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ABSTRACT

Described is a project involving the Manchester Public School System and St. Anselm's College, intended to bring about value-changes in the citizens of Manchester and surrounding towns and to bring about ecological reform, social ecology, and good conservation methods and practices. The project involved the use of students, high school teachers, college faculty members, and the State of New Hampshire officials from the State Water Pollution Board, State Conservation Departments, State Air Pollution Board, and State Education Department. The Studies Program, the program background, and the project staffing are described. An outline of the New England Inservice Environmental Education Program is included in the document. An Environmental Studies Guide, including a high school ecology curriculum, is presented along with a complete description of Environmental Education Homemade Equipment. A special report on Stevens Pond and a copy of the presentation units are also included in the Program package. (EB)

ST. ANSELM'S COLLEGE
USOE GRANT #OE-G-0-73-5422

ENVIRONMENTAL STUDIES PROGRAM:

A MANCHESTER WATERSHED TRAINING PROJECT

ST. ANSELM'S COLLEGE AND MANCHESTER PUBLIC SCHOOLS

a. Introduction

Nature has smiled kindly upon Manchester, New Hampshire in directing the glaciers to pass through the area, and cutting out one of the finest watersheds in all of America--Massabesic Lake and its feeder ponds and brooks, 46 square miles of watershed in all, is ranked sixth in purity and cleanliness. This beautiful watershed, Massabesic, in particular is indeed a great source of pride to not only the citizens of Manchester, but also to many of the neighboring towns bordering Manchester, that we now supply or that is partially supplied by the Manchester Waterworks.

> "Passaconaway, whose name signified 'Child of the Bear', was the sachem and hero of the Pennacook Indians. Although he became a Christian, he still played it safe, and gave thanks to 'Kichtou Manitou', the Supreme Being, of his childhood. To him, Massabesic was the one place where Kichtou Manitou dwelled, the place of calmness. We are told that as he became old and burdened with cares of his position, he gave his high place to his son Wonalancet. One day he journeyed to Massabesic Lake, pushed quietly away from its western shore in his canoe, and glided silently along toward Loon Island. This was a place of poignant memories for him since it had witnessed many an important pact in the days of his glory and power. Suddenly the placid sky was overcast with an enveloping black cloud, and in the cloud the old

sachem knew was the presence of the Great Spirit. He rose in his canoe and lifted his arms toward the vision. Darkness spread over the landscape, and the usually quiet waters of the lake rose and fell in great waves. In a few moments the cloud and storm had passed, and with them had gone the old chieftain of the tribe of the Pennacooks."[1]

This information, legend or fact, was passed down to us by the highly successful missionary to the Indians of New England, John Eliot. For what it is worth, the great chief's final message to his people was, "Peace--peace is the only hope of your race." And so, if today we look out toward Loon Island in Massabesic Lake, toward where Passaconaway journeyed to his Happy Hunting Grounds, perhaps, just perhaps, we too may hear an echo of his final message to a people bewildered as we are bewildered, with confused doubts concerning an unknown future: "Peace--peace is the only hope of your race."[2]

Today the citizens of Manchester are confused. They are told that Massabesic Lake, which was believed to have been enough to care for their water needs forever is insufficient. By 1980, eight years from now, we must be taking water from the Merrimack River. ("Massabesic" means "the place of Much Water," according to Potter's "History of Manchester.") It

1. Grace Holbrook Blood, Manchester on the Merrimack, (Manchester, NH: Lew A. Cummings Co., 1948).
2. Ibid.

has a surface of some 2,500 acres, with a depth varying from shallow to 60 feet or an average depth of 17 feet, a watershed of about 46 square miles, and a shore line of approximately 28 miles in Manchester and Auburn, New Hampshire.[3]

b. The Manchester Watershed[4]

In 1970 Manchester had a population of 87,754, and with the seven other towns in this region the total population was only 122,835 people. By 1995, twenty-two years from now, it will be 218,600 and by the year 2020 it will have climbed to 369,000 people. It is interesting to note that Candia was not included in this survey, and this town makes up part of the Manchester Water Works' Watershed. Candia is in Rockingham County, now listed as the fastest growing county in America. Candia, presently with a population of around 2,000, is slated to increase to 40,000 by the year 2020. The very next town to Bedford, but included in the Nashua region is Merrimack, with a population of 10,000 at present and due to reach 30,000 by 1995 and 58,000 by the year 2020. This total area will reach 216,000 by 2020. The region just to the north of us

3. Clarence Ahlgren, PE, Water Works Director, One Hundredth Annual Report of the Manchester Water Works, (Manchester, NH: Royal Press, 1971).
4. Environmental Studies Program training area for New Hampshire and Massachusetts high school teachers. This section deals with the objectives, need for project assistance, and the benefits expected.

is now 35,000 and will reach 95,200 by 2020. Already many of these small towns are looking toward Manchester to supply them with water. Merrimack has had its resources greatly stressed with the building of one of the largest Budweiser Breweries in the world. Lake Massabesic naturally looks large to these people because they have not got the message yet on the population explosion or they prefer not to believe it yet. Already the impact is being felt. We are getting 18 families a day into the Merrimack Valley Region from just the other New England States, let alone other parts of the country.

