discuss pertinent aspects of geology or hydrology before the trip, defer this until after you return, or have them read about it. "A Primer on Water" and "A Primer on Ground Water" are excellent sources of information for this discussion (see Appendix 1).

Once the basic physical operation of a headwater is understood, some individuals may become interested in determining how to protect or restore the resource.

Here is some background information to get the student started. A headwater in a virgin forest tends to produce crystal clear, clean water. When that forest becomes a housing development, small town, or shopping center parking lot, these headwaters may become contaminated with such materials as eroded soil, organic wastes, rubber, asbestos particles, and chemicals.

The teacher/student team or class can research ways of protecting the headwaters. What are the state and local laws, if any, which regulate construction in headwater areas of

tributaries? Can streams be filled in or piped without permission from state and local authorities? What is the local and/or county planning board policy on land use in headwater areas? Do you have a municipal environmental commission or advisory board which has taken a position on the management of land use in headwaters areas? What does the municipal engineer have to say about the effect on the mainstream when the headwaters of tributaries are filled in or drained?

The study team could report on the condition and potential problems in the headwaters region, and on the answers they have gotten to the questions above. When this report is completed and submitted to the appropriate agencies (planning board, board of health, municipal engineer, town council, etc.), students can work with them either to get enforcement of existing ordinances or to draft new ordinances which protect the headwaters while allowing for environmentally responsible development. If these agencies don't support what you are trying to do, and you feel your case is well-researched and your recommendations are justified, send a copy of your report, with a press release, to the local newspaper and a summary home to parents (see Chapter 3).

More information on ordinances is available from your State Department of Natural Resources, Environmental Protection Agency, or local planning board, Watersheds Associations, Land Trusts, and municipal environmental commissions also will be able to help with your research. Particularly search out laws or ordinances prohibiting stream encroachment without a permit. New Jersey has such a law, stating that no one can build upon or modify any stream bed with an upstream watershed greater than 1/2 square mile without a permit from the state. This unfortunately doesn't protect the headwaters!

Ground Water Resources

Some students as part of their chemistry course at Montgomery High School, Skillman, N.J., analyzed ground water chemistry to answer the question: "Can I find out before I dig a well what my chances are for getting hard or soft water, or iron or gases from my well?"

Activity summary: Students bring in water from their wells and analyze, according to Hach kit procedures, for hardness and iron concentration. These concentrations are then mapped on the township map and compared with the local geological map and soil survey to see if there is a correlation between soil or bedrock type and the kind of water coming from wells in that region.

Time for completion: This activity has been used for two years and has taken a minimum of three class periods each year. For some classes, it takes much more time.

Total number and grade level of students involved: 120 juniors over two years.

Equipment needed: Lots of quart jars for sampling home water from the faucet; a Hach or equivalent water testing kit.

Procedure: Students are given an assignment to bring in water from home (about 1 quart). They are asked to label it with street address, and if rural, the exact location on their road, so that this may be marked on the map with a pin. Depth of well (if known) should be recorded. In class the next day, students are shown how to determine the hardness of water with a LaMotte water hardness kit. This gives a student a quick check of the number of drops of hardness solution to use in the Hach kit for final analytical testing. pH of the water is also tested, as is iron concentration. Data obtained is plotted on a township map with color-coded pins or dots showing the number of grains of hardness per gallon. Each year more dots are added to this map. After enough data is obtained, veins of hard water and its depth throughout the watershed will be mapped. Soils and geological maps will enable us to see if hardness is correlated with certain soil types or geological formations.

Related activities: This activity can be used to introduce students to the physical and chemical properties of water and the solubility of gases and solids in water.

An activity related to ground water chemistry was an investigation of the effect of water chemistry on the cleaning power of laundry detergents. The following account of this experiment was written by Anna Bell, a student in the class, and serves as a good example of a student report which could be shared with the community.

"The chemistry class at Montgomery Twp. High School has made a study of various laundry detergents and soaps, testing their cleaning power in different types of water. The waters tested were tap, hard, distilled, and hard water softened with commercial water-softeners. The following is a report of their procedure and findings."

"The class was divided into four committees: stains, procedure, sampling and interpretation."

"The sampling committee collected the soaps and detergents from the class members and listed them. They also collected advertising materials from students, who got these from product boxes and from magazines."

"The procedure committee wrote up the process for testing: quantities of soap and water to be used to standardize the testing."

"The stains committee tested many types of stains to find the best ones suitable for the testing."

"The interpretation committee worked to rate the stains and to record these ratings in reportable fashion. They also

related their findings to the advertising media."

"They began their project by asking several questions which they hoped to answer:

1) What is the advantage of having water presoftened?
2) If hard water is presoftened, will one be able to use soaps and not stronger detergents?
3) Do the advertisements on the product and in the media give the total picture of the cleaning ability of the product in all kinds of water?"

"Their procedure consisted of gathering different stains, staining a piece of cloth, and then washing the cloths in the four types of water. The stains chosen are nearly always impossible to remove completely: chocolate syrup, grape juice, and red marking ink. In order to have a standard stain, they calculated the amount of detergent to be used, the amount of water, how long the cloth was to be washed, and in what medium it was to be washed. All these variables had to be met in a convenient, reasonable, and economic way."

"They used a Sears electric blender for their medium, placed at high speed for thirty seconds to agitate the soap and then for two minutes for the actual washing. The amount of water and detergents to use was based on the same ratio used in automatic washers, according to manufacturers' specifications. It was decided that 440 ml of water, heated to 60°C would be used. Two measures of an empty ~~22 short~~ cartridge were used for detergent."

"The stains were placed on a permanent press white cotton sheet cut into 16x1 inch strips. Stains were streaked in the middle of the sheet and as close together as possible. The strips were washed by suspending them over the blender with two flaps hanging over the blender so that the strip hung an inch to an inch and a half above the rotating blades. After washing, the strips were rinsed in the same kind of water that they were washed in and allowed to dry for twenty-four hours. Before washing, each strip had been marked with a code, identifying the type of water and the detergent it had been washed in."

"The students created a scale to grade the stains. They stained small strips of sheet and washed each in a control of 220 ml of distilled water and a filled shell of one detergent. The strips were shaken well in a glass vial for varying amounts of time: grape juice--not washed, thirty seconds, sixty seconds, and ninety seconds; chocolate--not washed, thirty seconds, and sixty seconds; red ink--not washed, thirty seconds, one minute, two minutes, two-and-a-half minutes. They were then dried and arranged from cleanest to dirtiest."

"The project used thirteen different detergents and four types of water, totalling fifty-two combinations and fifty-two strips of cloth."

"The stains were graded and these grades were totalled vertically according to the kind of water used to wash the strips. The four kinds of water gave varied results. The hard water column showed the smallest total; thus hard water's stain-removing ability was the least. Tap water had the next lowest total, with softened hard water and distilled water following in that order."

"These results show that if one uses tap water or hard water without first presoftening it, one will not get the best cleaning power out of his soap or detergent. It also shows that presoftened water gave cleaning power almost equivalent to that of the distilled water used in the control."

"The three brands of soap were tested and the results compiled in the same manner. These results were very similar to those of detergents. Hard water had the lowest cleaning ability, and tap water was behind or equal to softened hard water, which was in turn nearly equal to distilled water."

"The results show that if one uses presoftened water, he should be able to use the milder laundry soaps rather than harsher detergents and still have the same cleaning power."

"The final question was answered by collecting advertisements and information from different boxes of laundry products. The students found that while detergents advertise their cleaning ability and pollution factors, they do not give the consumer the total picture on what types of water the detergent works best in."

GRADES FOR CLEANING POWER OF DETERGENTS IN DIFFERENT WATERS

Range for scores	1-4				1-5				1-3			
Stains	grape juice				red marking ink				chocolate syrup			
Detergent and soap codes	T	S	H	D	T	S	H	D	T	S	H	D
IV	3	4	3	4	3	3	3	4	2	3	2	3
HL	4	3	3	4	5	4	4	5	3	2	2	3
BT	4	3	2	4	4	4	4	4	2	3	2	3
AH	3	3	2	4	4	4	4	5	2	3	2	3
BL	3	4	3	4	4	5	4	5	3	3	2	3
AJ	3	4	3	4	4	4	3	4	2	3	2	3
CW	4	4	2	4	2	4	4	4	3	3	2	3
IF	3	4	3	4	3	4	3	3	3	3	2	2
BO	4	4	3	4	3	4	4	4	2	3	2	3
AM	4	4	3	4	5	5	4	5	3	3	2	3
RN	3	4	2	4	4	4	4	4	2	2	2	3
BU	4	4	3	4	4	4	3	4	2	3	2	3
CP	4	4	3	4	3	4	3	4	2	2	2	3
Total	46	49	35	52	48	53	47	55	31	36	26	38
HL	4	3	3	4	5	4	4	5	3	2	2	3
IV	3	4	3	4	3	3	3	4	2	3	2	3
IF	3	4	3	4	3	4	3	3	3	3	2	2
Total	10	11	9	12	11	11	10	12	8	8	6	8

"T-Tap water known to have 7 gpg hardness with Hach kit
S-Hard water of 35 gpg after being softened by being run through an ion exchange resin
H-Hard water known to have 35 gpg hardness
D-Distilled water"

The results of this study, along with a small easy to use hardness test kit could be shared with community residents. The result would be cleaner clothes, cleaner streams, and excellent public relations for the watershed program.

Steep Slopes

In many places the earth's crust has bulged, folded, jutted, and cracked or tilted upward to create slopes of varying degrees. These sloping surfaces are exposed to:

- gravity, which pulls loose rock and soil constantly downward toward the base.
- heat, cold, ice and snow, which cause contraction and expansion of rock, breaking it into smaller particles over long periods of time.
- wind, which carries those particles away.
- rain, which washes the rock particles, and soil created from them, to the bottom of the slope and often away downstream. The steeper the slope the greater the velocity and the larger the amount of soil eroded from the slope.

Any slope above 12% is considered to be steep. The use to which steeply sloped land is put can either be an asset or spell disaster for a community. Questions your class can seek answers for regarding how steep slopes within your watershed function to protect and enhance environmental quality might include:

- What determines the type of soil that exists on the slope?
- What kind of plant cover can exist on the slope, and what is its function?
- How is the ground water supply affected by the slope?
- What animals inhabit steep slopes compared to flat land or more gentle slopes?
- How does plant cover affect percolation and runoff on steep slopes compared to gentler slopes?
- How do streams on steep slopes differ from those on gentler slopes?
- What effects do steep slopes in their natural condition have on surrounding lowlands? What effects do steep slopes that have been disturbed have on the lowlands?

If a steep slope is being considered for development, several questions should be asked to determine what effect this development will have on the slope itself and on the surrounding lowlands:

-What happens to the quality of rainwater runoff when the plants are stripped away?
-What happens to the speed of water when no plants are present?
-Does more or less water runoff in a flood when plants are gone and bare soil, roads, and roofs replace them?
-What happens to the character of the unprotected stream during and after development?
-When bare soil is washed away, where does it end up?
-If steep sloped areas are developed upstream, what happens to the height of flood waters in lowlands areas that the stream runs through[1]?
-Would there be increased hazards in the use of bikes, baby carriages, and cars on steep slopes?
-Do you feel there would be an increased safety hazard to lowland areas during rain and snow storms?
-Are there any local or state laws that regulate what can be built on steep slopes? And what protective measures must be taken?

You can visit a steep slope and experiment to check your ideas.

For example,

a) The change in runoff characteristics can be observed by pouring water on a natural covered strip of soil and a section adjacent to it that has been stripped bare of cover.
b) Ground water recharge can be observed by sinking open-ended #10 cans into bare soil and natural ground cover areas and pouring water in. Timing the rate of absorption gives you an indication of the rate of insoak of rainfall on the bare and natural cover soils.
c) The actual character of the steep slope streams can be observed and mapped.

The local environmental commission and planning board would probably be delighted to have a report on your questions raised, answers offered, experiments run and recommendations for steep slope land use.

County Soil Conservation districts and the local Soil Conservation Service Office can provide you with much information.

Local Wetlands

Wetlands are defined as year round or intermittently wet lowland covered with plant species adapted to wet soil. Wetlands are the most productive plant and wildlife areas in the world. They serve as natural flood storage basins that need

[1]Howard, James, III, 1971, Studying the Impact of Urban Encroachment, Am. Biology Teacher, 33(9):342-344.

no maintenance, and can be managed to provide many recreational and educational benefits.

You can begin the study of wetlands in your watershed by locating them on a topographic or town map, and taking a trip to the ones closest to your school. Make a general survey. What are the specific biological and physical features? Questions students might have after observing the wetlands may include:

-How many acres of wetland areas are there in the watershed?
-What plans does our town have for using them?
    a. How are they zoned?
    b. Is there any law that prevents filling them?
    c. Has anyone submitted plans to the planning board suggesting possible uses?
-Who uses the wetlands in our watershed now and for what purposes? Are these good uses for wetlands? What are good uses?
-What kinds of plants and animals must have this type of habitat to survive?
-Have any wetlands in the watershed or those surrounding ours been filled? What have the after-effects been? Survey residents living on the top of the filled marsh. Find out what problems they have noticed since the marsh has been filled.
-What does the town engineer know about local wetlands?
-What is the planning board's policy on the use of wetlands in the future?

Prepare a wetlands location map and report for use in planning for development of parks and recreation. Submit it to the town government.

Flood Plains

The flood plain of a stream or river is that area which floods during high rainfall and runoff periods. It is located within the first contour line adjacent to the stream on the topographic map, and is characterized by layers of water carried sediment and a typically wet soil vegetation. Because contour intervals are usually twenty (20) feet and flood plains usually extend only about 5 feet above stream level, soil survey maps provide a more accurate means for determining flood plain boundaries.

Certain soils, almost always found along river or stream beds, are classed as alluvial (water carried). The soil interpretation information which accompanies the soils maps indicates which soils are alluvial. They appear as long narrow bands of soil along the banks of streams. Piece together the soils maps covering your watershed, photograph them, and project the photograph over your watershed reference map. Align the streams and highways and copy the flood plain boundaries

onto your reference map.

A third alternative when you have no soils map is to use an enlarged contour map made from your negative (see page 100) and a soil augur, or obtain from the town or county engineer. Walk along the stream and, using vegetation, soil or topographic clues, measure the width of the flood plain and plot it on the map. Flood plain (alluvial) soils can be differentiated readily from upland soils because they tend to be homogenous or stratified without any observable A, B or C horizons. Plants are wet soil species such as willows and smartweeds. Have students predict the frequency and severity of floods at progressive distances away from the stream based on depth of the alluvium and the size of the particles which were carried. Vegetation zonation on the flood plain also may help students predict the demarcation between 5, 10 and 50-year flood plains.

The U.S. Geological and Coast and Geodetic Surveys publish maps outlining the extent of flood plains for major rivers. Check with them also.

Questions students might want to find answers for include:

-How is flood plain land used in the watershed?
-What problems do people who live on flood plains have with their homes?
-What law does our town, county or state have for regulating building in the flood plain?
-What is the chemical composition of flood plain soils? Are they fertile? Why?
-Which stretch of the river has the widest flood plain? Why?
-Stream channelization has been proposed as a way to check flooding. What are the advantages and disadvantages of channelization? Check with the Soil Conservation Service and Corps of Engineers and then with local environmental groups. Why the difference of opinion? Who is correct?

Your classes may want to check with the town clerk or the U.S. Geological Survey to determine when the last major flood occurred. What damage did it do? What was the cost of the damage? Interview people who were affected by the flood to find out what they would suggest doing to prevent future flood damage.

Students may also want to try drafting legislation for flood plain zoning and introduce it to the county or municipal planning board. (Copies of New Jersey Flood Plain and Stream Encroachment Law can be obtained from the New Jersey Department of Environmental Protection Water Policy Division, Box 1390, Trenton, N.J. and may serve as models for your ordinance.)

The path of a stream can change significantly in a few weeks if the area receives a few heavy rains. It is possible to make a rather accurate map of a length of stream bed, at two different times and compare them to see that things have indeed changed. (For technique, see BSCS Lab Book on Field Ecology). A portion of the classroom might be mapped first to determine the techniques involved.

Your Own Backyard

Many environmental problems start in a person's own backyard. Soils, pesticides, and fertilizers may be carried from nome gardens into the storm drain or local stream. Oil, detergent and animal wastes can further contaminate storm drain water. Septic tanks which aren't functioning properly may be another source of backyard environmental problems. Following are but a few of the many activities which will get students better acquainted with their backyards, and familiarize them with ecological concepts and skills at the same time. The following can be used as tasks to get students started in environmental problem studies.

Mapping

Make a scale drawing of your yard or school. Include house, garage, driveway, patio, walks, lawn area, garden, and areas of shrubs, trees, flowers.

What percentage of your lot or schoolyard is paved or covered in some way? Where does the rain go that would normally fall on the ground in this area?

Calculate what percentage of the total area is covered by each type of vegetation. Which type of vegetation covers the most area?

You may find some "problem areas" where erosion is occurring, regions with poor drainage, and so on. Are there any ways you could improve these conditions?

Food Webs

Your backyard or schoolyard probably comprises part or all of several food chains. When we consider the interrelationship of several food chains we have what is called a food web.

Identify the producers in your yard by asking your teacher or parents or bringing in leaves to identify in class.

Capture insects which appear to be eating the plants in your lot. Try to identify them, and any other first order consumers (plant-eating organisms) in the yard. (Your list might include rabbits, raccoons, deer, birds, mice, moles, or other animals.)

Attempt to observe and identify the higher order consumers in your yard. Use all of the data collected to draw a diagram of the food web to be found in your yard.

You might wish to consider the effects of the following on your food web: herbicides, insecticides, seasons of the year, household pets, etc.

Microhabitats

It is likely that various parts of your yard differ significantly from each other. An area receiving sunlight all day will be warmer and drier than a heavily shaded area.

1. List the kinds of organisms you predict might thrive in a moist area which receives little direct sunlight. Examine the vegetation along the north wall of your house or school and list the type of vegetation and animals you find. Now look at the organisms on the south side of the house or school. List the types. Summarize similarities and differences. Was your prediction confirmed?
2. Relative humidity is a measure of how much moisture the air holds, in comparison to the amount it can hold. It is easily measured by a pair of wet and dry bulb thermometers and a relative humidity table. Construct three pairs of these place them in locations you consider to be "wet", "dry" and "inbetween". Be sure to shade them from direct rays of the sun. Read daily for one or two weeks, and about the same time of day each time, and graph your data, all on one sheet of graph paper. You may wish to make readings every hour on one day of your study. Summarize your findings. Are there any differences in the three stations? What do you think are the causes of the differences?
3. Temperatures may vary considerably in a yard. Do the following investigation twice, if possible, once on a sunny day and once on an overcast day, when there is no wind. Tape a thermometer to a card. Hold the card at the same height above the ground at different places in the yard, and after 3 minutes read and record the temperature on the map of the yard. If you like you can connect similar temperatures with lines to represent isotherms, or areas of equal temperatures. What range of temperatures do you find? Which regions are warmest? The coolest? Does vegetation seem to affect temperature? Can you find any relationship between your temperature readings and the relative humidity information?
4. Another quantity which may vary in your yard is rainfall. Place rain gauges (BSCS Lab Book) at various locations around the yard, and record the rainfall daily for two weeks to one month. Graph the data (climatograms in BSCS Green). Summarize your data. Is the rainfall exactly the same in all areas? Why or why not?

5. Light intensity in different regions of the yard may be measured qualitatively with a light meter used with a camera (Source BSCS Field Ecology Lab Block). You may be interested in adding this data to your other information about the year.

Putting it all together, you now have data on vegetation, relative humidity, temperature, and rainfall. Have any patterns emerged from your data? Do regions of low humidity receive more sunlight (and thus have a higher temperature) and less rain than regions of high humidity?

Soils

Soil is the substrate on which all else rests. Many land use problems and water pollution problems arise from misuse of soil resources. Yet, the importance of soils seems to have been kept secret from the layman. At a meeting of environmentally concerned students and adults recently, people were surprised with the emphasis the speaker placed on soils in land use planning. Many said that in all the talk about water, noise and air pollution, no one had ever mentioned that soils were important. We hope this is an exception.

Subdivisions, shopping centers, highways and many other manmade structures are often built with very little regard for the characteristics of the soil they are built upon. The results include major changes in drainage patterns, erosion, inadequate treatment of septic wastes, broken asphalt, flooded basements, major flooding, filling of ponds and lakes and destruction of trout streams. These tragedies happen because planning and zoning boards often have very little appreciation of their opportunities to minimize environmental damage during building.

One activity which introduces students to soil characteristics and the use of soil survey maps is presented in Section 3. Activities two teachers use to involve their students with local soils follow.

A. Sean Reilly's Approach to Soils Mapping and Land Use Planning.

Step 1. Have students bring in a bag of soil from their backyards or from predetermined locations in town. Mark the locations on your reference map (page 100). Have them dig a pit 2 to 4 feet deep. Ask them to notice, when digging, whether there are distinct layers, and determine how wide each layer is. Have them record this on a sketch map.

Step 2. In class, discuss the general characteristics of soils and explain the various soil classes (silts, clays, loams, sands, and the intermediates between them). Then divide the class into small groups. Place the soils they have brought into numbered buckets. Wet them, if necessary, so that soil in all buckets is moist, but not soupy. Start each group (5

or 6 members) with one bucket of soil. Have them feel it, smell it, do anything they want, and come to a consensus about which soil class it belongs to. Record this on paper. The buckets are passed between groups until all groups have worked with each soil and recorded their findings. The groups report their findings. The teacher then takes each bucket, determines its class by feel, and explains the reasons for classifying it as he does. Students then see if they can, by feel, come to the same conclusion as the teacher. Questions, such as "what kinds of rocks and materials did these soils come from?"; "what is each soil good for?"; and "are there limitations on soil use, or critical soils areas?" might follow, and lead into Step 3.

Step 3. Mapping soils.

Alternative 1. Have students,

a. draw a map of a local open area (it should be an area of heterogeneous topography and vegetation types, including a stream or other wetlands area if possible).

b. Sample soils in each area and plot the characteristics on the map.

Alternative 2. If no such area is available, students can draw a map of the watershed, and draw in local features such as mountain ridges, swamps, local streams, hills, etc. and predict the types of soils they would expect to find in each area.

Step 4. Once this map is made and predictions recorded, students then can go into the watershed or local area, sample the soils, and determine how accurate their predictions were.

Step 5. Have students, preferably in small groups, discuss what uses they think each soil could support (i.e. farming, heavy buildings, light buildings, roads, buildings with cellars, parks, football fields, etc.). The teacher should meet with each group and help them with their discussions.

Step 6. Have each group present its decisions to the class. They should state what they decided to use each soil for and why (e.g., no buildings should be placed on silty or clay soils because they usually flood over, or are soft. Heavy buildings should go on rocky or firm soil areas. Farms should be on rich loamy soils, etc.).

Step 7. Have students find out if the town has used soils information in its zoning and planning. They can contact the local environmental commission or planning board and ask for a member to come and speak to the class about critical soils areas[1] in town.

[1]A critical soils area is one which should be used only for parks or recreational land and not developed. Examples include soils on steep, erosion prone slopes, flood plains, swamp or wetland soils, heavy clay soils, etc.

Step 8. If soils information is not now used by the local zoning board, students can plot critical soils areas within the watershed on their map using SCS Soil Survey maps (page 116), and present their report to local officials. They can then follow-up by watchdogging projects proposed by developers for those areas.

B. Kaye Widmer's Approach to Soil Studies

The intent of this section is to give the teacher and students a series of activities with which they can investigate the relationship of the soil to the water cycle. This could be used in conjunction with backyard studies (page 57), or Sean Reilly's approach above.

UNIT 1. WHAT AFFECTS HOW FAST THE WATER ENTERS THE SOIL?

Step 1. Discuss how does the type of soil (clay, sand, loam, gravel etc.) affect the rate of infiltration, and design experiments to test the ideas that are presented. How does adding organic matter to the top of sandy soil alter the rate of infiltration? How would the rate of infiltration affect the amount of ground water in the area? How would infiltration affect runoff? What could be done to improve the infiltration rate of a soil?

Step 2. Students investigate infiltration rate of soils under different types of vegetation (pines, oaks, grasses, etc.) to determine if vegetation changes the infiltration rate of soils. The soils may also be chemically analyzed and correlations made with vegetation and infiltration rate.

Step 3. Investigate the infiltration rate of subsoil. How does this compare with the infiltration rate of topsoil? What happens to the topsoil when a housing development is built in an area?

Step 4. Using soil and topographic maps determine where the rate of infiltration is low in the watershed. Why is it low in these places? How would the low infiltration rate affect the amount of runoff in these areas? The ground water? What are some ways the infiltration rate could be increased so the runoff from an area is decreased? How could we find answers to these questions?

UNIT 2. INVESTIGATING THE PERCOLATION RATE OF THE SOIL.

Step 1. Students investigate how particle size of the soil affects percolation rate by timing percolation rates in different types of soils - sand, gravel, etc. How does particle size of the soil affect the amount of hygroscopic water retained by the soil? How would the amount of water retained by the soil affect the type of vegetation in the area?

Step 2. Students investigate how the addition of varying amounts of organic matter affects the percolation rate and

the amount of hygroscopic water retained by the soil. How would different types of vegetation affect the amount of organic matter in the soil? How would this affect the hygroscopic water in the soil?

Step 3. Students compare the percolation rate of dry and wet soils of the same kind. How would this affect the amount of runoff from the soil?

Step 4. Students determine the percolation rate of the soils in their own yards. They put the percolation rates on a map of the town, then put in the maps where houses are that have constant trouble with their septic system or basement flooding. This can then be compared to soil type maps of the area. Why is the percolation test required before a house can be built in areas where individual septic systems are used to dispose of sewage? If the percolation rate were very poor, how might the percolation rate be improved in a particular area?

Step 5. How might the percolation rate and amount of hygroscopic water in the soil affect the type of plants which can be successfully grown in an area? How might this affect the types of plants you might choose to plant in a particular area?

Step 6. Students determine the amount of water and soluble chemicals such as salt that will dissolve and percolate through the soil. The water recovered from the plastic column and the amount of chemical weighed should be compared to the original amount. If different water soluble chemicals are stored on top of the soil, how much of the chemical percolates through the soil for a given amount of water? How might this affect the quality of the ground water? Are there areas in the community where there are water soluble chemicals stored on the ground?

SUGGESTED TECHNIQUES FOR THE ACTIVITIES ABOVE (modified from Curriculum Activities Guide to Water Pollution and Environmental Studies).

A. Soil Infiltration

Equipment: coffee can, water

Remove both ends of a large can (2-3 lb. coffee can) and set the can into the ground. Pour a known quantity of water into the area enclosed by the can and calculate the time for the water to enter the ground.

B. Soil Percolation

Excavate a hole 15 cm. in diameter and 30 cm. deep. Dig smaller holes around this hole at varying distances from it. Fill the first hole with water that has a tracer dye in it. Periodically check the smaller surrounding holes with blotter

or other absorbant paper to check for water flow and the appearance of the dye.

C. Soil Percolation and Infiltration Inside

Set up a plastic column 3/4 filled with the type of soil being tested. Pour a known quantity of water into the top of the tube and determine how long it takes for the water to reach the bottom of the tube and start to drain out. This time would be the percolation rate of the soil type being tested. The time it takes for the water to enter the soil would be the infiltration rate of the soil type. If the water which has drained through the soil is collected and the amount measured, the amount of water (hygroscopic water) remaining behind in the soil can be found by substracting the amount drained from the amount poured in.

Resources:

The local office of the Soil Conservation Service can provide you with a great amount of help. You will find their address in the Yellow Pages under Federal Government, Department of Agriculture. Among the information they can provide are:

a. Soil survey information on your watershed. Maps and interpretation sheets.

b. The pamphlets, Know the Soil You Build On, SCS Bull. #320, Controlling Erosion on Construction Sites, SCS Bull. #347, Conservation Plans for Developing an Area, SCS Program Aide #1029, are all available free.

c. Demonstrations by the district soil conservationist on how to do a soil survey.

d. Help in developing specific recommendations for erosion control for projects the class may wish to undertake within the watershed.

In addition, resources in local universities include soil scientists in the agricultural school and civil engineers.

Good judgement comes from experience, and experience -- well, that comes from poor judgement.

-anon.

CHAPTER 5 - THE IMPACT OF MAN'S ACTIVITIES ON WATERSHEDS

Introduction

Hopefully your watershed still has open areas - farmlands, woodland, meadow, hills and wetlands. If you live close to an urban area, however, this open space will soon be sought by developers, if it is not already now. You and your students can act now to help prevent a great deal of environmental damage as development takes place. In particular, you can make an assessment of laws that currently exist that protect against environmental damage and recommend laws that are needed. You can work with planning and zoning boards, calling their attention to construction practices which could create environmental problems. It takes experience to become competent at working with planning and zoning boards. The activities in this chapter will help you and your students gain this experience. Find some planners, civil engineers and other similar resource people to advise you as you work on these projects. The ideal source of such resources are the parents of students in your class.

The Environmental Assessment of Shopping Center Construction

The study of shopping center construction from inception to completion may help the class understand the impact of a man-made development on natural systems. If a shopping center isn't being constructed nearby, select a currently operating shopping center within the watershed and, as a class, answer the following questions about it and the area surrounded by it:

-What was there before the construction?
-How many acres of open space are gone?
-Can you estimate the numbers of living things that are now missing? (examples - trees, animals, insects, grassland, etc.)
-What happened to the animals?

Students can design experiments on nearby open space (i.e., conduct an environmental inventory, including population studies on an area of similar character and size nearby) to answer the above questions.

This could be followed by investigations which answer:

-What laws does your town have regarding how developers must care for the soil, streams, trees, and animals when they begin to work?
-What kind of soil underlies the buildings? Will it support a heavy building? Call your local soil conservation office director and ask him to give a field demon-

stration on the properties of soils.
-If the land is sloping, where will the eroded soil go during heavy rains? Will it run onto someone else's property? or into a stream?
-What effect does sediment have on a stream channel?
-What effect does sediment have on the fish, plants and insect life and on the water flow in normal periods and flood periods?

Regarding construction waste:

-Are there provisions on the site for catching sediment in ditches or ponds to prevent offsite damage?
-Where is the solid and liquid construction waste being disposed of? Is it in a local stream or wooded area? Where do the masons and plasterers and cement truckers wash their tools? Where do the heavy equipment operators dispose of their oil change?

Trees:

-Have the remaining trees on the site had the soil level raised around their trunks? If so, what will happen to them?
-Tree root systems aid rain-water in entering the ground. What will happen to much of the water now that the trees are removed?
-Will the water supply in the ground be increased or decreased by removing the trees?
-Are wells being used by the developer or nearby homes for their water supply? How will removing trees and grass affect the well-water supply?

Pipelines:

-Have any pipelines been dug for sanitary sewers or storm drain pipes? If so, were the areas re-seeded and landscaped after the pipes were put in?
-Where do the storm sewer pipelines empty? (Storm sewers are not sewers at all and should be properly called storm streams because whatever goes into them ends up in your streams).
-Do the storm drain pipes have protective headwalls and spillways to prevent the land from being washed away?

Streams:

-Is the construction taking place adjacent to a stream or pond? If so, is any fill being pushed into the area where flooding usually occurs?
-What are your state and local laws that affect building anything within a stream's flood water areas?
-Is the developer changing the course of the stream or putting it in a pipe? Is this legal?

Other Construction Issues:

A teacher-student team visiting a site may come up with many more issues to explore.

When the construction is finished and the buildings and parking areas are ready for use, a new impact is about to hit the area. Air pollution, noise, blowing litter, excessive rainwater runoff, water pollution, increased sewage load, and traffic congestion which increases air pollution.

A series of questions can be investigated to demonstrate the degree of environmental impact this new development has on the area.

Air Pollution:

-How many cars enter the shopping center in an hour, in a day?
-What effect does this concentrating of cars in one area have on the air quality?
-Which way do the prevailing winds blow? Does this air blow past homes all day?
-Will this change in air quality exceed federal or state standards?
-What happens to these air pollutants when it rains? How can you find out the method used in computing this?

Rainwater Runoff:

-All of the rainwater that hits the parking area and roofs will now be runoff. Where will it go? In a stream? Onto a property?
-What effect does this flash runoff have on flooding?
-What effect does it have on the shape and character of local streams?
-Can people sue the shopping center or the town if they get flooded because of it?
-The runoff now contributes rubber, dust, asbestos fibers, oil and assorted garbage into the local streams but it is difficult to pinpoint and is known as non-point pollution. Can this water be cleaned up?
-How can this flash runoff be slowed down to reduce flooding?

Sewage Load:

-Can the municipal sewage plant handle the increased flow from the shopping center without increasing its damage to the stream it dumps into?
-Is the sewage plant working up to state standards? (see resource list).
-What process does the sewage plant use in treating sewage?
-What stream does it dump the final product into?
-What else would you like to know about the plant's operation? Take a trip there and observe for yourself.

Blowing paper, traffic congestion, and noise are further areas where teacher-student generated questions can lead to experiments. (Local officials might give support and assistance if they know you are going to conduct these studies and will send them reports. This support might include money for equipment and supplies.)

Resources: in New Jersey,

1. N.J. Department of Environmental Protection
   Bureau of Water Pollution Control 609-292-4091
   Bureau of Air Pollution Control 609-292-6704
   Box 1390
   Trenton, New Jersey

In other states, check with your state Environmental Protection Agency.

2. Regional watershed associations
3. Local Environmental Commissions
4. Air quality information is available from the Local Tuberculosis Foundation.

The Impact of Housing Developments on Watersheds

If a new development is planned for your watershed, learn its location, size, anticipated number of residents, number and variety of units, and cost range. You can get this information from the town or county engineer. If no such development exists or is proposed, draw up the specifications for a hypothetical development as it might exist. Get a friendly contractor or architect to serve as advisor to the class in doing this.

At this point, the class can begin an environmental impact study, which is simply an attempt to determine how the presence of this new development will affect the surrounding environment. This study will involve using the skills and concepts of math, social studies, science, and several other key disciplines.

Population Study:

- -Using either the actual or projected development plan to determine the number of people who will (do) live there. Does the type of dwelling suggest anything about family size or number of children?
- -Sketch a profile of the people who will inhabit this development in terms of income, employment, social background.
- -If possible graph the populations of an actual development by age brackets.

Some questions you might ask include:

Vital Sources:

-Where will these people work?
-Where will they shop?
-Where will they attend school ?
-Where will they attend church?
-Where are their recreational areas?
-What about medical and civic services?

Transportation:

-If these people use cars, how many cars will the development bring? What routes will they travel? Take traffic counts. Survey the number of cars per family.
-Is it possible to determine the potential trouble spots (bottle necks, parking problems, pollution areas, accident sites) ?
-If certain segments of the population are to use other means of travel, what will these be? Does the current service schedule appear adequate to meet the need? If not, who is responsible for increasing it?

Water and Sewage:

-Have students determine how much water their family uses each day. Also check with the local utility and sewage plant to see how much water is used and treated each day. Compare these with national statistics.
-Determine how much water will be needed to meet the requirements of the new or hypothetical development.
-How much sewage will be generated? What is capacity of present sewage facility? What are the projected costs of meeting the expanded service required by the development? Who will pay for this?
-How many acres will be paved or covered in the development, considering roofs, roads, parking lots, sidewalks, etc.? How many gallons of water falls into the confines of the development during a one-inch rainfall?
-What provision is being made to carry this additional runoff water?
-What is the impact on the local flood plain of a one-inch rainfall? By gathering rainfall data and measuring stream flow over the year, they might also plot the impact of heavier rains. Is flooding affected by the time it takes for the rain to fall?
-If students observe or determine that significant flooding will follow heavy rainfall, what measures could control flooding and prevent erosion? How can you as a class, influence the developer or the local government to adopt these?
-Using topographical maps and hiking along any streams in the development area, determine what constructive uses are being made of the flood plain. Is any construction occurring on the flood plain? Are there any obvious danger or trouble spots?

Solid Waste Removal:

-Have students conduct surveys and experiments to determine how much solid waste their family and other families in their area are currently generating.
-Project how much solid waste will be generated by residents of the new development.
-Investigate how solid waste is currently being disposed of. How much will it cost to remove waste from the new development?
-How will the development affect the projected life of the town's sanitary landfill? The methods of collecting and handling wastes?
-What new methods are available? How much will these cost?

Economic Base Study:

-How much tax revenue will the ratables in the new development add to the municipal tax fund?
-Determine what will be the costs of providing the new residents with essential services:
  a. police
  b. fire
  c. health & sanitation
  d. roads and maintenance
  e. schools
  f. other

-Are the costs offset by the anticipated revenue?
-Will the development bring more workers into the community? Where will they work? What is likely to be their salary range? How much might they be expected to put back into the local economy? In mortgage interest? In purchase of goods and services? In taxes?

Construction of the Development:

-Has the developer taken advantage of natural land features? Have these been removed? Why?
-What evidence is there of erosion at the building site?
-Is there any evidence that the builders show in their plans how they would contain the sediments on his property (sediment catch basins, etc.)?
-Has he followed through with these plans (if the development is underway)? What power does the town (county) engineer have to insist that sediment control planned by the developer is implemented?

From this point in your environmental impact analysis, you can ask the same questions as in the previous exercise.

Activities to Explore Community Planning

Although most American cities and towns have grown spontaneously in relation to some strategic natural feature such as a good harbor, a confluence of rivers, a fault line, or the head of a valley, many of our communities have been carefully planned from their beginnings. Washington, D.C., Anna-

polis, and Williamsburg were designed to suit state functions before people settled them. New York and Philadelphia, similarly located between two rivers, began rather haphazardly, only to be subjected to rather rigid grid systems of planning when they were over one hundred years old.

Today, although many of our so-called new towns are the result of systematic planning to provide all the necessities and amenities in a manner which is economically, aesthetically, practically, and ecologically sound, many other subdivisions are springing up in the midst of our great megatopolis with little evident planning. Laymen staffing volunteer planning boards, often without professional assistance, are re-creating some of the horrors they have fled the inner cities to avoid. Traffic congestion, crumbling and flooding basements, inoperative sewer systems, inadequate sewage treatment facilities, over-crowded schools, and poor community support services are common problems in America's new suburbs.

Many of these ills could have been prevented or mitigated by better planning. Most citizens and students are only vaguely aware of the function of their regional and local planning boards. They have no realization of the ways in which they could and should assist these groups. "Leave it to the experts", is their attitude. Little do they realize that often there are no experts, merely public-spirited volunteers trying to learn as they go, with never enough time or help to do the job as it should be done.

While community planning is a professional field with complex principles, students can learn a great deal by careful observation and the application of common sense. Students might begin by taking an analytical look at their town. Often making a map or series of maps of the community will help to focus their investigation more pointedly. Drawing maps of different factors - roads, services, natural features, population densities, etc. - on clear plastic acetate sheets will allow students to overlay these maps to correlate various data they have observed.

Specific Activities for Students

1. You might begin by drawing maps of the boundaries of your community.
2. Next, you might pin-point natural features such as rivers, stream ravines, cliffs, etc. (How have these features figured in the town's growth?)
3. A look at the transportation network might follow. Attempt to sketch in networks of all methods of transportation, private and commercial. A number of studies could be built around this topic. Classify streets as arteries, feeders and minor. Determine areas of greatest congestion, greatest pollution, highest incidence of accidents. Develop some simple but practical methods of reducing traffic congestion. Often

one-way streets, elimination of on-street parking, bus lanes will help. Make some traffic surveys to see what streets are used most heavily and why. Is there any pattern?

4. A map of land use is very useful in understanding how and why your town works as it does. By selecting a different color for each of the major land uses, commercial, residential, industrial, services, parks, etc., one can quickly learn why traffic patterns develop as they do, why the zoning codes have been established, and the likely areas of residential and commercial development. Begin now to overlay some of your maps. Is there any noticeable relation between topography and land use? Between transport routes and topography?
5. A study of population is another important aspect of community planning. There are several ways to obtain this information. The U.S. Census Bureau records are generally the primary sources. These are often available in local planning offices or libraries. Frequently, school administrators will have population figures available. Using this census information, which is updated every ten years, students can plot the population of their community by age, ethnic composition, income and employment categories. This information is useful in determining the growth potential of the community and its projected needs for schools, parks hospitals, and other services. Students might ask themselves which areas are apt to produce the greatest number of children in the next ten years. Will there be a need for more schools? Is there a likelihood of attracting new industry?
6. These last questions bring to light the possibility of taking a look at the economics of your town. A town is not unlike a family. Its budget must attempt to balance its expenditures against its income. What sources of income does your town have? List them. Call upon a councilman to explain the tax system to the students. Is the town actively seeking new ratables? Why and how? Why not? Besides taxes, what other income does the town have? What kinds of expenses does your town have? To whom must your town pay taxes? What services does it provide and at what cost? How is the budget prepared? What input can the citizens have in the budget making process? Which items of obvious need are not included in the budget? Have students ask several councilmen why they aren't included. Attend a budget hearing.

City planners try to identify the needs of the community in the foreseeable future. They also suggest ways in which the community tax structure can finance these needs. Try to piece together some of the obvious five-year needs of your town in terms of police, fire, health, water and sewage, solid waste, recreation, public works, welfare and public assistance.

Will the normal increase in tax revenue support these needs, or will other methods have to be found?

As a final example of the manner in which careful planning should proceed, here are two possible activities, both focussing upon highway planning. They could, however, be adapted to other segments of community planning. The first activity is a classroom activity, developed by Paul Palmer in his article, "Planning Highways" published in Environmental Workbook, Donald Coates, Binghamton, SUNY, 1972.

Activity in Planning

Question: Where do we locate the highway?
Purpose: This activity is designed for the student to learn about planning and its problems by becoming involved in the planning process for the site location of a fictitious major highway.
Age group: Junior-senior high school students can engage in this activity. It is capable of being modified to deal with the location and design of many other community facilities such as schools, parks, shopping malls, etc.
Objectives: Below are some of the skills which this activity can teach:

1. Present a highway planning process.
2. Show the impact a highway can have upon its environment.
3. Show the trade-offs involved in planning and building a highway.
4. Show the necessarily political aspects of road-building.
5. Demonstrate by example the application of eminent domain.
6. Role play a condemnation proceeding.
7. Show the economic impact of highway building.
8. Arrive at a statement of principle concerning best route for locating a highway.

Materials: Pictures showing homes and businesses students would like to own and operate. Pictures also of pleasant places students enjoy. A large bulletin board or poster board on which these pictures can be mounted. Materials to mount them.
Procedures: Give only as much information as is necessary to get started. Do not give out the full purpose of the game in the beginning.

1. Designate the surface and manner for the mounting of pictures. Mark off an area at each side which must remain open.
2. Have the students mount the pictures they have collected over the entire surface of the board, keeping open only the spots at each end of the board. Try to have an overall coverage.
3. After all pictures have been mounted, designate the areas at each end of the board as city A and city B.

4. Tell the students now that a highway six inches wide is going to be built from A to B. Nothing can stop its construction and obviously some of the properties presented in the pictures will have to be condemned.
5. Have the students divide into two or more groups. One or more of these will decide upon the location of the road. The others will construct arguments showing why their property should not be condemned.
6. Now you may wish to role play an open public hearing at which the various groups present their points of view.
7. At the conclusion of the hearing, announce the final selection for the site of the road.

Suggested Follow-up Activities:

1. Speak with builders to learn the actual cost of building a road.
2. Determine the location of necessary roads in your area.
3. Attend a public hearing concerning a road project.
4. Do this activity using topographic maps. This will give a further dimension of reality.

Another Method of Highway Planning:

Ian McHarg, the ecological planner, in his book, Design With Nature[1], presents his scheme for planning a road in the most efficient manner possible. McHarg, whose method should be studied in its entirety, states from the start that the best route for the road is that which "provides the maximum social good at the minimum social cost." To determine the best route, that which will not only provide time saving, safe transportation, but also retain and enhance the values of the surroundings, McHarg examines a number of social and topographical parameters.

He begins by establishing sixteen parameters for consideration. These are listed on page 74. For each of these, he assigns a value from 1 to 3. (Zone 1 represents the highest social value and Zone 3 the lowest social value. Zone 2 is intermediate.)

Next, McHarg prepares sixteen base maps of the area to be considered. Each map is used to record the various values of one of the parameters. Zone 1 is colored a dark gray, zone 2 is colored lightly and zone 3 is left white. After all sixteen parameters are mapped and colored, each map is photographed to make a transparency. After these are completed, they are overlain one upon the other. The areas which in the composite have the darkest color represent the areas retaining the highest social value. Those which are the lightest show the area of least social value, and therefore, most desirable for the

[1]McHarg, Ian, Design With Nature, Doubleday Press, N.Y.

road. In those parameters showing various natural features, the darkest zones represent those areas which are least conducive to road construction; those which are lightest show the areas best suited for construction of roads.

By using this method, McHarg has already succeeded in having the most direct, low-cost routes of some roads altered so that they conform to the highest social good, lowest social cost formula he advocates.

Below are the parameters upon which he makes his selection. It is possible for a group of students to follow this approach using many or all of these criteria, and perhaps even develop some additional ones on their own.

1. Slope
   - Zone 1 - areas with slopes in excess of 10%
   - Zone 2 - areas with slopes less than 10% but more than 2 1/2%
   - Zone 3 - areas with slopes less than 2 1/2%

2. Surface Drainage
   - Zone 1 - surface water features, streams, lakes, ponds
   - Zone 2 - natural drainage channels and areas of constricted drainage
   - Zone 3 - absence of surface water or pronounced drainage channels

3. Soil Drainage
   - Zone 1 - salt marshes, brackish marshes, flood plains, swamps, and other low-lying areas with poor drainage
   - Zone 2 - areas with high water table
   - Zone 3 -areas with good internal drainage

4. Bedrock Foundation
   - Zone 1 - silts and clays are a major obstruction to the highway; they have poor stability and low compressive strength
   - Zone 2 - sandy loams and gravelly sandy to fine sandy loams
   - Zone 3 - gravelly sand or silt loams and gravelly to stony sandy loams

5. Susceptibility to Erosion
   - Zone 1 - all slopes in excess of 10% and gravelly sandy to fine sandy loam soils
   - Zone 2 - gravelly sand or silt loam soils and areas with slopes in excess of 2 1/4% on gravelly to sandy stony loams
   - Zone 3 - other soils with finer texture and flat topography

6. Land Values
   - Zone 1 - $3.50 a square foot and over

Zone 2 - $2.50 - $3.50 a square foot
Zone 3 - less than $2.50 a square foot

7. Tidal Inundation (for coastal areas and flood plains)
Zone 1 - inundation during the 1962 hurricane
Zone 2 - area of hurricane surge
Zone 3 - areas above flood line

8. Historic Values
Zone 1 - town historic area
Zone 2 - historic landmarks
Zone 3 - absence of historic landmarks

9. Scenic Values
Zone 1 - scenic elements
Zone 2 - open areas of high scenic value
Zone 3 - urbanized areas with low scenic value

10. Recreation Values
Zone 1 - public open space and institutions
Zone 2 - non-urbanized areas with high potential
Zone 3 - areas with low recreation potential

11. Water Values
Zone 1 - lakes, ponds, streams, marshes
Zone 2 - major aquifer and watersheds of important streams
Zone 3 - secondary aquifers and urbanized streams

12. Forest Values
Zone 1 - forests and marshes of high quality
Zone 2 - all other existing forests and marshes
Zone 3 - unforested lands

13. Wildlife Values
Zone 1 - best quality habitats
Zone 2 - second quality habitats
Zone 3 - poor quality habitats

14. Residential Values
Zone 1 - market value over $50,000
Zone 2 - market value between $25,000 - $50,000
Zone 3 - market value less than $25,000

15. Institutional Values
Zone 1 - highest value
Zone 2 - intermediate value
Zone 3 - least value

By now the student should be able to see how careful observation together with common sense formulating and answering of questions will give him a better understanding of how his community has developed and how it will continue to grow. By carefully recording his data and cross-relating it, he will build a data bank of value to many in the community.

As a few parting suggestions, he might try some of these:

1. Gather promotional literature from the Chamber of Commerce and see how it compares with his own observations of the town.

2. Interview newly arrived residents to see why they chose your community, or the residents of a new housing development after living there for six months, to determine what problems they have, and what their attitude is about the community.

3. Conduct a neighborhood survey to learn what community services residents think should be improved or added.

Activities to do at Home - the Impact of Your Home and Family on the Environment

All of us live somewhere, usually in a house, apartment, or mobile home. The following investigations suggest a few approaches to studying homes to determine our personal impact on the environment.

1. Energy - how much energy do we use, and what do we use it for? What kinds of energy are used in your home? How do they get into the home? Where do they come from? What is their original source?

Compare the temperature you maintain in your home in winter (and summer, if you have central air conditioning) with others in your class. Is there a correlation between the kinds of clothes you wear and the temperature of your house? Of what use are storm windows, blinds, shades, and awnings in maintaining house temperature? Does insulation help conserve heat or cool? How much insulation is best?

Do a room-to-room inventory of electrical appliances in your home. Rank them in order of their importance in the daily life of your family. Compare lists with others in the class. Are some items at the bottom of all lists? How did you happen to purchase these? Talk with parents, grandparents, and older residents of the community about the kinds of electric and gas appliances they had in their homes when they were young. Do their lists differ from the one you've just made?

Ask your parents to tell you the number of units of gas and electricity you used the preceding month. Compare your findings with other class members. Is there a relationship between the number of electric appliances and the number of kilowatts used? Divide the number of kilowatts by the number of people living in your house to determine the electrical use per person. Do the same thing with gas. Compare your results with others in your class. Can you offer any explanations for differences?

2. Water - ask your parents how many cubic feet of water you used in the last billing period. Divide to determine the cubic feet used per day in your house. What was the water used for?

How much was used for each purpose? How much water is used to flush a toilet, take a bath or shower, in a washing machine or dishwasher, a person brushing their teeth, etc? Can a toilet flush with less than a full tank? How much water could be saved daily by putting a brick in the toilet tank? Which takes more water, a bath or a shower? You may wish to calculate the gallons of water used per person each day in your house, and compare it both to class figures and to the national average of 100 gallons per day per person. Does your community have any problems with its water supply?

3. Waste - if a water testing kit is available, you may wish to test waste water from your washing machine, dishwasher or dishwater and bath for chemical pollutants and compare it to tap water. Data could be tabulated or graphed. What, specifically, have you added to the water? How much?

Grow algae in the wash water and compare the growth rate to the growth rate in pond water and tap water. Use the waste water to water a portion of your garden or lawn or plants grown especially for the experiment. What happens? Why?

4. Density - determine the density of people in your house (no. people/sq. ft.). Could you exist in less space? You may wish to compare the density of humans in your house to the density of humans in apartments or dormitories. Do you have a bedroom of your own? Did your parents? Your grandparents? What kinds of densities are found in other parts of the world? What would be the advantages and disadvantages of these densities? Compare the frequency of occurrences of different kinds of crimes in areas of different population densities, in the same and in different income classes.

5. Automobiles - some things to find out about your family car, and to compare in class are: no. cars/person in your family; mpg average for your family's cars, the weight of the car and number of cylinders, distance driven per day/car. With this information, you can make a graph showing mpg vs. car weight, mpg vs. number of cylinders. Are some cars more efficient than others? The number of gallons used by your family in a day, a week, a year. Why did each family choose the cars it did?

Population Studies

Many Americans are aware that the population of the world is increasing very rapidly but that, in the U.S., the birthrate is declining. This series of investigations suggests a few ways to study the population of the local community.

1. Graphing - obtain population (census) records for your community and make a graph of population vs. time for your community. From your knowledge of the behavior of populations (see any ecology or biology text), predict the population in years to come. Check with the regional planning commissic to see what they say.

2. Mapping - obtain a map of your community. Find out from real estate agents the ages of the houses in different areas of town, and color the houses of a certain age a particular color. How have the dimensions of the community changed? Can you predict the dimensions of the community in future years? Are any problems evident in your community which have been caused by the change in either population or size?

3. Population Density - given sufficient time and data, you can construct a contour map of your community to reflect population density. Each contour level could represent a certain no. people/area, such as square mile.

4. Housing Value - an interesting accompaniment to your density study and mapping studies might be a housing value study. You could prepare either a contour map or a color-coded map to represent the average value of the real estate (dwellings) in different areas in your town. The data might be obtained from the tax assessor or from a real estate agent. Note any correlations between ages of houses, population density, and housing value.

5. Age Structure of Community - obtain census records for the ages of residents in your community, and prepare a diagram of your community reflecting ages. You may wish to determine the age structure of the U.S. as a whole, and compare it to your community, also to make studies of specialized housing areas such as developments or apartment houses.

6. Death Rates - obtain death records from Bureau of Vital Statistics in your county and make calculations of the deaths per 1000 individuals at 25 year intervals for your community. Determine what has happened to the death rate for various age groups (0-9, 10-19) etc. over the years. Explain your data, and predict future patterns.

What You Can Learn About Watershed Environment in a Graveyard

Some of the population who are no longer with us have had impact on the development of the community. The following provides the teacher and student with a series of activities using the little-used resource, a graveyard. Suggested activities vary in subject matter from social studies and biology to geology and economics.

UNIT 1 - Studying Cultural and Population Changes Using a Graveyard.

Equipment: map of community or topographical map, paper, graveyard, pencils, newsprint paper, large crayons.

Activity #1: students locate on a map of the town where all the graveyards are in the watershed. Label the oldest graveyards and determine geographic relationships to the locations of the oldest towns. This relationship can be compared to the new graveyard locations in relation to present town centers.

Activity #2: students visit a graveyard and complete a population study using the gravestones as source material. Several aspects of past populations may be studies such as:

1. The change in mortality rate of different age groups through time (see data card below).
2. The change in birth rate through time.
3. The change in death rate through time.

The students may design their own data collecting cards before the trip. The results can be tabulated and graphed, and comparisons made with present day birth and death rates of various age groups. The percentage of deaths of people in different age groups as well as the average age of death can be calculated and compared for different time periods.

DATA CARD	_____ STUDENT'S NAME			
Age at time of death	TIME PERIODS			
	1700-1750	1751-1800	1801-1850	1851-1900
0-5 yrs.				
6-10 yrs.				
11-15 yrs.				
etc.				

Activity #3: Study of cultural changes through time. For this activity one graveyard containing old stones or several graveyards, including one that dates back to the town's beginnings are to be surveyed. Students collect data to determine relationship of date of death to the shape of the gravestone, material of gravestone (slate, marble, etc.), decoration of the stone (death's head, cherub) and style of epitaph. Gravestone rubbings (see technique, page 80) may be made of unusual stones or of examples of different styles of gravestones and displayed in the school library or exhibit area.

The resulting data can be tabulated and graphed. Look for correlations between gravestone styles and known religious attitudes of the time of immigrations of different cultural groups or other factors which might have influenced change in gravestone imagery. Correlation of gravestones, quarries, and transportation routes could be made. If several graveyards are studied, patterns of cultural change away from the cities can be traced.

UNIT II - Study of Geologic and Biologic Processes in the Graveyard.

Activity #1: students determine the composition of different gravestones and note how each type of stone weathers.

Hardness of different stones may be compared by determining the date on the stone and the amount of weathering. Where the stone has been protected, as by grass at its base, the protected, nearly original width of the stone and depth of the letters chisled in it can be determined with calipers and compared to those on the exposed part of the stone. Agents of weathering can be found or surmised (lichens, human activity, acidic air pollutants, ice, etc.). In graveyards near busy roads, signs of the effect of air pollution can be looked for and compared to those stones in protected areas or further back from the road. Correlations can also be made between weathering of limestone and distance from industrial air pollution sources, if several cemeteries are being studied. The amount of acidity in the rainwater can be determined by collecting rainwater in a bottle placed in an open area and testing for pH. In graveyards on the sides of hills, downhill creep can be looked for and the amount of downhill creep correlated to the amount of time the stone has sat in the hill.

Activity #2: map the vegetation, take a wildlife census, look for evidence of food chains, and construct food webs in the cemetery. Correlation between amount of cover, food species, and the number of animals the area supports. Does this differ from the information you found in your backyard study (page 57)?

UNIT III - Study of Economics of Graveyards and Changing Land Use Patterns.

Activity #1: students investigate changing land use patterns surrounding and affecting graveyards. They will need old and modern maps, obtainable from the library or town engineer. How has land use surrounding the graveyard changed since the cemetery was established? What other uses are being made of the cemetery? What other uses could be made of the cemetery without destroying it? How has increased population affected the cemetery? How much land is required for one person in the cemetery, and for how long? How much does a cemetery plot cost? Why? Do cemetery plots cost more, on a square foot basis, than the land values in surrounding properties? Are taxes paid on private cemetery properties?

Suggested Technique for the Above Activity

GRAVESTONE RUBBING

Equipment: large newsprint paper or gravestone rubbing paper, large crayons or gravestone rubbing crayons, masking tape.

Procedure: securely fasten a piece of newsprint over the stone to be rubbed with masking tape. Rub over the paper with even back and forth strokes with the side of a large crayon. The writing on the stone and the imagery should come up as light markings on the paper. NOTE: This works best on smooth stones such as slate and red sandstone.

What Can You do in an Urban Area Watershed?

A great deal of water pollution comes from man's activities in urban centers, but it is seldom thought about. Most of this polluted water runs off into the storm drain and surfaces many miles away in a stream or lake. Storm drains are to the city what streams are to suburban and rural areas, the plumbing system for the land. Toilets, sinks, and storm drains are sometimes thought of as "magic holes".[1] Once waste goes down it, you don't have to worry about it any more! It becomes a public problem.

Many fascinating comparative studies can be designed to determine the effect of city air and land use on water quality. Among them:

Activity #1: Is rain water polluted? Compare the pH, nitrate and sulfate levels in rain water, distilled water, and distilled water run through an air filter. Collect rain water running off buildings and compare it with rain water falling directly to the ground, again using distilled water as a control.

Activity #2: What is the distribution of air pollutants in the city? Have students who live in different parts of town put jars out in their backyard or on their roof, collect rainwater, and bring it to the next class to be analyzed for pH, nitrate and sulfate. Plot the results on the map. Arrange with schools in the suburbs to do the same thing and compare results.

Activity #3: Define the watershed of a single storm drain. This can be best done during the rain so that you can determine precisely where the water is coming from that goes into the drain. Students might also fabricate some kind of sighting level to determine the topography, if rains are infrequent. Prepare a questionnaire for residents in the area to determine what effect they have on water quality. Questions should include:

- -how many pets do you have?
- -what happens to its feces and urine?
- -do you wash your car in your yard? how often? what products do you use for washing?
- -do you have a garden? what fertilizers do you use?
- -do you change the oil in your car yourself at home? what happens to the old oil?

Determine if you can detect any of these human activities in runoff water.

Activity #4: What effect do stray dogs have on water quality?

Equipment needed:

- storm sewer map
- topographic maps
- sanitary sewer maps

[1]Attributed to John T. Hershey, University City Science Center, Philadelphia, Pa.

Hach kit
questionnaires
Millipore apparatus for coliforms

One Possible Procedure:

a.divide the class into committees to investigate the several areas of town.

b. select streets throughout town in varying districts. Choose dirty streets with over-turned garbage cans, clean streets, streets in towns with stiff dog laws, very well kept streets with lots of pet dogs penned up, well kept streets with few animals, streets in business districts, etc.

c. during or immediately following a storm, take water samples in ditches leading into storm drains. Take bacteria samples in sterile bottles. Determine counts of fecal coliform and fecal streptococcus bacteria[1].

d. analyze. Construct a water quality map. Determine causes of the differences. Plan a community education program in areas where personal habits can be changed to improve water quality. Work with street clubs, media representatives. How should we conduct the community education program?

The Impact of Specific Land Uses on Water Quality

Certain specific activities that go on within the watershed can have considerable impact on environmental quality in the vicinity of the activity or land use. Three examples that lend themselves to student investigations are presented here. You can undoubtedly think of many others.

1. What to do with Industry?

Industries are often earmarked as the primary polluters, fairly or unfairly. Before you draw any conclusions about them, find out their process. Get to know the people in the company. Find out what problems they have with competition, technology, etc. Are the explanations they give you excuses or are they reasonable? What alternatives are available to deal with their problems? What are they doing now? Which is the best alternative, considering future growth plans for the watershed?

2. What You Can Do with a Golf Course Within Your Watershed.

The problem during the spring and summer is that heavy fertilization often increases hardness, alkalinity and nitrate levels downstream from the course. Grass clippings left on stream banks may wash in, creating at times a higher than normal organic load to decay, and a correspondingly high bacterial level and depressed dissolved oxygen concentration. How-

[1]Millipore Corp., Biological Analysis of Water and Wastewater, Applic. Manual 302, Millipore Corp., Bedford, Mass.

ever, the forest which preceded the golf course contributed its leaves to the stream. Does the grass equal that load or exceed it?

Golf course investigation may appeal to students interested in nothing else. Some class members may be golfers, or want to become golfers. If nothing else turns them on to environmental problem investigations, you may ask, "what kinds of sport do you like?" If they say golf, follow with, "what do you think is involved in owning and maintaining a successful golf course? Why don't you find out?"

This can lead the student to study some of the following questions:

Economics-Math aspects:

-What kind of staff does it take to run a golf course? What kinds of jobs must be done to keep a course running?
-What does it cost to operate a golf course of ____acres for a year? How are these costs broken down (i.e., salary, green maintenance, equipment, etc.)? Over what period can you amortize equipment?
-How do managers determine their pricing policy and how many customers constitute break-even at the rates they are now charging?
-What would happen to the number of customers if they raised their rates? lowered them?
-What other things can be done with golf courses (if any) to make them year-round sports centers?
-What qualifications must a man have to operate a golf course? fill the other specific jobs at the course?

Biological and Soil Sciences:

-What kinds of grasses do best on the golf course? Where does the owner obtain these?
-Are new types being developed? where? why?
-What factors must be considered in selecting land for a golf course?
-Are there certain soil types which are unsuitable for golf courses? which and why?
-Are different grass types suited to different soil types?
-What kind of land treatment is required to prepare for the establishment of fairways, greens, etc.?
-What are the effects of addition of different concentrations of fertilizer to fairways and greens on keeping them green? Is there a point of diminishing returns? How is the amount computed so that the best effect is obtained for the least money?
-In design of golf course, how are natural features used to enhance the challenge of the course?
-What criteria are used in designing a course?

Communications, Public Relations:

-How do I approach a golf course owner to gain his confi-

dence and have him help me?
-What are the biggest problems he faces and what does he do to overcome them? How can I help him?
-What personal qualities and experience would I have to have to become a caddy, greenskeeper, groundsman, equipment repair, golf pro, etc.? How can these qualities be developed?

As the student gets into the investigation, other questions will suggest themselves.

What Can You do With a Truck Stop in Your Watershed?

Trucks are noisy, dirty, and pollute the air. Oil and grease, as well as detergents from washing trucks have to go somewhere, as does the sewage from the restaurant and the runoff from the parking area. Questions you might investigate include:

-What effect does noise from the truck stop have on residents nearby? on the drivers themselves?
-How loud are the trucks? Is the noise they make potentially damaging to the hearing? Can you detect hearing damage in nearby residents? How far away from the truck stop does the damaging noise affect man? Does sound carry different distance at different times of day?
-When is traffic use of the truck stop highest? Is this at a convenient or inconvenient time for the people living nearby?
-What happens to oil, detergent, sewage, and runoff water from the service station? Do they pollute streams? If so, how and what effect does that have on stream life? How far downstream does the effect last?
-What alternatives are available to correct noise problems?
-Does vibration caused by heavy trucks damage houses nearby? What precautions can be taken to minimize these damages?

You and your students will undoubtedly uncover more interesting possibilities for study as you walk your watershed and talk with people to get their ideas.

SECTION 3 — SOME OPERATIONAL AND TECHNICAL SKILLS NEEDED IN WATERSHED STUDIES

CHAPTER 6 - OPERATIONAL SKILLS

Introduction

There is no "right way" to solve problems. However, certain techniques can be taught which make the planning of projects more enjoyable and satisfying. The approaches on the following pages are intended to guide you in developing skills training sessions which will make your students aware of, and give them practice using, these techniques. Your best guides, still, are your senses and your intuitive knowledge of your students' capabilities.

The sequence in skills training seems to be:

1. Give the students a task or let them select a problem they want to study.
2. If they can handle it, leave them alone.
3. If they can't, show them a way they can organize their thinking without wasting too much time.
4. Let them practice on a problem of their own or a new problem (awareness task) given by the teacher until they master basic skills.
5. Evaluate the effectiveness of the technique; make appropriate changes.
6. Immediately have them apply the skill to another problem that interests them, so they can practice while the evaluation is fresh in their minds.

Following are some basic techniques and skills for organizing thinking that we hope will be helpful.

You may want to translate some of the guidelines into simple handouts for kids to refer to when they have the responsibility to perform in any of the roles, functions or situations. These could be compiled into a skills guidebook.

How to Conduct Meetings That Accomplish Their Purpose.

Groups often spend a great deal of time trying to determine what they should do. They philosophize, talk in generalities, debate insignificant or irrelevant points, or are led off into non-related subjects, and are no further toward defining and/or meeting their goals and objectives in the end than when they started. People don't like to spend time in meetings that go nowhere. While they may not know how to correct the situation, they do know that there are better ways to spend their time. In disorganization, enthusiasm drops, absence increases, and the project fails.

Fifty minute class periods are very short. If time is not used effectively, members of project teams become frustrated, apathetic, and finally non-productive. They sit around class talking to their friends, and are often lost for the rest of the year. Students who have participated in these kinds of

experiences say, "this class was a joke. I feel I've wasted the whole year, and learned nothing."

To avoid this, sit in with groups during their first few experiences. As you sit in with the group, observe how it functions. Notice whether:

-group roles are defined. Is anyone keeping notes? Bringing discussion back on the track? Periodically summarizing progress being made? Leading the group through some systematic process to get the job done? Most of these roles don't have to be assigned to specific people, but successful groups must have members who naturally assume these roles, if they are not assigned.
-they have specific objectives for the meeting which they all agree on, and plan for meeting the objectives during the prescribed meeting time.
-responsibility for specific planning of projects decided upon is delegated to individuals or committees.
-they spend their time on generalities, avoiding the specific purpose for which they have met or do they get right down to business.
-they have a schedule, set deadlines, and hold committees accountable for meeting their deadlines.

If a group is functioning well, leave them alone. If they are not, convert your observations into questions such as:

-are you meeting your objectives? What is keeping you from meeting them?
-what changes could you make in your organization to use the time you have more effectively, and get more done?
-has anyone functioned as coordinator, synthesizer, recorder, watchdog, organizer, etc.?

and hold an evaluation session. If the group is unable to answer these questions, you might share some of the following suggestions with them, and demonstrate how they can be used by conducting their next meeting for them.

1. Determine the objectives of the meeting and develop an agenda for achieving them. Whoever is leading the meeting should ask, "What is it that we want to accomplish before we leave here today?" (If an agenda meeting was held, and objectives determined by group leaders, they should still ask the group if there are other items which should be considered.)

   Items are listed, then rank-ordered according to importance (i.e., "if we were only to get to four of these five items today, which would we leave off?")
2. Beginning with the first point, each item is discussed and decisions are made about how to accomplish the task. Responsibilities for planning and carrying out specific steps in the plan are delegated to an individual or committee. Detailed discussion of specific points that can be easily handled by the committee in separate session is discouraged.

3. Deadlines are set, and a time schedule is constructed listing each step required to get the job done. For example, if it is a workshop you are planning, and you have two months to plan it, the schedule might look like this:

DAYS COUNTDOWN	PROGRAM	PUBLICITY	EQUIPMENT	FOOD	FACILITIES
60 days before event	Plan program Invite speakers Give copy to publicity, equipment comm.	Arrange for artists, materials, printing	Get list of people who can lend equip., etc.	Determine source and price for meals	Arrange for building, lab etc. Fill out all forms
45 days before event	Confirm speakers, meet with them to discuss role	With info on food, cost, facilities, & program, prepare fliers, brochures, posters, news releases, etc.	With info on program line up equip. & transport. needed	With info on program give time schedule to caterer	With info on program, arrange for specific rooms lab facilities, et
30 days before event	Meet with people resp. for various parts of program, finalize details	Get numbers of people expected. Tell food people	Pick up equip. Check it out	Order meals	Make directional signs, registration forms, etc.
15 to 1 day before event					Arrange registration table and man it.

A similar schedule can be developed for any project that has a deadline and for which a number of people and steps must be coordinated to meet the deadline. For example, in the schedule above, publicity can't begin until facilities, food and program are arranged; equipment and facilities committees are dependent on the program committee and so on.

Every member of the group should receive a copy of the schedule. When the first item on the agenda is completed, the group goes to the second item. Subsequent meetings should include formal or informal committee progress reports.

Meetings conducted systematically, which accomplish their objectives, satisfy the participants. Other ways of systematizing the planning process include:

The Force Field Approach to Problem Solving.

Every problem is a problem because there are some people, things or circumstances that resist efforts to change. To solve problems we must increase the power of positive forces

favoring change, and neutralize, or convert to positive, the negative forces. Problems are brick walls to many people but they need not be. Most problems have a solution but it may take experimentation and persistence to find it. As soon as you or your students give up you are effectively saying that you accept the situation as being okay.

The following scheme was developed to systematize the process of finding solutions to problems. It is a tool to structure your thinking in any problem situation, whether it be getting faculty or administrative support for your program, solving a family dispute, or combatting environmental damage in your community or watershed.

Step 1. Define the problem, as you see it. This is usually a statement accompanied by a sense of helpless resignation. Forget the resignation and write down the problem, or set of problems.

a. Decide whether...
1) you care enough to spend the time needed to solve the problem.
2) the problem is stated in terms that you have the resources, time, background, and ability to do something about. (DDT, Lake Erie, and population are too large and unwieldy. Substitute such things as an education program for local homeowners on specific uses of pesticides, water quality studies on your local stream, and the effect of population density in your town on amount of solid waste generated.)

This is a preliminary assessment of feasibility. You will make a more thorough feasibility study later.

Step 2. Describe:

a. The situation as it is now. What are the conditions prevailing in your organization, community, etc., with regard to the problem now--the things you want to change. List them all.
b. The situation that you are interested in achieving. (What is the ideal--the goal and objective you would like to reach.) Objectives should be stated in terms of a product, or measurable outcome, i.e., given soils map information, the Planning Board will use it in examining new subdivision plots. This is evaluatable. They either are or are not doing this at the end.

Step 3. What are the forces pushing toward improvement in the situation?

Brainstorm. List all of these regardless of importance. After you have brainstormed and gotten all pushing forces on paper, underline those that are most important.

Step 4. What are the forces keeping you from solving the problem?

Brainstorm. List all, and underline the most important force or forces that you might be able to change for the better.

IF YOU FIND GAPS IN YOUR KNOWLEDGE OR UNDERSTANDING OF THE PROBLEM AT ANY POINT IN THIS PROCESS, DON'T GUESS OR GO BLINDLY ON. SUCCESS REQUIRES THAT YOU UNDERSTAND THOROUGHLY EACH ELEMENT YOU ARE DEALING WITH. STOP! THOROUGHLY RESEARCH THE POINT (review the literature, technical advice, etc.) BEFORE GOING ON.

Step 5. For each important restraining force (forces keeping you from solving the problem) list some steps you could take to reduce or eliminate its effect.

Brainstorm. Don't worry about practicality of the idea. You can eliminate the irrelevant ones later. Get all steps down that you can think of.

Step 6. List all action steps you could take to increase effect of each driving force (forces pushing to improvement).

Step 7. Underline the action steps which seem most promising in 5 and 6 and put them in order of execution.

Step 8. For each action step, list materials, equipment, personnel, literature and other resources you need to carry out the action.

Step 9. Based on this list, determine feasibility of dealing with the problem.

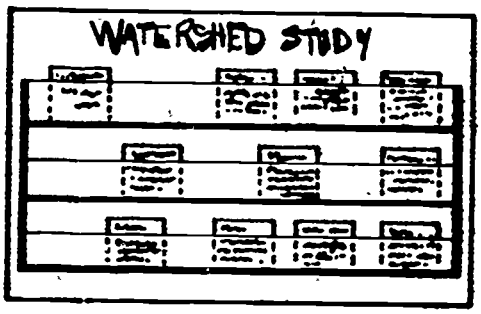
If you have or can get the needed resources, begin implementing the action steps.

Using a Planning Board to Develop Community Education Programs

A planning board is simply a visual way for a person or group working together to organize their thinking on some subject. Using it, they can build, step by logical step, toward a conclusion, decision, a way to accomplish a project or develop an idea.

Usually it's about 3 by 4 feet, made of plywood, and contains several thin plastic strips spaced horizontally from

top to bottom. In using the planning board, words, phrases, ideas, drawings, and the like are written on 3x5 cards or 4x6 cards and placed along these strips. Gradually, as cards are added by the person or group using the planning board, main ideas begin to stand out, subordinate ideas are seen to be subordinate, similar ideas suggest consolidation, and things begin to fall into rough order. By changing the position of cards, adding new ones as they occur, and removing unneeded cards, you can speed up and make infinitely clearer and easier the development of the solution, decision, or project under consideration.



For maximum efficiency from the planning board, we recommend the use of a set of key phrases and questions, arranged in logical order and designed to lead a group through these four steps:

1. state the problem or situation
2. analyze it
3. decide what to do about it
4. decide the best way to do it

Here, in the order given, are these key phrases and questions. The words capitalized should actually be written on cards in advance, and placed on the planning board one at a time, in proper order. The group then discusses each step, makes its contributions and tentative decisions, then proceeds to the next card.

1. SITUATION OR PROBLEM. (What brought us together? Is there an actual problem of some kind, or are we proposing to launch a new project, or what?)

2. WHAT DO WE WANT TO DO ABOUT IT? (In other words, what is our--)

3. NEED OR GOAL. (Are we proposing to raise money, get more members, convince people that a new park is important, or what? Insist on specific goals, if possible. Not just "get more members", but "recruit 25% more schools.")

4. WHO'S INVOLVED? (What groups? parents? community leaders? school systems? business community? general public? again, be specific. "Everybody" is unacceptable.)

5. WHAT DO WE WANT THIS (THESE) GROUP(S) TO DO? (In other words, what "terminal action" would we like to see. Do you want them to give money, adopt a watershed, take training, send a letter supporting a new park? Wanting them to "understand us, support us, like us" is no good. Nail it down.)

6. IF WE COULD GET THIS TERMINAL ACTION FROM ONLY ONE OF THESE GROUPS, WHICH WOULD WE CHOOSE? (now we force the group to set priorities. Which group under consideration could move us furthest toward the need or goal established in #3 above?)

7. KEY GROUP. (The group chosen is called the key group. From here on it is number one, and we center our aim accordingly. Do not accept "all groups" -- make them choose. Rank all groups, but aim at #1.)

8. POSSIBLE APPROACHES TO MOVE KEY GROUP TOWARD TERMINAL ACTION DESIRED. (We know our key group, and we know what we want them to do. Now discuss how we can get them to do it. Training courses, booklets, meetings, visual aids, etc.)

9. WHICH APPROACH (APPROACHES) MOST LIKELY WILL WORK? (Does one stand out loud and clear as the obvious approach? Two or more in combination? Try to agree on a number one.)

10. IF THIS APPROACH (OR ONE OF THEM) IS AN AUDIOVISUAL... (And up till now we haven't assumed it would be anything in particular. If we have played the game right, we have left this decision till this moment.)

11. THEN WHAT WILL BE ITS (THE AUDIOVISUAL'S) ROLE? (A continuation of the preceding thought. Will the audiovisual try to shoulder the whole burden? If not, what part of #5 above (terminal action) will it try to achieve? When the group has answered this question, they have their--)

12. PURPOSE. (This means the purpose, or aim, of the audiovisual the group decides on making. It should be specific and crystal clear.)

13. AUDIENCE. (To whom will you show the audiovisual? Will the audience necessarily be the key group? Not necessarily. Sometimes you show something to students (audience) in order to reach their parents (key group). Avoid generalities, such as "adults". Narrow it down to "fathers of students in my class" or the like.)

14. MESSAGE. (What main points will you be making with this audience, in order to motivate them to the desired action? Not abstractions like, "watershed studies are important" but rather, "studies of local problems by students teaches them to be self-learners".

15. CONTENT. (No, not the same as "message". Message is ideas. You sell these ideas by showing your audience pictures. Pictures of what? When you have answered this question, you have your content. At this point the other cards are removed from the planning board and it becomes

a story board. Write all key phrases you think you may want in your presentation on the right hand side of the card, and draw a picture of the visual you will use to illustrate the phrase in a small box on the left hand side (see figure 1.) When all your ideas are on cards and placed on the story board, review them, toss out those that don't fit, add new ones and finally arrange them in the sequence in which you wish to present them.)

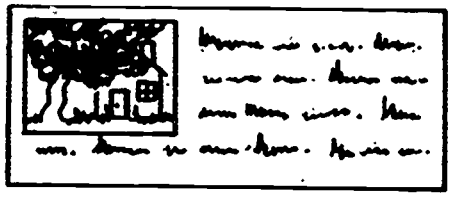


figure 1

16. WHAT MEDIUM? (If you're making an audiovisual, you have your choice of slides, filmstrips, movies, flip charts, records, tape recordings, etc. Which of these can do your particular job best? Establish a priority, then pick the best you can afford.)

We have used an audiovisual as an example, but the planning board works with almost anything--writing books, speech, recruiting or finance campaign, special presentation, etc.

TRY IT. IT WORKS!

There are many other ways to conduct meetings and plan action. Group dynamics and management training books are full of them. These are just a few we have used in our programs. We hope you find them useful.

A Minisession in Phone Interviewing

Considerable time is often wasted in making phone calls, and often the person who can answer the question isn't reached because of poor phone interview technique. The student is frustrated and loses confidence. The people contacted have wasted their time, and to a degree, resent it. There is an art to getting things you need over the phone. Once the art is mastered, phone time and dollars will go alot further.

An example of a phone interview that will get an answer follows:

1. Call the potential resource,
2. Ask "May I please speak with the person who is most knowledgeable about_____." Remember, the one you get is a receptionist. He or she generally doesn't know very much about details and besides, her switchboard is usually very busy. The less of her time you take the better she will like it. It isn't necessary to give her your name, where you are from, or what details about what you want. All you want her to do is transfer your call to the right person. Keep it short and simple, but give her enough information so she will know who to connect you with.
3. You will probably be connected with a secretary. Explain to her, "I'm _____, and am beginning research on_____. Would you please tell me

who is most knowledgeable in that field and how I can contact him." If it isn't her boss, whom she would then connect you with, get the full name, address, and phone number.

4. When you reach that person, say, "I am _____. Dr._____from_____recommended that I call you. I am starting an experiment on _____ and have alot of gaps in my knowledge. Would you please be able to answer some questions for me?"

Have ready:

a. A list of specific questions. One of these may be, "What work has been done by you and others in this field? Would you please give me the journal citations, or could you send me reprints of these papers?"

Do as much homework as possible in the literature before contacting him, and be familiar with the vocabulary and basic concepts of the field. If the student speaks as if he knows what he's doing, has the script in front of him and doesn't waste words, the resource person will generally be happy to answer questions. Don't have too many questions or take too much of his time the first time.

A parting question may be, "May I make an appointment to visit you and discuss this research further?"

If the answer is positive, the student is on his way.

Role-play phone and in-person interviews in class with a tape recorder running. You, a class member, or an outsider (another teacher, parent, etc.) act out responses you might expect from community residents or resource people.

Preparing Proposals for Funding

Proposals submitted to local industry, citizens' organization or government agency for funding should be as professional as possible. Instructions for preparing and assessing an environmental study plan are contained in the Environmental Education Guide for Teachers, pages 38-41. Proposals should satisfy the standards set there. Following is a sample research proposal outline.[1]

Introduction
- Background on problem
- Situation that exists
- Situation you are working toward
- Work by others
- Your own preliminary work
- Area to be studied

Purpose (to answer the following question)
- Optional - hypotheses being tested
- Goals
  - Goal 1
    - Objective 1
      - Procedure

[1]Samples of student written research proposals can be obtained in the EEGS (see inside front cover)

Equipment and resources
Objective 2
Procedure
Equipment and resources
Objective 3
Procedure
Equipment and resources
Goal 2
Objective 1
Procedure
Equipment and resources
Objective 2
Procedure
Equipment and resources
Schedule for completion of objectives
Budget
Literature cited
Resume on investigator(s)

A statement of justification (why you are doing the project, why should others be interested in the results, and what benefit will the organization funding the proposal get) should be included if the proposal is being submitted for funding to an organization.

Constructing Questionnaires.

Questionnaires which will be used to gather information from residents should be constructed to get tangible information, not opinion. Questions that sample opinion (do you think the Millstone River is polluted?) are of little value in correcting problems. "Do you use fertilizers on your lawn?" is a bit of information students can build a research project around.

Arrange questions so that you get the people talking about their feelings about their town (i.e., the situations or problems they would like to see corrected.) early in the interview, saving potentially sensitive questions (i.e., do you dump your garbage in the woods?) for the end. Examples of effective and ineffective questionnaires follow.

The quality of the door approach will determine often how well people respond to the student. Practice it under conditions the student might face in the community. Role play with teachers, parents, or other students. Students should be prepared to answer such questions as, "what do you want to know for?" or, "how will this information be used?" or, "will my name be used and will I get into trouble?"

If the respondent is told that a report will be published summarizing your findings for the town council, don't disappoint them. It is bad public relations not to follow through on a promise.

Questionnaires, whenever possible, should be filled out

at the door, rather than being left behind for later pick-up.

Questionnaire #1 - example of a well-constructed questionnaire.

WATERSHED SURVEY

Good morning, Mrs. Jones. We are working to help you get improvements in the community that you feel are important. We are interviewing some of the people in our town to find out what they would like us to include in our report to the town council, and to get information to support the research some of our class members are doing. Any help you give us will be kept confidential. The report will be a summary of responses and won't mention any names.

1. What situations or problems concern you in our town?
2. How do you feel these could be corrected?
3. Would you be willing to help us by
   a. reporting problems to us when you see them?
   b. going to council and planning board meetings to support changes you would like to see if we let you know when these issues will be coming up?
4. Do you have a garden? ____yes ____no
5. Do you use a fertilizer? ____yes ____no;what kind?
6. How do you dispose of raked leaves? grass?
7. Do you feel the city of_____uses an excess of salt on our roads? ____yes ____no
8. Has the salt affected your car or driveway? ____yes ____no
9. Do you own a well? ____yes ____no
10. Is it presently in use? ____yes ____no; Has it ever been contaminated? ____yes ____no
11. Do you have a septic tank? Or tie in to the town sewer?
12. Does your basement flood? ___often ___occasionally ____almost never
13. Has your septic tank ever over-flowed? ___yes, often ___yes, once or twice ___no, never
14. Do you have a garbage disposal? ___yes ___no
15. Do you have a creek nearby? ___yes ___no
16. Is it on or off your property?
17. If so, are there any odor problems? ___yes ___no
18. Has your creek ever over-flowed? ___yes, often ___yes, once or twice ___no, not that I can recall
19. Has the over-flowing of the creek ever caused any damage? ___yes ___no
20. If so, what kind?
21. Have you noticed any large amounts of sediment in the creek? ___yes ___no
22. When especially?
23. Have you noticed any life in your creek? (algae, frogs) ___yes ___no
24. What kind?

25. Have you noticed ___iron deposits? ___suds? ___oil? ___other?
26. Have you noticed any wildlife in your area? ___yes ___no
27. What types?
28. Do you presently own ___swimming pool? ___pond?
29. List problems, if any_____.
30. Do you own any pets? ___yes ___no
31. What in specific and how many?
32. How do you dispose of animal waste?
33. How do you dispose of your garbage? ___incinerator ___garbage truck ___outdoor burning

Name_____
Address_____
_____

Example of a questionnaire that yields very little useful information.

QUESTIONNAIRE

1. Is there a pollution problem in your community? ___yes ___no
1a. Is the problem getting worse? ___yes ___no
1b. How would you rate the problem? ___serious ___moderate ___slight ___no problem ___don't know
1c. Why do you think this_____
_____
1d. What are the major pollutants in your community? (Rank in order of seriousness, 1-the most, 5-the least)
___water treatment plants ___septic systems ___industry ___erosion ___residential garbage
2. How would you rate your local government in its efforts in dealing with pollution problems? ___good ___fair ___poor ___no effort made ___unaware of effort
3. Is your house ___rented ___mortgaged ___owned by yourself ___jointly owned?
4. Would you vote for a candidate who is proposing pollution abatement measures, knowing that this would raise your taxes? ___yes ___no ___don't know

Comments:

PLEASE RETURN THIS WITHIN ONE WEEK----------

The first questionnaire yields specific information; the second only determines awareness and opinion. The specific questions to be included in your questionnaire should be determined by the research needs of students and the characteristics of your

watershed.

Tips for Preparing Reports on Student Research

There is no excuse for poor presentations because it isn't difficult to present ideas and information in an interesting way. Some of the following tips might be given to students to help them organize their ideas.

Phase I - Organizing and researching a talk.

Step 1. List everything you already know about your subject.
Step 2. For each of these, list data and other information you have gathered which support your conclusions.
Step 3. Organize this information into a logical sequence.
Step 4. Determine gaps in your knowledge or data (particularly in concepts and mechanisms, which explain why what you observed happened.)
Step 5. Research the literature, or conduct experiments, to fill these gaps. Anticipate questions the audience may ask and find answers to them.
Step 6. Review your outline. Make revisions as needed. Fill in the gaps with information you have gained.

Phase II - Constructing the talk once you have the information.

Step 1. In a 15-20 min. talk, the most you can cover are 2-3 main points. Decide which are the most important findings (or most interesting findings for the specific audience to which you are speaking). Cover these three in depth instead of covering more points superficially. Your written paper will contain the rest.
Step 2. Take people from what they know into what they don't know. Introduce your talk with an illustration or story which covers things familiar to them and also relates to what you are doing. (See Berkshire PTA presentation, Environmental Education Guide for Teachers, Appendix 4).
Step 3. Define terms which may be unfamiliar to the audience.
Step 4. Outline for the audience what you will be discussing so they will have a framework into which they can put what you tell them.
Step 5. Illustrate each concept with an example or story. These illustrations are often all that your listeners will take home with them.
Step 6. Use humor if it comes naturally, and voice dynamics (change of volume, inflection, etc.) to keep the talk lively. This comes with practice and by critically listening to good speakers. Practice your talk into a tape recorder before giving them and decide where emphasis should be placed.

Step 7. NEVER READ A TALK UNLESS YOU HAVE PRACTICED SO THAT IT DOESN'T SOUND LIKE YOU ARE READING.

Step 8. Choose a topic that interests you, not one you think the audience will be interested in. If you are enthusiastic about the subject, the audience will catch this enthusiasm no matter what the topic.

EXAMPLES OF SPEECH OUTLINES

The Informative Speech - objective: to communicate facts and ideas to the audience.

Introduction

attention getting opener -story, quote, shocking statement

introduce topic at level people already understand.

Body

idea oriented

1st principle, idea or concept
explanation
illustrations

2nd idea, concept or principle
illustration
explanation

3rd idea, concept, etc.
illustration
explanation

Summary - repeat main ideas, restate points briefly, tying them together in logical memory sequence. Close with strong quote or statement.

Notes on this approach: Sometimes it is effective to lead into the concept with a story and then present the idea. Illustrative material and expansion of thoughts are interchangeable in order, and are often intermixed.

The Persuasive Speech - ojective: to sell a product or an idea and motivate people to act on it.

1. Introduce the problem in the form of a question or statement. This may be a quote illustrating the concern others have about the problem or a story that illustrates the problem vividly.
2. Give background necessary to understand the problem.
3. Vividly illustrate the consequences if the problem is not solved.
4. Discuss alternative solutions (optional in some cases.
5. Propose what you feel is the best solution and reasons it is best.
6. Challenge them to act - strong closing statement that gets them ready to do what you want them to do.

When the talk is prepared, check to see that:

___it is limited to 2-3 main ideas
___each concept is (or idea) illustrated with examples
___you start with an illustration that captures the audience's attention
___your introduction shows the relationship of your work to what the listeners already know.
___potentially unfamiliar terms are explained
___you outline the main points for the audience before talking about them.
___you close with a summary of points made
___you understand completely the mechanisms of each concept you plan to present so that you can handle any questions you anticipate the audience will ask.

A "rule of thumb" is that you should have about six times the amount of information which actually ends up in your talk ready in reserve to handle questions.

Making a memorable talk is no accident. It takes planning and practice. The more you speak, the better you become. Provide students with as many opportunities as possible to develop their public speaking skills.

Organizing a written report for reading by a general audience generally follows the same style and procedure as used in preparing a talk. Advice on the preparation of technical reports can be found in MacKenthun[1].

A Method for Conducting Seminar Sessions

Seminars are often conducted with a panel of experts sitting at the front of a room. Each is given 10-15 minutes to present his/her position, after which the audience asks questions. An alternate format for conducting seminars was used by R. Tabor Hand, a student at Lawrenceville Prep. A committee of students interested in a particular problem decided what they wanted to know, prepared questions, and ranked them in order of importance. They invited specialists to meet with the group informally, and the committee asked questions and got responses from whoever had them. Each question served as a springboard for a series of related questions. The meeting chairman was responsible for controlling the discussion so that it was cut off before it went too far astray from the original topic and so that all important questions could be handled. Seminars like this can be taped (videotaped) and made available to member schools to view at their leisure. Suggestions for finding and using resources, seeking funds from outside sources, handling out-of-classroom problems, and conducting evaluation sessions are covered in detail in the Environmental Education Guide for Teachers.

[1]Mackenthun, K.M., 1969, Writing a Water Quality Report, Journal of Water Pollution Control Federation, Jan. 1969, pp. 82-88

CHAPTER 7 - TECHNICAL SKILLS

Introduction

Most of the technical skills and conceptual background needed to investigate environmental pollution problems is available in the popular literature. The books listed in Appendix 1 are particularly valuable sources of information on watershed study techniques and should be available to all students engaged in watershed studies.

The following information and skills training activities have not been found elsewhere.

Making a Watershed Reference Map

When a watershed study is begun with stream monitoring or any other specific study, those involved often lose sight of the overall project goals. It helps to have a large map of the watershed on which project participants can regularly plot their findings and list the questions or problems discovered. This map should be made at the beginning of a watershed study and posted on a conspicuous wall where it is readily accessible to all. In addition to keeping everyone current on the progress of the project, it can also serve as a recruiting tool. As intriguing questions needing study are listed, other students interested in those questions often get involved.

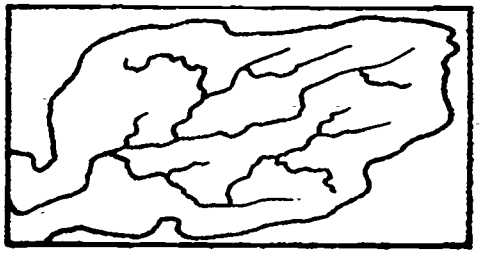
Equipment needed

U.S.G.S. topographic maps of the entire watershed (not just the stream)
fine blue line magic marker
red magic marker
pencils
access to a single lens reflex camera for an hour or so
1 roll Tri-X film or Kodachrome slide film (if Tri-X, you also need some slide mounts and developing chemicals)
large sheet of white paper (minimum 4' x 6')
slide projector
masking tape and tacks
optional
- acetate sheet to cover map (protects from damage; allows for removing markings later)
- soil surveys maps, tax maps, and other land use maps for watershed assessment.

Procedure

1. Piece together the topographic maps of the watershed area,
2. Find where the stream to be studied starts and where it empties into the next largest stream.
3. Mark the stream and its tributaries with the fine line blue magic marker so they can be readily distinguished from surrounding detail. Also mark streams in adjacent watersheds.

4. Using contour lines as your guide, trace the perimeters of the watershed with a pencil.
   a. each of the brown contour lines around the stream represents a 20 foot rise in elevation. Every fifth line (approximately) is slightly darker than the rest. If you follow this line you will find a number printed on it. This is the elevation of that point above sea level.
   b. Place your pencil on the stream at any point along its course. Move it uphill perpendicular to the stream, as if you were walking uphill away from the stream. When you get to the ridge or highest point, put a mark there. Do this first on one side of the stream and then on the other.
   c. Repeat step 4 at intervals all along the stream from its mouth to the headwaters. You will now have an irregular semicircle of dots forming a halo around the stream.
   d. Connect the dots. All the land area within the halo drains into the stream you are studying. Pollutants you measure at stations along the stream may come from anywhere within the area upstream from the station, but generally from nowhere else.
   e. When you are sure the watershed boundary is accurately marked, go over the pencil marks with a red magic marker. You should then have a picture looking something like this:



5. Photograph the map. Develop the film and mount the negative in a slide mount for projection. If you use Tri-X film and have developing equipment and chemicals available, the entire project can be completed within one or two class periods. Negatives can be ready to work within 20 minutes after the picture is taken. (Kodachrome slides take several days to process and the students learn nothing about the photography techniques involved).

6. Project the negative on the giant piece of white paper tacked or taped to a wall.

7. Trace the stream, the watershed boundaries, and prominent land marks (hiways, towns, housing developments, airports, sewage treatment plants, etc.) on this paper.

8. Tack another strip of paper next to the map. On this participants list the questions and problems they find while filling the map with information. The reference map is now ready to use. It can be protected with acetate. Acetate overlays expand its utility considerably also.

Types of information which can be plotted on this map include water chemical data, land use, location of potential polluters, location of complaints received (water pollution, air pollution, etc.) by the health department, soil survey information, flood plain boundaries, land ownership from tax maps and questionnaire responses.

References:

McHarg, Ian, Design with Nature, Natural History Press (American Museum of Natural History, N.Y.) (Shows how to use acetate overlays to develop good overview of watershed problems.)

Preliminary Stream Survey Procedures

When conducting a preliminary survey of a stream, certain kinds of information are needed from stations, from headwaters to the mouth. This includes data on water chemistry, stream flow, sediment load, conditions around the stream and plants and animals occupying the stream. Work goes faster if the labor is divided: a recorder should oversee the entire operation at each station, making sure all data are in. In addition, the recorder should:

___a. make a detailed survey of the stream and its surroundings and record these observations on the stream data sheet. Don't feel limited by the categories listed. If you observe something interesting that doesn't fit, record it on the back.

___b. make a rough but detailed map of the station, showing location of pools, riffles, rocks, trees, fallen logs and other features. Also show where each sample was taken, and where the permanent stream profile stakes are located.

___c. by asking questions of the other teams, bring together all the data needed to complete your watershed characteristics checklist.

___d. make sure that the following are accounted for before you leave the station to return to the lab.

___1. a plankton sample
___2. 1 or more bottom organism samples
___3. oxygen, ammonia and chlorine concentrations and pH are determined and recorded
___4. a water sample of at least 300 ml. (unless the analysis was done in the field)
___5. a sediment sample
___6. data to graph the stream profile
___7. a water sample for bacteriological analysis

Some other teams, their equipment and responsibilities, include:

1. BOTTOM SAMPLING TEAM
   A. Equipment needed:

shovel (to be shared with stream flow people)
surber type bottom sampler
several plastic bags
sorting screen
porcelain pan
forceps
magnifier
5 or 6 baby-food jars
marking pencil
Ekman dredge (optional)

The job of the Bottom Sampling team is to characterize the animals inhabiting the bottom of the stream. Therefore, they should sample as many microhabitats (slow current near edge, rapid current, pools, behind rocks, in front of rocks, etc.) as time permits. Different organisms are adapted to the specific conditions in each. Samples from each microhabitat should be kept separate so they can be compared.

PROCEDURE FOR RIFFLE AREAS

1. Place surber sampler in the stream with the net facing downstream. Make sure the frame is securely placed on the bottom so that all animals dislodged will flow into the net.
2. With hand or shovel, thoroughly stir and disturb all rocks, and soil within the frame in the upper 3 or 4 inches (hint--if the water is cold, put a plastic bag on your arm and secure it at the top with a rubber-band). Rub animals off the rocks. When finished, all life in that square foot should be trapped in the net.
3. Dump the contents of the net into the porcelain tray. With forceps and magnifying glass, pick out all the organisms and place them in a baby-food jar containing water. Label and store in a cool place until time to return to the lab.

PROCEDURE FOR QUANTITATIVE SAMPLING OF POOL AREAS

1. Using the shovel, or Ekman dredge, dig out a sample of bottom mud approximately 4 feet deep.
2. Place this sample on a sifting screen and wash it through the water to remove all fine sediments. (taking care not to wash out the small organisms)
3. Place remnants in the white porcelain tray. Pick out organisms as before and store in baby-food jar. Make sure all the animals have been removed from the screen. Label and store in a cool place.
4. If the pool is deep and/or you wish to sample ponds, an Ekman dredge or its equivalent is necessary.

QUALITATIVE SAMPLING

1. Make a general survey of the stream bottom, checking to see which organisms live on rocks, in front of rocks,

on plants, and elsewhere. Collect rock scrapings, pieces of plant material and anything else you feel might provide a home for aquatic animals. Record details and place the samples in separate bottles or bags for later analysis. IN THEIR ROAMING, THE BOTTOM SAMPLING TEAM SHOULD TRY NOT TO DISTURB THE STREAM ECO-SYSTEM ANY MORE THAN NECESSARY. LEAVE THE SITE IN AS GOOD CONDITION AS YOU FOUND IT, MINUS A FEW ANIMALS.

2. PLANT TEAM

   A. Equipment needed:
      measured bucket
      scrapers for rocks
      plankton net
      plastic bags for higher plants
      baby-food jars

The Plant Team objective is to characterize the plant life in the stream. The following facts will help.

a. Algae occur in many forms in streams. A black or green crust or scum on the bottom is usually a blue-green algae. A brown slimy rock that you consider covered with silt may be covered with many yellow-brown diatoms. Many other algae attach themselves to plants or to rocks. All are adapted in some way to withstand current. Plankton (small algae and animals suspended in water) are found only accidently in rapidly moving streams as they are carried from one pool to the next. They will be most abundant just downstream from a lake or pond, and in pools along the stream.

b. Higher plants (submersed, floating and emergent) are present where the bottom is silty, the stream is slow moving and relatively shallow. They are especially abundant when the water flowing past them is enriched with nitrates and other derivatives from organic waste, and where upstream erosion has supplied them with much rich topsoil.

PROCEDURE FOR GATHERING QUANTITATIVE PLANKTON SAMPLES

1. Pour measured quantities of water through the plankton net until the water in the test tube begins to be green or cloudy (up to 30 liters). If nothing happens after you pour 30 liters through, you have relatively little plankton.
2. Concentrate this sample to about 25 ml. (mark on the test tube) by pouring the water carefully from tube into the net and back. This also washes plankton trapped at the mouth of the tube into the water.
3. Transfer this sample to a baby-food jar. Label the jar.

QUALITATIVE SAMPLING

1. Collect samples of rocks and plants with attached algae. Place each in separate plastic bags and label them with location and date.
2. Collect leaves, stems and flowers (if available) of higher plants for future identification. Give each a code name and record them where it was found in the stream and how abundant it is.
3. You may wish to sample the soil under the plants and in open water for later comparison of nutrients and sediment size.
4. Keep specimens in a cool place until ready to return to the lab.

3. STREAM FLOW AND STREAM PROFILE TEAM

A. Equipment needed:
4 stakes
1 hammer
2 measured ropes
1 stream profile data sheet
1 watch with second hand
1 level
1 orange
1 stream flow data sheet
1 or more pair of hipboots
shovel (share with bottom organism team)

Read "Streamflow and Sediment Measurements". Follow procedures outlined to:

___a. measure flow using float method
___b. compare results from the two methods
___c. install permanent stakes at points across from each other on the stream. Construct a stream profile.

4. WATER TEAM

A. Equipment needed:
300 ml. sample bottle
60 ml. sample bottle for oxygen
1 each powder pillows for dissolved oxygen 1,2 & 3
1 pair clippers
1 gallon jug for sediment sample
Hach kits or equivalent for analyzing chemicals listed on the data sheet on page 111.
eyedropper
1 sterilized bottle for bacteria sample

Your job is to bring back to the lab water samples to be analyzed by the whole group.

1. Take the oxygen sample first. Any disturbance in the water can cause the amount of oxygen in the water to change. There-

fore, go upstream from other teams and be careful not to agitate the water. (This includes letting it bubble into the bottle while taking the sample.)

2. Place bottle in stream with mouth facing into the flow. Incline it so that the bottom is under water, and the mouth is half in and half out of the water. This provides an air space at the top and prevents bubbling.
3. Gradually tilt the bottle as it fills until it is finally vertical and completely underwater. Allow it to stay under until all air bubbles are evacuated. Remove from water, but don't put the stopper in.
4. Make room, by removing a small amount of water from the neck, for the chemicals in powder pillows I and II.
5. Open the pillows with the clippers and pour the chemicals, Pillow I (slight pink color) first, into the water.
6. Insert the glass stopper quickly to exclude all air. If any air bubble forms, remove the stopper carefully, add a few drops of water with the eyedropper, and reinsert the stopper. Check again for air bubbles. Any air bubbles will invalidate the test.
7. Shake vigorously until the chemicals are dissolved, or nearly so, (a white residue on the bottom is common). A brownish precipitate should form. If the precipitate is white, the water contains very little oxygen. If no precipitate forms, you added either 2 pillow I's or 2 pillow II's. Take a sample and start over.
8. Allow the precipitate to settle. Shake. Allow to settle a second time, then add contents of D.O. pillow III. Shake. A clear amber liquid will result. Titrate with sodium trisulfate or PA according to instructions.
9. Fill the 300 ml. bottle with water. No special precautions need to be taken. Do analyses for chlorine, pH and ammonia immediately after collecting the sample; all other tests may be done either in the field or laboratory.
10. Fill the gallon jug from the fastest flowing section of the brook. Cap the jug, label it with station no. and date.
11. Determine air and water temperature (in C°),
12. Take air temperature first. Why?
13. Gather a water sample for bacteriological analysis.
14. Report bottle numbers for oxygen and water sample and temperatures to the recorder.

Once finished, you may assist the stream flow team with stream profile measurements or conduct water chemical analyses on the field for those parameters listed on the data sheet on page 108. All chemical analyses should be completed within 12 hours of taking the sample.

Sample Data Sheets, Check Lists and Water Quality Criteria for Use in Watershed Studies

ON-SITE PHYSICAL PARAMETERS DATA SHEET

Site No.____ Time Sampled_____ A.M. P.M.

CLOUD COVER_____(0/10 to 10/10)

Apparent Water Quality_____
(Presence of debris, odor, floating scum, sediment, turbidity, dead life forms, etc.)

CHARACTERISTICS OF WATER surrounding site (sample taken in a riffle, in a pool, in a riffle below a pool, etc. Record on back of paper the site GRAPHICALLY).

_____

_____

STREAM FLOW: (cfs)_____

Last date of rainfall, how hard did it rain?_____

CONTRIBUTING SOURCES OF FLOW_____

_____

_____

TEMPERATURE OF: Air (C°)_____ WATER (C°)_____

APPARENT POLLUTION PROBLEMS_____

_____

_____

BOTTOM CHARACTERISTICS: (Rocky with small pebbles, large rocks, solid sheet of rock, muck and sediment (depth), sand or mud, covered with plant and/or animal growth, etc.)

_____

_____

CHARACTERISTICS OF SURBER SITE: (as in water surrounding the site above.)_____

Number of SURBER SAMPLES_____

Number of PLANKTON SAMPLES_____

Number of BACTERIA SAMPLES_____

CUYAHOGA RIVER WATERSHED PROJECT
WATER QUALITY DATA REPORT FORM

STREAM: _____ DATE: _____

INVESTIGATORS:

STA. #	LOCATION	Bottle #	Air Temp. (C°)	Water Temp. (C°)	Cloud Cover[1]	Flow (cfs)	Diss. Oxy. (% sat)	Alkalinity ($ppmCaCO_3$)	pH	Diss. Solids (mg/l)	Susp. Solids (mg/l)	Volatile Solid (mg/l)	Nitrate (ppm) as NO_3	Ammonia (ppm)	Chloride as Cl (ppm)	Total hardness (ppm)	O-phosphate as P	Color (APHA unit)	turbidity (JTU)	Fecal strep (per 100 ml)	Fecal coli. (per 100 ml)	Heavy metal (specify)			Sulfate (ppm)	Time since last rain
1.																										
2.																										
3.																										
4.																										
5.																										
6.																										
7.																										
8.																										
9.																										
10.																										

[1]Cloud Cover is recorded in 10ths of the sky covered (i.e., 0/10 = clear sky; 10/10 = completely overcast)

REMARKS REGARDING STATIONS ON DATE TESTED

Station #	Comments

WATERSHED CHARACTERISTICS CHECKLIST

The following information will help you understand the water chemistry of each station. Compile as much of it as possible.

STREAM_____STATION #_____

1) ABOUT THE STREAM (Check when done)

_____A. What is the character of the stream bottom (rocky, muddy, covered with slime, etc.). What is the bedrock geology of the stream bottom (diabase, shale, sandstone, etc.)

_____B. How deep is the stream at the sampling point? Construct a profile of the stream channel using permanent stakes, so it can be checked again. Graph this profile. Superimpose future profile measurements over the original to determine changes in depth and route of the stream channel.

_____C. Can you see the bottom, or is the water too murky? What is the apparent color of the water? Does it have visible particles in suspension creating this color and/or murkiness, or is the water uniformly colored?

_____D. Is your water sample site in a pool or riffle? Are you sampling bottom animals and plants in both areas?

_____E. How much sediment is the water carrying? Normally? After rain? You may have to return on a non-sampling day to get this "after rain" figure.

_____F. How wide is the flood plain? What is it composed of? (rich alluvial soils, fines originating from local bedrock, etc.)

_____G. What kinds of plant and animal life are in the stream above and below the sample site? (filamentous algae, attached animals, larger invertebrates, plankton, higher plants) Classify as precisely as possible using available references. Is the stream rich in organisms, or are they relatively scarce? (overgrown with plants, etc.) How do you account for this? (shallow bottom, muddy, nutrient enriched waters, etc.).

_____H. What are the characteristics of the soil the benthic invertebrates live in? Distribution of particles sizes can be determined from dry soil using screens, and weighing the material passing through each screen.

_____I. What kind of vegetation surrounds the stream and how would this effect life in the stream? (forested stream edge, compared to field surrounding stream.)

2) ABOUT THE STREAM'S WATERSHED

____1. Map the perimeters of the watershed-survey land use away from the stream that could be contributing to poor water quality.

____2. What is the total area of the watershed?

____3. What laws and/or practices protect the public interest?

____4. How is land use planned for? Are soil survey maps used by the Planning Commission? Are such maps available for your watershed? If not, could you make one? Who would you get to help you?

____5. What sources can you see between the last station and this one for sediment in the stream bottom? What is the characteristic of these sediment sources? (point source or sheet erosion from large field, erosion from development, etc.)

____6. What industries, institutions, housing developments, shopping centers, municipalities, sanitary landfills, sewage plants, and other water users are located and dumping used water into the stream between this station and the last one you sampled? Can you estimate the amount of effluent they are putting in? Is it constant or intermittent?

____7. Map any pipes you see coming into the stream and any violations of the State and Municipal Sanitary Code. How would you find the sources of the pipes? Where would you find information about the laws governing environmental quality?

____8. How do homeowners near the stream use the water? Prepare a questionnaire to get information about pesticide and fertilizer use, attitudes about the brook, and observations people have made on conditions in the brook at different times of the year. Let them know who you are and how to contact you if they observe anything unusual happening in the brook. Get the homeowner's confidence and solicit their help in cleaning up THEIR brook.

____9. What is the water budget for your watershed? How much precipitation falls annually? How much is lost to runoff? How much is recharged to ground water?

You will undoubtedly think of other information that will help you characterize the current problems on the stream that need solution. Record all this information in as much detail as possible.

DESIRABLE WATER CRITERIA-FRESH SURFACE WATERS[1]

TEMPERATURE - No thermal discharge should be present which will detrimentally affect the natural aquatic biota. This is especially dangerous in the summer.

ODOR - Offensive odors should be absent.

pH - 6.0 to 8.5

DISSOLVED OXYGEN - 4 ppm minimum - saturation desirable.

CHLORIDE - 250 ppm maximum - less than 25 ppm desirable.

HYDROGEN SULFIDE - should be absent.

PHOSPHATE - Less than .05 ppm is desirable. Average concentration in weak waste water is 5 ppm, in medium waste water is 15 ppm, and in strong waste water is 30 ppm.

NITRITE AND NITRATE - 10 ppm (as N) maximum - absence desirable.

TOTAL HARDNESS - less than 120 ppm.

COLIFORM MNP VALUE - Less than 100/100 ml. is desirable.

BIOCHEMICAL OXYGEN DEMAND - 15 ppm or less is desireable

SOME OTHER TESTS and SUGGESTED LIMITS

COPPER - 1 ppm maximum - absence desirable.

IRON - .3 ppm maximum - absence desirable.

SULFATE - 250 ppm maximum - less than 50 ppm is desirable.

AMMONIA - .5 ppm (as N) - less than 0.01 desirable.

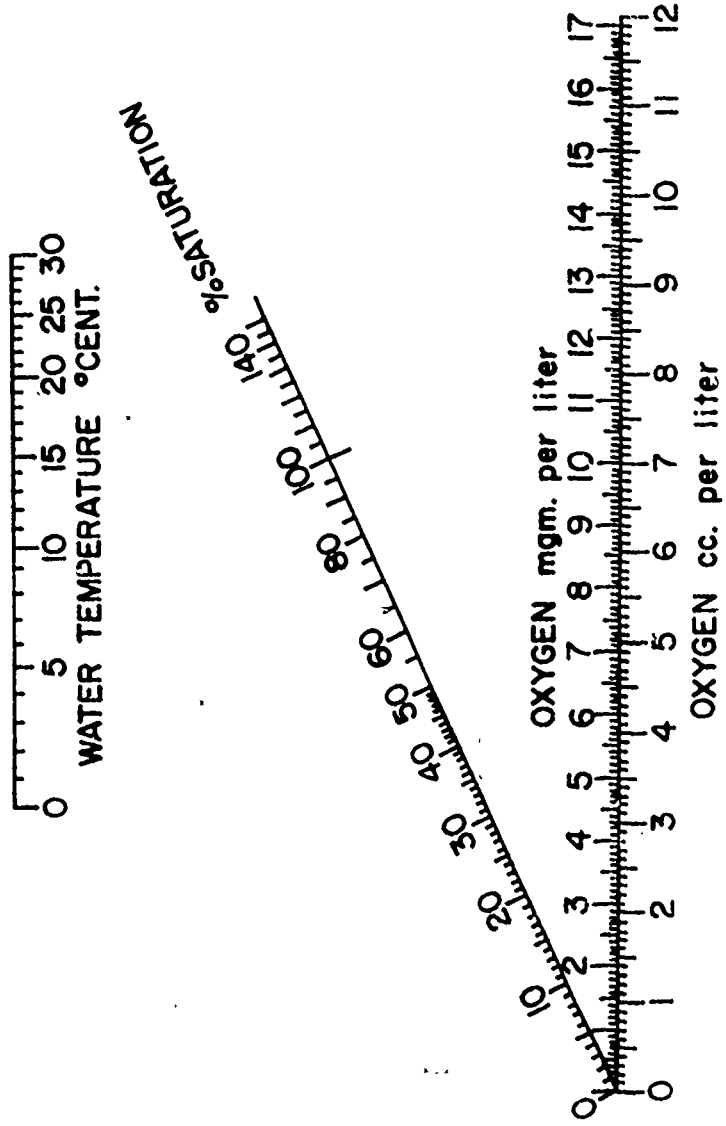
LEAD - .05 ppm - absence desirable.

[1]Based on The Report of National Technical Advisory Committee on Water Quality Criteria to the Secretary of Interior 1968 and other sources.

REPRINTED from the text, WATER QUALITY MONITORING MANUAL, Conservation and Environmental Studies Center, Drowns Mills, New Jersey, F. J. Mason & J. F. Houdart.

Correction Factors for Oxygen Saturation at Various Altitudes

Altitude Feet	Altitude Meters	Pressure mm	Factor
0	0	760	1.00
330	100	750	1.01
655	200	741	1.03
960	300	732	1.04
1310	400	723	1.05
1640	500	714	1.06
1970	600	705	1.08
2300	700	696	1.09
2630	800	687	1.11
2950	900	679	1.12
3280	1000	671	1.13
3610	1100	663	1.15
3940	1200	653	1.16
4270	1300	647	1.17
4600	1400	639	1.19
4930	1500	631	1.20
5250	1600	623	1.22
5580	1700	615	1.24
5910	1800	608	1.25
6240	1900	601	1.26
6560	2000	594	1.28
6900	2100	587	1.30
7220	2200	580	1.31
7550	2300	573	1.33
7880	2400	566	1.34
8200	2500	560	1.36



Dissolved oxygen nomograph for determining percent saturation of oxygen in water. To use this nomograph you need to know the ppm (mg/l) of oxygen and the water temperature. Place a rule across the diagonal line, with one end resting on the water temperature and the other on the oxygen concentration you found. Percent saturation can then be read directly from the diagonal line.

*From Welch (1948) Limnological Methods.

Stream Flow Measurements in Microwatershed Programs

Concentration of minerals and waste in water is lower when the volume of water being discharged by the stream is greater because:

a. most stream water during low flow periods (August and September) comes from discharges of ground water into the stream. This water has been in contact with and has dissolved a maximum concentration of soil minerals.

b. water running over the ground has less opportunity to dissolve minerals. It carries, however, a much bigger load of suspended and dissolved solids (silt and organic debris) picked up from the watershed on its way to the stream

c. volume determines how much toxic wastes and bacteria will be diluted, and therefore, how polluted the water appears to be. The same amount of waste may have little effect on water quality at high flows, but will be a serious pollutant at low flows.

Therefore, water chemistry and bacteriological data mean much more if they can be correlated with stream flow information. The velocity of water will determine the kinds of organisms living in a portion of the stream. Organisms in riffles are different from those in pools. Velocity also effects

a. transport of nutrients and organic food past attached filter feeding organisms

b. transport of plankton and benthos which serve as food for higher animals

c. transport of silt and sediment

d. aeration of water

Therefore, correlation of velocity with species composition, sediment load and species diversity reveals much about interrelationships.

In interpreting biological data taken after a flood, remember that populations of organisms in the stream following the flood will be low, because high velocity water dislodges bottom organisms and sweeps them away. Several weeks may be required before the biota has recovered sufficiently through repopulation from upstream to be a good indicator of water quality. When using species diversity as a water quality indicator, take biological samples during base flow periods.

The amount of silt, sediment and regularity of sediment presence in water also affects the diversity of stream biota. Silt clogs gills of fish, interferes with the feeding mechanism of benthic organisms and blocks light needed for photosynthesis. The regular presence of silt indicates environ-

mental problems upstream. Measurement of silt loads over a long period while you are working to eradicate the sources provides a measure to evaluate your effectiveness.

WHEN SHOULD YOU MEASURE STREAM FLOW

As with water chemistry, one data point doesn't mean much. To properly characterize the stream, and pinpoint all the various periodic and seasonal inputs, requires regular sampling. It is important to know

a. how water quality varies with stream flow throughout the year

b. what the flooding pattern of your stream is and why

c. how much silt does your stream carry and where is it coming from

Measurement of stream flow at the same time water and biological samples are gathered yields much more valuable information than the chemical and biological analyses alone.

As a rule of thumb, flows in medium to large streams decrease from peaks at rates of about 10% a day. In one week, flow could fall to less than 1/2 peak, and in 2 weeks to less than 1/4 of the peak. Substrate geology has a great deal of influence on this. Check with the U.S. Geological Survey and the Soil Conservation Service in your area to determine the specific pattern in your stream.

Knowing the time it takes water and its contents to travel between stations is very helpful to pollution detectives. Students will rarely be notified or be able to get to the site of a fish kill in time to detect the materials responsible for the kill at their source. If your informant knows the time of the kill and the time of water travel can be computed by you, the downstream location of the watermass the fish were killed in can be estimated. Sampling of that mass increases the possibility of identifying the probable cause of the kill.

PROCEDURES FOR MEASURING STREAM FLOW AND SEDIMENT LOADS

A. The float method:

1. Select a length of stream that is uniform in its flow pattern. 50 feet is a common distance. Place stakes on both sides at the beginning and end of this course.
2. Stretch a piece of line marked at regular intervals (intervals of one foot are commonly used) so that there are at least 20 markers crossing the stream (one every foot for a 10-foot wide stream).
3. Measure the depth at each mark. Use a meter stick with a can lid tacked on the bottom if the stream is shallow, a boat and sounding line with lead weight if the river

is deep. Measurements may also be taken from a bridge.

4. Record these depths on a stream profile drawn on graph paper, or on a data sheet (see attached).
5. Place a float in the water at the beginning of the course and record the time it takes for it to travel to the end of the course. Divide the number of feet by the number of seconds to determine velocity in feet per second.
6. Repeat the above procedure at each mark on the line so that you have ten velocity readings for each stream.
7. If time is a factor, take fewer readings. Remember to keep the intervals between marks equal, however, and that accuracy is improved when there are more data points.
8. Multiply together
   a. depth at the point in feet
   b. the velocity in feet per second
   c. interval between points (feet) for each of the points across the stream
9. Add the values obtained in #8.
10. Multiply by .85 to correct surface velocities (which you measured) to mean velocity. (Actual stream velocity is greatest about a foot beneath the surface, or 1/3 of the distance between surface and bottom, because there is less friction from either surface tension or bottom there than elsewhere.) Smooth-bottomed streams, multiply by .9; rough-bottomed streams, .8; and in between, .85.
11. This value is the estimated flow of the stream.

Notes on the Float Method:

1. Floats tend to travel into quiet water or eddy areas, or to become stuck on tree limbs, the stream bank or other obstacles. Therefore, they must be frequently retrieved and returned to the current of the stream. It takes judgement to determine how long floats should be left in quiet areas before being retrieved, and where they should be put in the current. Much of this problem is solved if you select a section with an even flow.
2. Oranges make good floats because
   a. their density is such that they float with only a small portion of their tops exposed to wind action
   b. the orange color is easy to spot
   c. they tend to rotate around obstacles rather than to hang up on them
   d. they are easily thrown back into the current when picked up in quiet areas
   e. they are good to eat when you finish using them as floats. Try this with a rubber ball or a cork!
3. Corks, twigs, or straws can be used in very shallow streams.

It doesn't work to dump a number of oranges into a stream at a bridge, and then race to a downstream bridge to time the oranges as they arrive. Streams purge themselves of litter. Floating objects tend to move toward the banks of a stream fairly quickly and get deposited there.

Since velocity is one of the factors of flow, by computing flow, you also have velocity measurements needed to determine speed of travel for water masses (page 114, para. 5), if you use the float method.

SOURCES OF FLOW DATA

The U.S. Geological Survey is the official government agency for stream flow measurement and recording. Stream pollution control agencies rarely make stream flow measurements on any or at most two official gauging stations on a stream being studied. Often there are none.

Stream flow data should be available at every sampling station to provide a sound basis for interpreting water quality results.

Any data carefully recorded by the methods outlined in this pamphlet should be forwarded promptly to the U.S.G.S. The date, exact location of observations, methods used, and person making the observations should be noted. The existence of any regularly monitored stream flow station should be reported to U.S.G.S.

The time and effort spent in collecting data usually justify a few more minutes to record facts carefully and send them to the places where they can be properly evaluated and tied in with continuing programs of water resource investigations. The Water Resources Division of the U.S. Geological Survey places a high value on these types of data as an extension of national and state data collection programs. The survey has prepared guidelines, and will when appropriate, furnish record books and forms for data collection, give instruction on methods and equipment used, and be helpful in other ways.

Use of Soil Survey Information in Land Use Planning

Many environmental problems result from misuse of land resources, particularly soils. This need not happen. Information is available to help planners avoid these problems, but through ignorance or for less valid reasons, this information is ignored. Students need to know about soils and their limitations because they are the planners, taxpayers and homebuyers of the next generation. Following are three activities to build student awareness and skills in this area.

ACTIVITY #1 - Soil Survey Map Use

OBJECTIVES

A. Participants will understand:

1. What soil is and from what it is derived
2. That there are different kinds of soil, each with its own limitations for use
3. That improper use results in environmental problems costly to taxpayers and deleterious to environmental quality
4. That Planning Boards are responsible for master planning land use in each municipality
5. That there is no need for misuse of land, since the Soil Conservation Service has mapped soils for most counties and prepared interpretations that can be used by Planning Boards and individuals, and that SCS services are free of charge

B. Participants will be able to use soil survey maps to determine potential problem areas within their own watershed and will be able to work with their Planning Board to use this information.

EQUIPMENT

2 or 4" bucket auger - SCS type
set of soil maps - obtainable from the local Soil Conservation District
Handouts of soil descriptions for each person - from SCD
Sets of soil survey interpretations - from SCD
Tracings of soils of the area to be studied (your microwatershed or portion of it)
colored pencils (red, yellow and green)

Optional
Soil test kits
graded soil screens
pan balance
graduated cylinders or Mason jars
drying oven for soils

DEVELOPMENT

A. What is soil? What is it derived from?
B. Are there different kinds of soils? How do you classify them?
   1. Significant soil properties that affect use of soil are:
      a. natural drainage - this property varies with the season. It is highest in late winter and early spring -- lowest in summer and fall.
         1) well drained -- no free water within four feet of the surface
         2) intermediate -- free water one to four feet from surface
         3) poor -- free water 0 to 1 foot from surface
      b. texture - proportionate amounts of particles 2 mm or less in size, called sand, silt, and clay in order of coarse to fine. This property

is important in determining the limitations of the soil in regard to:
1) natural fertility
2) workability
3) available water capacity
4) permeability rate

c. slope - this property is important because it is significant in determining the runoff and erosion hazards

d. stoniness - extremely stony areas must be cleared before they are suitable for farming and many other uses. Stones are defined as being larger than 10 inches across; boulders are over 24 inches across

e. depth to bedrock
1) deep, more than 40 inches to bedrock
2) moderate, 20 to 40 inches to bedrock
3) shallow, 10 to 20 inches to bedrock

C. There can be different soils derived from the same bedrock. Looking at this area, where would you expect to find soils with different characteristics? Why?

1. In soils developed from similar parent materials
   a. hilltop soils are (1) generally well drained
      (2) deep or shallow
   b. sidehill soils are (1) generally well drained
      (2) likely to be shallow
   c. lowland soils are (1) generally deep
      (2) likely to be poorly drained
      (3) may be subject to stream overflow
      (4) may be formed on stream deposits
   d. soils in wet meadows differ from those on dry uplands
   e. flood plain soils are composed of alluvial (water carried) deposits
   f. on bare areas, where erosion has taken fine particles, bedrock may be exposed.

D. With a bucket auger, take samples of soil from the variety of topographic sites available.

1. Have students run their fingers through each sample and describe them in terms of texture, color, profile, amount of organic matter, amount of water, depth of water table.
2. Have someone record the observations.

E. As time permits, add the following activities:

1. Test for soil fertility using Sudbury test kits
2. Determine percolation rates for various soils
3. Shake soils with water in graduate cylinders or Mason jars and let it settle. Compare percentages of various particle sizes.
4. Take soil samples, dry them, screen through graded screens, compare sediment sizes.

F. Can all these soils be used for the same purposes?

1. What soils would you build a house with a basement on?

2. What soil would you put a septic system into?
3. What soil would you build streets on?
4. How would you find this information?

G. What kinds of problems do you think arise when the type of soil and rock and its limitations are not considered when subdivision or other developments are being planned? Who loses? the developer? the homeowner? the taxpayer?

H. Can soil misuse cause water pollution?
   1. What kinds?
      a. sedimentation
      b. leaching of wastes
      c. contamination of ground and surface water with septic wastes

I. Who's responsible for planning land use?
   1. Township Planning Board
      a. Review criteria they use in planning--References: Local laws (subdivision ordinances, sanitary code, zoning resolutions, building codes); Smith, H.H., 1961, A Citizens Guide to Planning, Chandler-Davis Publishing Co., West Trenton, New Jersey.
      b. What aids might be available to them to help them understand soils? What government agencies have this responsibility? (Soil Conservation Service)

J. Functions and services of the SCS
   1. SCS has developed, using the techniques we used in the field to identify soil, soil maps for most counties overlaid on aerial photographs. (Interpretation sheets, soil descriptions, and soils maps should be shown now).
   2. Lay out topographic maps of your microwatershed and soils maps. Ask; How could we use these maps to determine potential problem areas in our microwatershed?
   3. Procedure:
      a. Piece together soils map adjusting the picture size so that the streams on the slide are lined up over the streams from the soils map. (this is a chance to check on the accuracy of the topographic map. If streams don't line up exactly, could the streams have moved?)
      b. Project the watershed reference map slide over the soils map.
      c. Draw the streams and watershed boundaries on the soils maps using blue and red felt tip markers.
      d. Photograph soils map, including all or part of the watershed area and make several 8 1/2" x 11" copies.
      e. Divide class into five teams -- one each for determining suitability of soils on that land for:
         1) basements
         2) septic systems

3) streets and parking lots.
4) lawns and landscaping (agriculture)
5) parks and picnic areas

f. Hand out the 8 1/2" x 11" maps.
g. Distribute interpretation sheets for soils in the watershed so that all teams have easy access to them.
h. Explain that teams are to color soils, using stoplight colors (red for severe limitations, orange for moderate, green for slight).

K. What can we conclude about the land in the watershed? If the map says severe limitations, does it mean the soils can't be used for that purpose at all, or that it can be used with corrections?

L. What happens if corrections for soil limitations are not made?

Examples:

1. Septic systems are often installed where there is inadequate filtration. Effluent gets into rock fractures and pollutes streams and wells.
   a. Methods to correct for this:
      1) spread drain tiles over much larger area (see Soils and Septic Systems; Agricultural Information Bulletin 349--SCS "free") or install a single home package plant of the Chromglas aerator type. (literature: Cast Products, Butler, New Jersey)
2. Septic systems are often installed where the water table is high. Effluent will contaminate wells, flow to surface when water table is discharging. There is no way to correct for this condition except for town sewers. Houses built here will also have wet basements--the best advice is to not build or, if that is impossible, build on a slab or install a sump pump.
   a. Hint--where land is still forested in lowland areas, it may be because it was too wet for farmers to plow.
3. Houses built on flood plains (which belong to the river anyway and not to the developer) will be flooded in heavy storms. There is no way to correct for this. Do not build houses or other buildings on flood plains. Moving the stream doesn't help.
4. Streets, driveways, and parking lots on same soils as in above will have water frozen under them all winter. Spring thaws will create a lens of water between road and ice. Water can't support weight and the road will break up. Solution--excavate and build a crushed rock roadbed under the asphalt. Additional background can be found in the pamphlet, Know the Soil You Build On, Agricultural Bulletin 320-SCS.

M. Additional follow-up which may result:
1. Field trip to visit Planning Board, interview members. Ask about use of soils maps.

2. Prepare soils maps of microwatershed or whole town if it covers more than one microwatershed. Identify potential problem areas. Assign group of students to work with the Planning Board, review agenda and plans submitted to them to see if problems can be averted.
3. Attend Planning Board meetings, raise questions based on soils. Request that they consider problems.
4. If they ignore requests, prepare information sheets for residents, telling them the facts and consequences. Take residents and media representatives to Planning Board meetings.

ACTIVITY #2 - Water Budget Exercise (This is an advanced exercise which may take a team of students an entire year to complete)

OBJECTIVES

A. Student will understand and be able to measure input and one output factor in the water budget.
B. Student will be able to determine the land area a stream drains to a given point.
C. Student will be able to measure concentration of suspended solids and determine the effect of velocity on size of particles carried, relative percentage of debris (organic particles) vs silt.

PROCEDURE

A. Set up rain gauge on watershed being studied. Keep records of rain fall.
B. Compute area of watershed being drained.
   1. Graphing method
      a. delimit boundaries on topographic map
      b. transfer watershed outline onto graph paper
      c. determine scale of map (from bottom of topographic sheet). How much area does one square of the graph paper represent? Count squares within the watershed outline. Area of one square x number of squares counted equal area of watershed.
      d. Hint--the smaller the squares on the graph paper, the more accurate will be the estimation.
   2. Area by weight method
      a. same as "a" above
      b. transfer watershed outline onto heavy cardboard; cut this out with knife or scissors.
      c. determine, using map scale, a square of known area. Cut this square out and weigh it on a balance.
      d. weigh the cardboard outline of the watershed. Compute area using ratio and proportion equation.
   3. Use of Polar planimeter--instructions for use are included with the instrument. This is the most

precise means if the instrument is available.

C. Determine base flow of stream. (Base flow is the average of 4 or 5 measurements for the station during the same season taken at least 2 weeks after rain.)

D. Knowing area of the watershed above the gauging station:
   1. Compute amount of water, in gallons or cubic feet, falling on the watershed during any rainstorm.
   2. Immediately after the rain, measure stream flow; do this every day thereafter until stream returns to base flow (previously determined). Take measurements several days after to make sure flow has stabilized.
   3. Compute total volume of water that ran off watershed during the storm. Subtract this value from the amount that fell on the watershed during the storm. This value is the amount lost to runoff.

E. Compare runoff rates on different bedrock types. (Possibly through arrangement or exchange of data with students at other schools who are conducting similar studies on their watersheds).

RELATED EXERCISES

1. Compute weight of suspended solids in water of varying velocities. Examine sample. What percentages are silt? Organic debris? (Organic fraction determined by drying solids, weighing them, then igniting in minimum 500° oven and re-weighing.)

2. How much load do different velocities hold? What is the maximum size of particles carried in suspension at different velocities? Relate this to bank erosion in your stream.

3. Analyze flood waters for coliform bacteria, D.O., BOD: ammonia, other salts, sediment and turbidity. How do analyses differ from analyses done during base flow periods? How do they compare with rain water? With low flow periods? To what can the differences be attributed? What are the sources of substances you find in water under different flow characteristics? (Surface runoff can add loads of polluting materials that may equal or exceed those from sources of waste under study. High coliform densities are almost certain to occur.)

APPENDIX 1

Annotated Bibliography

GENERAL AQUATIC ECOLOGY

1. Andrews, W., 1973, A Guide to the Study of Environmental Pollution, Contours Series: Prentiss Hall, the best resource test we've seen for high school environmental science. The other books in the series by the same author, are equally good, and should be available for reference. These are:
   A Guide to the Study of Freshwater Biology
   A Guide to the Study of Soil Ecology
   A Guide to the Study of Terrestrial Ecology

2. Hynes, H.B.N., 1963, Biology of Polluted Waters, University of Toronto Press, basic treatment of water pollution biology in readable form.

3. Hynes, H.B.N., 1971, Ecology of Running Water, University of Toronto Press, Toronto, the "bible" of stream ecology, covering the literature up to 1966 in easily readable form. Good reference for serious students.

4. Reid, G., Ecology of Inland Waters and Estuaries, Reinhold Press, good basic text presenting limnological methods and principles understandable to advanced high school students.

5. Ruttner, Franz, 1963, Fundamentals of Limnology, University of Toronto Press, a rather technical, but difficult reading, reference book.

GENERAL ECOLOGY AND LAND USE PLANNING

1. Bartelli, L.J., et al, 1966, Soil Survey and Land Use Planning, Soil Science Society of America, 677 S. Segoe Rd., Madison, Wisconsin 53711.

2. McHarg, Ian, 1969, Design With Nature, Natural History Press, treatise on concept and methodology in environmental planning, based on resource inventories. Excellent. Should be in every environmental science class library.

3. Odum, E., 1971, Fundamentals of Ecology, 3rd Edition.

4. Scientific American, The Biosphere, Wm. Freeman Co., San Francisco.

5. Smith, R.L., 1967, Ecology and Field Biology, Harper & Row, Excellent methods appendices and bibliography.

6. Strobbe, M., 1971, Understanding Environmental Pollution, C.V. Mosby Co., St. Louis, a compilation of papers on environmental pollution presenting an objective view of the subject. Very useful.

TECHNIQUE AND IDENTIFICATION

Algae

*1. Palmer, C.M., 1962, Algae in Water Supplies, Public Health Service Publication #657 ($1.00), groups the common fresh water algae based on their occurance under specific conditions, good treatment of algae as indicator organisms.

2. Prescott, G.W., How to Know the Freshwater Algae, Wm. Brown Co., Dubuque, Iowa, the best key to general available for the algae.

3. Prescott, G.W., Algae of the Western Great Lakes, Wm. Brown Co., Dubuque, Iowa, one of the most commonly used keys for definitive work with algae, in which the investigator needs to classify to species level.

Aquatic Organisms - General

1. Edmondson, W.T., (ed.), Freshwater Biology (Ward and Whipple), a standard reference for freshwater biologiest since the early 1900's, large and expensive.

2. Needham and Needham, Guide to the Study of Freshwater Biology, Holden-Day, San Francisco, paperback, the standard picture key in use in high school and college biology courses. Very good for introductory work, but not for making precise identifications.

Aquatic Plants

1. Fassett, N., Manual of Aquatic Plants, University of Wisconsin Press, the most commonly used key to aquatic plants. Can be used relatively easily by serious high school students interested in learning the vocabulary and willing to work.

Bacteria

1. Millipore Corporation, Biologycal Analysis of Water and Waste Water, Application Manual 302, Millipore Corporation, Bedford, Mass., probably the best general treatment on use of membrane filtration techniques for the analysis of wastewater. Amply illustrated, in color, with detailed explanations about bacteria, their ecology and identification, best of all, it's free - write to Millipore.

2. Standard Methods for the Examination of Water and Wastewater, also presents membrane filtration methodology in detail, (See Water Chemistry below)

Invertebrates - Benthic Organisms

1. Cairns, J., Dickinson, K.L., 1971, A Simple Method for the Biological Assessment of the Effects of Waste Discharges on

Invertebrates (continued)

Aquatic Bottom-Dwelling Organizms, Journ. Water Poll. Contro Fed., 43 (5) : 755-772, a good discussion of the importance c and methods of getting biological data from streams to support water chemical analysis information. Explains how to calculate the sequential diversity index. Write Dr. Cairns for a reprint, c/o Center for Environmental Studies, Virgini Polytechnic Institute, Blacksburg, Va.

2. Pennak, R., Freshwater Invertebrates of the United States, Roland Press, the definitive text and identification manual on aquatic invertebrates used by serious workers. Very technical.

3. Usinger, John, Aquatic Insects of California, University of California Press, ranks with Pennak in quality, and is easi to use.

Soils and Ground Water

*1. Primer on Ground Water, 1966, 26 pp, 25¢, U.S. Govt. Printing Office, explains ground water hydrology and geology in an e y to read text with many diagrams.

*2. Primer on Water, 1966, 50 pp, 35¢, U.S. Govt. Printing Offic Written by one of the U.S. Geological Survey's best, Luna Leopold, more technical then Primer on Ground Water. Covers the hydrological cycle in detail, but is still relatively easy to read for the average high school student.

The following publications are available from your local Soil Conservation Service Office. Look for them in the Yellow Pages under U.S. Government, Department of Agriculture.

1. A Conservation Plan for Developing Areas

2. Controlling Erosion on Construction Sites, Bull. 347

3. Know the Soil You Build On, Bull. 320

4. Soils and Septic Tanks, Bull. 349

EDUCATION PHILOSOPHY AND METHODS

1. Fader, Dan, 1969, Hooked on Books, Harper Torchbooks, explanation of how Fader enticed non-reading high school students to read and write regularly, not only in English classes, but in all classes.

2. Herndon, James, How to Survive in Your Native Land, Dell Books, a journal of Herndon's experience as a teacher, which offers some humorous and very important insights into teaching.

3. Mager, R. F., 1962, Preparing Instructional Objectives, Fearon

Education Philosophy and Methods (continued)

Publishers, Belmont, Calif. 60 pp, clear, concise and evaluatable objectives are crucial for achieving the desired outcome and meeting administrative needs. Every teacher should have this book, refer to it whenever planning a lesson or unit, and not begin teaching until he/she knows precisely what outcome they are striving for in their students.

4. Sanders, N.M., 1966, Classroom Questions, What Kinds?, Harper & Row, N.Y. ($3.50), 176 pp, the companion book to Mager's. Covers the other end, which is how to write effective questions to determine whether the objectives you set at the beginning are met.

Water Chemistry

1. American Public Health Association, 1971, Standard Methods for the Examination of Water and Wastewater, 13th Ed., Amer. Publ. Health Assn., 1730 Broadway, N.Y., N.Y., the "Bible" of water analysis. Contains sections on water chemistry of both clear and waste water, interference problems and how to deal with them, bacteriological analysis, methods for the collection and study of algae and invertebrates. Every environmental science laboratory should have a copy.

*2. Vietti, David, 1971, Laboratory Procedures - Analysis for Wastewater Treatment Plant Operators, U.S. Environmental Protection Agency, 911 Walnut St., Kansas City, Mo., 64106 (write - if you are lucky they will send you a free copy) the best basic and practical water analysis book available for the high school laboratory, written in simple English, presents the most precise techniques for the most widely used chemical, bacteriological and suspended solids parameters consistent with a low budget, should be used with Standard Methods.

General Laboratory Manual for Environmental Science

1. Strobbe, M., Environmental Science Laboratory Manual, C.V. Mosby Co., St. Louis, 1972. Provides instructions for conducting analyses on air and water quality parameters, including pesticides, using easy to obtain and use materials and equipment (Hach powder pillows, Millipore apparatus, etc.) very good manual to have on hand, particularly if students want to do rapid survey work without setting up elaborate Standard Methods procedures, easy to read and follow.

U.S. Government Publications in Water Quality Methodology

The following publications, along with those preceded by an asterisk (*) above, are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 at very low cost.

1. A Primer on Waste Water Treatment, 1969, 24 pp, 55¢, a clearly written pamphlet on methods and problems in waste water treatment.

2. Federal Water Quality Administration, Water Quality Criteria, ($3.00)

3. Keup, L.E., Ingram, W.M., and Mackenthum, K.M., 1967, Biology of Water Pollution, U.S.D.I., FWPCA-CWA-3.

4. Kittrell, F.W., 1969, A Practical Guide to Water Quality Studies in Streams, U.S. Dept. of Interior, FWPCA-CWR-5.0.70. Details the procedures for setting up and conducting water quality studies in streams, easy to read but very thorough. The novice will get many tips about how to conduct a high quality survey and those experienced in stream surveys will find much of interest also.

5. Public Health Service Drinking Water Standards, 1969, 61 pp, discusses water supplies and their protection and individual limits for chemical, bacteriological, radioactive and physical parameters.

6. The Practice of Water Pollution Biology, 1969, 281 pp, $1.50, covers characteristics of aquatic environments, organic wastes, toxic materials, acid mine and radioactive wastes, eutrophication problems in marine environments, and methods for studying water pollution problems.

APPENDIX 2

Agenda for a Microwatershed Conference

PLACE: Rider College Science Building
Lawrenceville, New Jersey

DATE: Saturday, February 27, 1971

Program

9:00 - 9:30	Registration in Science Building by first floor Lecture Hall (Registration fee of 50¢ covers coffee, donuts & milk)
9:30 - 9:40	Introduction and Orientation - Objectives of the Conference BY: Peter A. Gail, Program Director, Stony Brook-Millstone W.A.
9:40 - 10:25	"Current Environmental Problems Associated With Development in the Millstone Watershed" BY: Ian R. Walker, Executive Director, Stony Brook-Millstone W.A.
10:25 - 10:35	BREAK
10:35 - 11:20	"Coordination Between the Microwatershed Program and the Raritan River Basin Project" BY: George Pence, Chief of Simulation and Forecasting, Water Quality Office, Environmental Protection Agency, Edison, N.J.
11:20 -12:00	"A Microwatershed Program in Operation - The Case Study of Germantown Academy and the Tilton Water Pollution Program" BY: Jack Hershey, Chairman, Science Dept., Germantown Academy, Ft. Washington, Pa.
12:00 - 12:30	LUNCH
12:30 - 2:40	GROUP DISCUSSIONS BETWEEN SCHOOL PARTICIPANTS AND REPRESENTATIVES FROM INDUSTRY, GOVERNMENT, UNIVERSITIES AND RESOURCE AGENCIES.

1) SOCIAL, POLITICAL AND ECONOMIC ASPECTS - Student Moderators: Guy Calcerano (Peddie School), David Barss (Montgomery School) and Joan Kimple (South Brunswick High School).

2) WATER QUALITY RESEARCH ASPECTS - Student Moderators: R. Taber Hand and Douglas Armitage (Lawrenceville School) and Tom Gopsill (Princeton High School)

A 10-minute break scheduled for 1:30-1:40 will allow students and teachers to move between discussion groups if they wish.

APPENDIX 3

Minutes of Cuyahoga Watershed Project Meetings and Activities

The watershed studies coordinating committee, formed at the February 14th meeting, held its first planning session Thursday, February 28th, at the South Euclid Library. Lakewood, Independence, Woodridge, and Berkshire High Schools and Western Reserve Academy were represented.

The objectives they set for the remainder of the school year were:

- -to publish a water quality report summarizing data from all studies conducted in the watershed this year.
- -to establish a centralized data bank for water quality data with each school sending data in monthly.
- -to assist Ohio EPA with regular checks on identified pollution sources on all Cuyahoga tributaries being studied.
- -to identify training needs and plan sessions to meet those needs both in the monthly meetings and at a special all day Saturday session.
- -to increase communications among schools, through publication of a brief watershed studies newsletter and regional meetings.
- -to recruit other schools now involved in watershed studies into the Cuyahoga Heritage monitoring network.

It was decided that there should be three co-chairmen of the coordinating committee, representing regions, and 3 adult advisors. Schools were organized into three regional clusters to increase communications and to stimulate recruitment and training of new schools. These clusters are:

Upper Cuyahoga - Berkshire and Cardinal. Jack Arnold, Berkshire was appointed pro-tem chairman until a student leader can be elected.

Lower Cuyahoga - Western Reserve, Woodridge, Independence, Davey Jr. High and St. Wendelins. Dave Livingstone, WRA, chairman.

Rocky River - Lakewood, St. Edwards, and St. Pats. Pete Pourzanjani, Lakewood, was elected chairman.

Two other regions, Chagrin River and Euclid Creek, will be organized if there is enough interest.

Ron McEachen, Peter Gail, and Jack Arnold were elected adult advisors. Mickey Carmichael of Woodridge was elected secretary.

The Watershed Studies Group Agenda for the March 14th Meeting at St. Ed's is:

Program - Sedimentation in Independence area streams - Independence
Thermal pollution effects on Rocky River - Lakewood use
of computers in data analysis - Woodridge

Business - Minutes of the February 28th Meeting -
Input from other schools on objectives and plans
Discussion of training needs
Identification of schools which should be involved in Cuyahoga Heritage and how to recruit them
The next coordination committee meeting will follow the regular meeting.

If you have ideas or items you want included in the agenda, contact Pete Pourzanjani through Frank Jefferis at 579-4062, or Dave Livingstone, 653-5721, extension 48.

Mickey Carmichael, secretary

MARCH CUYAHOGA HERITAGE MEETING TO BE HELD AT ST. EDWARD'S

The next Cuyahoga Heritage meeting is at St. Edward's on March 14th from 7:00 p.m. to 9:00 p.m. At the meeting small group topics will be: Watershed Studies, Cuyahoga-park studies School and Community Problems, Consumerism, Energy, and Air Pollution. If you have other interests, you can sign up for them at the meeting.

Come to the meeting, share your ideas, find out what others are doing, you'll meet friends. Spring is about to burst out and so are we, how about a hike between Cleveland and Akron along the Cuyahoga? A canoe trip on the Mohican? Anyone got plans? Let's hear them, we might want to join you.

Mike Graven
Don Lydon

FEBRUARY CUYAHOGA HERITAGE MEETING "GOOD FUN"

February's meeting was one of the best attended meetings yet this year, with representation from Cuyahoga Heritage schools throughout the watershed. Spirits ran high, and Woodridge High School did a fine job as host, helping sustain participants with a dessert or punch, eclairs, donuts, and coffee.

Mr. Walter Bogan, Director of the U.S. Office of Environmental Education and Technology, attended the meeting, sat in on the school: community involvement discussion, and talked with CH participants after the meeting adjourned.

Highlight of the meeting was a slide presentation on the application of arts and environment by Ron and Marie Thomas from Thomas, Attic and Cellar Studios in Washington, D.C.

The Special Interest groups which met and submitted summary reports on their discussion were:

Cuyahoga Valley park - tossed around and began to synthesize into a general plan of action some exciting ideas for publicizing the value of preserving the natural beauty of the valley to the general public. Nancy Glass suggested a student hike through the valley, perhaps along parts of the old Ohio-Erie Canal. Other ideas included a bicycle tour, possibly a camp-out, and student directed public service announcements to explain why this area should be protected.

Watershed studies - formed a coordinating committee, with two representatives from each school and scheduled an initial coordinating committee meeting for February 28th to set regional study goals and objectives. Al Kriz, from Independence, described a method he and colleagues developed for training students to interpret water quality data. Dave Livingstone, John Hardee, and Mike Donovan of WRA discussed studies they are doing on Brandywine Creek.

The editor received no minutes of discussion from the other groups that met: Population Studies, School: Community Involvement, Energy Consumer Interests, and Air Pollution. GET WITH IT GUYS.

Watershed Studies

The Watershed Coordinating Committee met April 4th to plan the Watershed Skills Training Conference, scheduled for May 4 and 5 at Western Reserve Academy. The program will include both basic and advanced sessions and will cover concepts and skills in bacteriology, soil survey techniques, biology, chemistry, topographic map use, flow measurements, and sedimentation. There will also be sessions on making equipment, monitoring water quality using U.S. EPA methods, water quality statutes, resources, and preparing proposals and reports. Resource people representing several Cleveland area universities and government agencies will be available to answer questions. Please mark this weekend on your calendar and ask all students and teachers who might be interested to do so also. Program details will be sent to you as soon as they are finalized, and will be shared in more detail with those attending the April 25th Cuyahoga Heritage meeting. Program committee members include: Peter Pourzanjani (Lakewood), Tony Byler (Berkshire), and Al Kriz (Independence). Publicity is being handled by Ron McEachen and Mickey Carmichael (Woodridge).

The meeting was attended by representatives from Beachwood, Berkshire, East, Euclid, Independence, Lakewood, Wickliffe, and Woodridge High Schools, Davey and St. Wendelin Jr. High, and Western Reserve Academy.

Program for the April 25th Cuyahoga Heritage Meeting - a look at the Northhaven Housing Development Controversy and the roles students are playing in it.

Mickey Charmichael
Secretary, Watershed Coordinating Committee

INDEPENDENCE BIOLOGY SOCIETY LEARNS BY DOING

The Independence High School Biology Society recently held a Saturday workshop for training members to interpret water quality data. Two weeks prior to the workshop each club member was assigned to research one water quality factor - pH, sulfate, nitrate, etc. - and determine such things about it as possible sources of the pollutant, normal concentrations, how it affects life, and how to test for it. Each student was given a form for recording his findings and asked to bring it with him to the workshop.

On Saturday, the group was divided into three sub-groups, each with at least one specialist for each of the factors researched. The sub-groups were then given data representing four theoretical stream conditions, with instructions to interpret the data and try to figure out what the problems in each stream might be.

After two hours, the entire group reconvened to discuss their sub-group conclusions. The total group came up with 85-90 percent accuracy in analyzing the situations.

This activity proved very worthwhile in working with a group of thirty people. If you would like to try a similar workshop and need more information call me.

Al Kriz, Senior
Independence High School

WATERSHED WORKSHOP PROGRAM SCHEDULE May 4 and 5, 1974

Saturday, May 4

1:30 - 2:00 Registration - Wilson Hall entrance

2:00 - 3:00 Introduction, George Watkins"Rivers"- Wilson Lecture Hall

3:00-5:00 General Introduction Overview - Wilson Lecture Hall

1. Soil Ecology
2. Chemical Aspects
3. Organisms
4. Bacteria
5. Sediments
6. Flow

5:00 - 6:30 BREAK, Dinner - picnic supper next to hockey pond or in gym

6:30 - 8:40 Watershed minicourses

6:30-7:10		
Bacteriology Biology classroom	Chemistry-Commercial methods-Shields Center	Soil Ecology Kib's room
7:15-7:55		
Aquatic Organisms Biology classroom	Chemistry-Standard methods-Shields Center	Sedimentation Kib's room
8:00-8:40		
Benthic Organisms Biology classroom	Water Criteria Shields Center	Flow Kib's room

8:45 - 9:15 Watershed Overview - Wilson Lecture Hall

9:15 - 9:30 Donuts and Punch, and registration for Sunday's groups

Sunday, May 5

10:00 - 10:15 Break up into groups

10:15 - 11:00 Plan what to do (in groups)
Group 1 - room 101
Group 2 - room 102
Group 3 - room 103
Group 4 - room 104
Group 5 (advanced group) - Advanced Biology Lab

11:00 - 3:30 In field

3:30 - 4:30 Wrap Up

APPENDIX 4

Plan for Scout Troop Data Gathering Activity on Rocky Brook, Coordinated by Students at Peddie School, Summer, 1972

AUGUST 17:	Team A	Team B
Driver:	Mrs. Benson 448-4837	Mrs. Swale 448-5192
Coordinators (HHS, Peddie)	Chuck Rue 799-1265	Cathy Holtzclaw 448-5150
Boy Scout:	David Saiffi 452-9348	Scott Holtzclaw 448-7202

AUGUST 31:	Team A	Team B
Driver:	Mrs. Pat Plumeri 448-5690	Mrs. Cunningham 448-1315
Coordinators (HHS, Peddie)	Art Ammermuller 448-9419	Anne Miller 448-4546
Boy Scout:	Ed Simmons 448-1131	Bob Lammattina 448-6703

SEPTEMBER 14:	Team A	Team B
Driver:	Mrs. Heaney 448-5205	Mrs. Philips 448-2756
Coordinators (HHS, Peddie)	Frank Cerza 201-757-7947	Erol Beytas 448-2463
Boy Scout:	Cappy Decker 448-3265	David Saiffi 452-9348

BONE PILE (list of numbers in case of emergency)

1. Erol Beytas 448-2463
2. Jane Reese 448-5259
3. Cathy Ulestad 448-5150
4. Bob Lammattina 448-6703
5. Bill Stevens (Board of Health) 448-5760
6. Paul Hancerzaryk 448-5653
7. Anne Miller 448-4546
8. Mrs. Vosburgh (E. Coalition) 448-4032
9. Frank Cerza 201-757-7947

Equipment: Kit will be equipped with chemicals to do these tests and a procedures book.

1. Dissolved Oxygen
2. Hardness
3. Color
4. pH
5. Turbidity
6. Iron
7. Phosphate
8. Nitrate
9. Ammonia
10. Chloride

These tests must be done for each station. Thermometer from kit, 18 colorimeter bottles, 16 data sheets (one for each station) along with procedures guides.

Team Member Responsibilities

A. HHS or Peddie Student -
   1. The student is the team leader and must assume full responsibility for arranging the site for testing, getting samples, and getting test results complete.
   2. Their team leader should get the Hach kit in advance from previous team leader (week in advance)
      a. Prepare 16 data sheets and check chemicals necessary.
      b. Place to use kit (his or her home) or some predetermined spot.
   3. Next, team leader calls the driver for that date, the boy scout, and anybody else helping in advance. He works out convenient meeting time and place to test.
   4. On date of testing, he directs driver and boy scout to sites to collect samples. A dissolved oxygen sample is fixed by using powder pillows I,II, and III. Air and water temperature, and record station number on data sheets are to be filled in.
   5. He returns home to testing site and helps driver and boy scout test samples, records results and mails results to Erol Beytas, 15 Maple Stream Rd., Hightstown, New Jersey 08520
   6. He then calls Erol Beytas (448-2463) or Bob Lammattina (448-6703) to confirm test completion. If can't be reached, call Cathy Ullestad (448-5150) or Jane Reese (448-2054).

B. Driver -
   1. To drive HHS or Peddie student or boy scout to test sites.
   2. To assist in doing tests if available.

C. Boy Scout -
   1. To assist in getting samples
   2. To do chemical tests under supervision of Peddie or HHS student.

WHAT IF?

1. Chemicals run out or equipment breaks or have trouble with Hach kit? - Call Erol Beytas or Bob Lammittina who will replace it as soon as possible.
   You can't get a driver or a Scout? - Call for someone from alternate list.
   You are coordinator and people you call can't get together on assigned day? - You try to do it as close to assigned day as possible. Be flexible to the times of

drivers and scouts.

4. You find very high amounts of certain chemicals or unusual results? - Call Mr. Bill Stevens (448-5760) immediately or Mr. Robinson (201-454-3319) from fish and game.

Team A	Team B
Collect and Test stations	Collect and Test stations
1	10
2	11
3	12
4 & 5	13
16	14
6	15
7	
8	
9	

SUPPLEMENT

SUPPLEMENT TO "ENVIRONMENTAL EDUCATION GUIDE FOR TEACHERS"
September 11, 1974

If you are using Approach #1 (page 19) and find students uninterested in identifying studies and sitting apathetically around class,

You can

1. Live with it until they, seeing that time is being wasted, and that they are failing the course, decide to get busy.

   Many teachers can't tolerate this, and even more administrators and parents would look askance upon this type of folly. Therefore, more practical methods would include:

2. Go to a task oriented approach (Approach 2). Give a series of tasks related to an overall goal, with each person or group assigned a part, or have the students identify possible projects within a larger general topic. Keep projects short, and enforce deadlines.

3. Make individual students accountable for specific work by well defined deadlines. Certain students, under this system, become project leaders with responsibilities for insuring that an important report on a certain problem is completed on a certain date. Make sure the project is important (provides a service to the community), and isn't just busy work.

4. Divide the process of planning into short segments, and require oral and written reports on each phase. No more than a week, and preferably 2-3 days, should be allowed for each phase.

5. Test each week on a case or problem, asking them how they would deal with it, and grade it severely. Choose problems they would likely have to deal with when they get out of school. If the class does poorly, you might want to devote some time during the following week to having the students evaluate and figure out how they could handle the problem they botched up on the test.

6. Start your class by stating what you have as a year, quarter or semester end objective. (i.e., a report assessing environmental quality in the community that you can give to the town council and the newspaper). Make sure your expectation is some tangible product and let them know the product will be expected to be of professional quality. Then ask the students for their expectations, and together come up with other class objectives that meet all student needs.

Developing proficiency in evaluating the work of others

Being able to evaluate the worth of a product, whether it is a proposal, report, service or material item, is a skill of value to everyone. One of the best ways to gain experience in evaluating is to participate in constructive evaluation of the work of others. This can be done by dividing the class into proposal and report review teams, and assigning them to review and comment on reports and proposals written by other students.

The instructions you would give a group evaluating proposals might go something like this:

> "You are a group of environmental experts. A foundation has just received these proposals from scientists who want them to support their research. They want you to judge whether they should fund them. Your job is to review these proposals and offer constructive suggestions to the authors on how they might improve the quality of their work. What are the kinds of things you will want to look for?"

The students should develop their own criteria, which you may want to enrich with your ideas. Suggestions for evaluating proposals and reports that might help are on pages 39-43.

In evaluating reports, the assignment might be:

> "You are a review panel of experts. A group of scientists has submitted this paper to a major journal for publication, and the journal editors have asked you whether it is worth publishing. If you judge that it is not, they want your comments about what would need to be done to make it publishable. What will you look for?"

Teachers who have used this technique caution that names should be removed from papers to eliminate bias for or against anyone, and that if several classes are involved in environmental problem studies, each class could review papers written by another class rather than by project teams in their own class.

Gaining the support of watershed residents

It is important that students get permission to work on private land and solicit the support of the landowner in his work. It helps if the student has a letter of introduction which explains what he is doing. Following is the text of a letter introducing students from one school who are involved in local watershed studies:

Dear Homeowner;

_____ is studying the stream you live on as part of his/her work in the Watershed Study Class at Independence High School. It is part of a total effort involving students from 29 high schools in the Cuyahoga, Rocky River and Chagrin River watershed, who are cooperating with the Three Rivers Watershed District, local government and the Ohio Environmental Protection Agency to determine the current water quality in tributary streams to these rivers.

We would appreciate whatever help and cooperation you could give to_____ _____.

SUPPLEMENT TO "WATERSHED STUDY RESOURCE BOOK FOR TEACHERS"
September 17, 1974

Flexibility and sensitivity to student needs is essential--an example:

We have found that, while the approach presented on page 31 is logical, it is not always, or for that matter, even often, the path students choose. They often favor analyzing the water early in their study to find out what kind of "pollution" is in the stream. Let them. Show them how to use the equipment, but don't stress it. Be flexible enough to go with their interests. It's important to get them started where they want to start, rather than where you want to start. If you are out of step with them, you will feel it immediately. It will be difficult to get them to respond in discussions, and spontaneity, excitement, and enthusiasm will be missing. You will constantly have to prod them to get them to do anything. That signal should prompt you to find out what the students feel they need.

An example to illustrate this might make it clearer. Several small streams with small watersheds flow out of the hills and through the town of Independence, Ohio. At the high school, students in a watershed class were divided into project groups based on the watershed the student lived in, and were assigned to identify problems or potential problems within their watershed over a weekend. Monday, the teacher tried to get them to discuss the problems, and plot them on a map, but got very little response. A schedule for developing a plan to conduct a study on each watershed was proposed by the teacher. The students listened, but did not say much. A discussion on what should be included in a well developed plan got no where. The relationship between teacher and students was uncomfortable. It was clear that they were operating at different levels. The next day the teacher took a different tact. He asked the students what they felt they needed now, and all verbal and non-verbal evidence indicated that they needed more time to sort out the impressions they had received from walking the watershed the weekend previous. They were not ready to discuss their findings yet, because they weren't really sure what they had found. They wanted more time to gather more information upon which they could make decisions. Others wanted training in water chemical analysis so that they could test the water at various sites along their stream. Following the students lead, the teacher projected a picture of the topographic map, on which the students had marked streams and defined watershed boundaries the week before, on a bulletin board (see page 100 for the technique) and brought out a Hach water testing kit. He asked if anyone knew how to use the Hach kit, and assigned two students who responded to teach the others. The teacher instructed those wanting to make a map, and returned to oversee the training in water analysis. Students and teacher both felt comfortable with one another. Had the teacher been insensitive to these mostly non-verbal signals and followed his lesson plan, he would have lost rapport and credibility with the class, which could only have been regained with difficulty later.

Class size as a function of class effectiveness

Class size seldom poses a problem unless it is too small, because the more people you have, the more problems or projects you can undertake. A class

of 25 or 30 effectively becomes 5 or 6 classes of 5 people each, with each group working on a project of their own or a part of the total class project. If 10 people are added to your class, you simply add 2 more project groups, and utilize some of the more experienced students (maybe project team leaders) as trainers of the new students.

The function of the teacher in a problem solving class

In effect, the problems solving class operates like a company, with the teacher as the president. A successful company has objectives and deadlines, and hires people to help them meet those objectives. The class should have objectives that all members share. The teacher functions as would a supervisor in a company. He has 5 basic jobs:

1. He teaches principles, concepts and processes as needed to prepare the student for the job to be done.

2. He helps the student set goals and objectives for himself and devise a plan for accomplishing the goal.

3. He studies and prepares himself to serve as a resource for the student when the student needs guidance.

4. He builds a relationship between himself and his students in which the student feels comfortable using him as a resource.

5. He helps the student periodically evaluate his progress toward the goal and make whatever corrections are needed to succeed in the project.

Alternatives to grades for building incentive in students

A reward system, similar to that in the adult world, can be used to stimulate students to develop leadership skills. Committee or project members can be advanced to project or committee chairmen when their work as a committee member shows that they can handle the greater responsibility. Project leaders can be rewarded with more responsible positions in the class when they show by their performance that they merit the recognition. Students in leadership positions can be given special privileges or opportunities.

One biology teacher plans a 4-day field trip each spring to a highly desirable location some distance from the school. He announces that only 20 people can be accommodated on the field trip, and that these positions will go to those who amass the greatest number of activity points during the year. They get points for participation in projects, for responsible leadership of projects and other activities the class decides on. The teacher and students together decide on the location and on the criteria for chosing the 20 students who will go--what activities are worth, how many points, etc. A teacher using this system must be very careful not to show preference for certain students, however, lest he lose rapport with the rest.

What do you do with information once you have accumulated it?

One of the most perplexing problems facing a teacher who involves his students in environmental problem investigations is how to answer the question, "Now that we've got this data, what do we do with it? Who do we give it to?"

Very often, there is no one to give it to who will do anything constructive with it, and having the data is only the beginning of the project. Students will have to devise their own plans for using the information to get change. Some ways that teachers and students have handled this include:

- gathering information needed by a local agency for decision making. Identify the organizations doing environmental research in your area, contact them, and determine what contributions you can make that would help them with their work. In Cuyahoga Heritage, schools have been collecting data on water quality in the tributaries of the Cuyahoga, Rocky and Chagrin Rivers for the Three Rivers Watershed District. They are providing a service that the District could not afford to pay for, which helps them in pinpointing problem areas for followup and long range planning. Students also are gathering certain kinds of data from specific stations for the Ohio Environmental Protection Agency, and submitting it monthly under contract with that agency. Reports such as these can also be submitted to the local government and other interested local organizations, with whatever publicity is appropriate. In one school, students gave their report orally to the town council and persuaded town councilmen to walk the creek with them to see the problems first hand. They had the foresight to inform the local newspaper about their plans, and the event was featured in the paper.

- developing a constructive, positive plan in which the class members involve community members in finding solutions to the problems the students have studied. Often, no one wants or will use the information students have gathered. In fact, many people in power would rather not have their boat rocked or their interests exposed especially by students in schools whose money they control. Teachers and students studying sensitive local issues should be prepared for considerable resistance to their efforts, and not become discouraged. After completing a study, and thoroughly documenting whatever problems were encountered so there can be no question that the facts are correct, the class can, depending on the nature of the issue:

  - begin a community education program. This could include a public relations program involving the media (see chapter 3); slide-cassette shows presented to local organizations, such as Kiwanis, PTA, the town council, Women's League, and local businessmen's organizations; distribution of

information leaflets in affected communities; presentations of methods for solving the problems in shopping centers or other public places, etc. (The planning board technique (p. 89) may be helpful to you as you develop your community education plan and will help insure success.)

The objective of community education programs is to develop support from adults so that they can exert pressure on the town leaders to take action. IT IS VITAL THAT YOU SHOW PEOPLE, WHENEVER POSSIBLE, WHAT ALTERNATIVES THEY HAVE THAT WILL IMPROVE THE SITUATION RATHER THAN JUST POINT OUT THE PROBLEM. IF YOU CAN OUTLINE AN ACTION PLAN AND SHOW THEM THEIR ROLE IN IT, OR TEACH THEM TECHNIQUES FOR SOLVING THE PARTICULAR PROBLEMS, THEY ARE MUCH MORE LIKELY TO ACT THAN IF THEY HAVE TO DEVISE THESE PLANS OR LEARN THESE TECHNIQUES ON THEIR OWN.

- approach those creating the problems with your information, and offer to help in any way you can to find a solution to the problem, including recruiting volunteers, doing further research or examining alternatives available to them. MAKE SURE YOU SEE THE PRESIDENT OR GENERAL MANAGER OF THE ORGANIZATION, HOWEVER. Avoid the public relations people. The President is the one who can take action, and the one who will be most interested in keeping the problem out of the public eye. If, after going to the presiding officer, nothing is done, you, or a local environmental organization, can report your actions to the media, calling the official to task for his failure to act. From a political standpoint, it is often best for students, after they have studied the problem, to associate with an active, respected citizens' group and have that group present the findings. The students can work with the group to formulate plans and carry them out, but the project then becomes an activity of that group and not of the school.

The key to success in solving problems is to get secret issues into the public eye. However, since you are representing a public institution, paid for by tax dollars, you cannot involve your students during class time in activist pursuits without threatening your job. Your responsibility is to teach them how to handle problems so that, when they graduate, they don't join those who say, "You can't fight city hall." There is ample proof today that if your case is honest, just and in the public interest, you can "fight city hall", all the way to the top, and win. People are beginning to demand responsible government, which is concerned with and responsive to their interests.

What can you do if you discover government corruption?

No responsible teacher would get his students actively involved in exposing and otherwise fighting corruption in local government because of the potential threat to the students' safety and the school administration. In addition, very sophisticated detective techniques are required to adequately document corruption and these skills are usually not possessed by either teachers or their students. If you find corruption to be a problem in your area, you could:

- discuss in class how you can deal with the problem. Have students come up with plans, and invite a lawyer, a good detective, an experienced journalist, or representative of an organization which specializes in exposing such problems (Nader's Raiders) to critique your plan and discuss techniques they use to inform the public about such problems and ultimately solve them.

- turn your information over, anonymously, to a public interest action group or to a reporter experienced in researching such stories, and then drop out of the picture. Students can, without involving the school or you, and with the permission of their parents, volunteer to help on the case if they wish, but it should be made clear to them that the school and class can have no further part in the study.

The ultimate solution to environmental problems of all types lies not in the scientific examination of the problem, but in converting these findings into plans which overcome social, political and economic objections and are acceptable to the community as a whole. All disciplines are involved in finding solutions to these problems.

Sample Research Proposals (supplement to p. 93)

Samples of student-written research propcsals which have been funded can be obtained at cost from the author.

Equipment for watershed studies (Supplement to page 15)

Basic equipment needed to conduct a watershed study is minimal, and is generally found in the modern school science department. This includes:

1. Water chemical analysis equipment - Most schools start water investigations with commercially available analysis kits. Hach Chemical Company of Ames, Iowa and the Lamotte Chemical Company of Chestertown, Maryland market reasonably accurate kits that may be within school budgets. Most students soon require more reliable data, especially if they are reporting their results to a regulatory agency. IEE has developed a kit with modifications of Standard Methods techniques. This kit can be made in school shops and uses easily obtainable glassware and chemicals. The kit is used by all schools in the Institute's National Water Monitoring Projects to measure Dissolved Oxygen, Fecal Coliform, Fecal Strep, pH, Alkalinity and Hardness Data. Instructions and materials are available from IEE.

2. Membrane filtration equipment for bacterial, sedimentation, and air quality analyses - Millipore Corporation (Bedford, Mass.) makes a wide variety of membrane filtration apparatus for the high school market which produces results equal in accuracy and precision to their more expensive industrial and research apparatus Procedures and equipment needed are outlined in their Application Manual 302 (see Appendix 1). There is no need to buy an expensive water bath incubator. You can make one from a dry incubator simply by putting a dishpan of water in it and placing the petri dishes in that. An aquarium can also be used as an incubator for fecal coliform but this requires an expensive thermostatic heater if you wish to maintain the temperature within .2^0 C.

3. Stream sampling equipment - Plankton nets, Surber samplers, aquatic D-ring dip nets, water sampling bottles, and a large variety of similar equipment can be simply and inexpensively made by students. In fact, home economics and shop teachers often welcome an opportunity to employ their students on useful projects. Sources of information on how to make water pollution analysis equipment include:

   Kriebel, D. (ed). 1974. Curriculum Activities Guide to Water Pollution Equipment and Environmental Studies. Institute for Environmental Education.

   Hall, James A. 1973. Environmental Studies Program. St. Anselms College - Manchester Public Schools. Write Mr. James Hall, West High School, Manchester, N. H. 03102 for a copy. The book includes a chapter on developing and building homemade environmental equipment, and others on using Hach and Millipore equipment.

If money is a problem, local service clubs, garden clubs, and other citizen groups are often glad to donate equipment and supplies if they are assured that these will be used to help improve the community. Industry also funds projects which they feel are worthy.

Permission to conduct watershed studies during class hours

The following permission slip was developed to satisfy the requirements of a high school with strict policies about students conducting environmental research outside of school during the school day. The student fills out the first three items, and then seeks the permission of those indicated. You can add as many lines to "Classes to be missed" as are appropriate.

WATERSHED STUDY CLASS - PERMISSION SLIP

1. Purpose of the trip - (specific objective to be accomplished by the time you return).

2. Schedule:

Date	Time Out	Destination	Time you will return

3. Mode of transportation to be used (include name of driver)_____

_____

4. Classes to be missed, if any:
I gave my permission for_____to be absent from my class for this activity.

_____ _____
Teacher Signature

5. Authorization:

_____Teacher

_____Principal

6. Parental Permission:
_____has my permission to leave school to fulfill the objective he/she lists above. I give my permission for him/her to travel in the way described to his/her destination and return.

_____
Parent or Guardian