Massabesic has long been praised and lauded for its exceptional purity and its cleanliness, its clearness and sparkling waters. Today all this is changing, what with a rapid expanding population in the surrounding towns, and our neighboring states populace looking for a place to play on weekends. On any given day, rain or shine, cars from Massachusetts are parked around this lake. When they leave, one can see the beer cans, soft drink bottles, paper and litter of all description, including cast-off clothes, grease rags from cleaning their cars and boats that they have left behind. It is not all the discards of the Massachusetts' visitors; some of our own citizens and those from Canada and other states are just as ignorant, crass, selfish and as unconcerned. This is being covered at present in a unit of Social Ecology, and the students are quite angry about this and rightfully so. They are for new and stricter laws, and tighter security. Perhaps we will get what they want now that we have the 18-year old vote. Let's hope so! Of course this means more money must be expended and already the city is in a money bind. The Water Works has done an outstanding job up until now--a fantastic job in fact! But it is clear at the moment that they will have to have a large increase in funds as the population increases if they are to meet the water needs of this population boom. If they are to maintain the standards of purity that they have done so admirably over the past hundred years (1971 was the 100th anniversary of the Water Works Department), they will need many more dollars than they are budgeted at present.

Massabesic Lake could be drastically altered during the next ten years unless steps are taken now to educate the students (tomorrow's voters), and the general public of what can happen without the cooperation of all of them, including the citizens of the surrounding towns of the Manchester Region.

According to the Anderson-Nichols, "Public Water Supply Study" phase one report, New Hampshire Department of Resources and Economic Development, 1969, Region #13 which includes

Manchester and thirteen other towns, these towns will have a total deficiency of 97.5 (MGD) million gallons per day by the year 2020. In just eight more years, 1980, they will have 7.0 (MGD) Million Gallons a Day Deficit. Manchester itself will have a 1.8 (MGD) deficit by 2020.

The above figures and facts dictate Manchester, New Hampshire will have to take its drinking water from the Merrimack River by 1980. The citizens of Manchester and surrounding towns look at this with revulsion and stunned disbelief. Manchester's Merrimack River, one of the ten dirtiest in the nation! "Drink it! Never!" These were the responses received by the West High Ecological Study Unit on one of its road show trips before a group of elderly people. They do not understand modern technology, and do not believe the water can be made potable again. Social ecology is needed here; value-changes must be brought about. The Manchester Public School System and St. Anselm's College are trying to do this through their OE Grant under PL 91-516.

Manchester-by-law, and in accord with its Federal and State Funding, must have completed its regional treatment system and have it in operation by 1975. This will cost $36,000,000. The total cost of cleaning up the Merrimack River statewide is pegged at $210,000,000.

The Manchester Regional Secondary Treatment Plant, will cost the Federal Government $25,200,0[illegible] nd the State of New Hampshire will pay $9,000,000. The City of Manchester's share will come to $1,800,000.

From the above information, it is easy to see why not only ecological reform and education are vital to the region, but social ecology and good conservation methods and practices.

c. Environmental Studies Program (Approach)

This project involves the use of students, high school teachers, college faculty members, and State of New Hampshire officials from the various departments--State Water Pollution Board, State Conservation Departments, Soil, Fish & Game, State Air Pollution Board, and State Education Department. Private non-profit organizations, such as the N.H. Society for the Protection of Forests, and Zero Population Growth, N.H. Chapter, and many others have all been more than generous to our students.

It has been important, and it continues to be important, that we have these people involved, that we have their interest in our students if we are to achieve our goals. Those goals are to develop an understanding and attitude as well as dissemination of information about the potential pollution of Manchester's watershed and Lake Massabesic, and to develop an awareness for the need of community cooperation. It is further hoped that the students will realize they are the ones who are the teachers of tomorrow; it is they who must educate the public and bring about the sweeping ecological changes that are needed.

There are five continuing phases to the major components: (1) West High School Demonstration (Ecology I, II classes); (2) Community Awareness and Education Program; (3) Curriculum Development for Environmental Education; (4) Student Independent Studies Program; and (5) Inservice Teacher Training Program.

The applicant agency is St. Anselm's College, Manchester, New Hampshire, in cooperation with the Manchester School District (Supervisory Union #37).

Project Administrator: James W. Morrison, Assistant to the President, St. Anselm's College, Manchester, New Hampshire, 03102, Tel: (603) 669-1030, Ext. 222.

The second year of the OE-6-0-71-4620 Grant, the project's interest was shifted from the Merrimack River--the scene of most of last year's environmental classes--to the Manchester Watershed.

The third year of the USOE/OEE Grant, the project began an intensive program of inservice training in Nashua, Manchester, Concord, Exeter, and North Conway.

Our project has been one of a problem-solving and issue-centered learning for students and teachers of Manchester and surrounding towns. Therefore, Social Ecology sets the scene for most classroom debate. As it deals with all forms and levels of life, and especially man's interrelationships with his ponds, lakes and rivers, along with population trends, it will be an overriding theme throughout all phases of our studies. By its very nature, the project provides a focus for learning activities which will prepare students for real life situations. The project requires a multi-disciplinary approach with emphasis on interrelationship of man and nature. The focus is on contemporary problems relating to urban and rural environment (man-made and natural); the program incorporates the nonformal as well as the formal educational processes and makes effective utilization of resources (state and private) outside of the classroom. Each phase of the project develops an understanding and attitude as well as information on the environment. The program offers a student and/or teacher "participant-centered design," involving each learner/participant in choosing priorities both as to the ecological issues to be studied and the solutions that seem most appropriate for the City of Manchester. The project design allows high school students to participate to learn "how to learn" about new environmental problems, how to weigh alternatives and how to test solutions.

d. Program Background

As previously mentioned the major components of the Office of Education Environmental Studies Program in Manchester, New Hampshire are: (1) The West High School Ecology Program. This is made up of four Ecology I classes plus one Ecology II class. Ecology I students are all junior or senior class students. Ecology II (advanced class) students are all seniors who have completed one year of ecology with at least a B+ average. They assist in the training on field trips and in laboratories, in order to get as many students involved as possible and to allow more individual attention; (2) The Community Education Program ranges from seminar workshops to group presentations. "The West High Ecological Presentation Unit" is one of the more active units and last year put on over 154 showings throughout the State of New Hampshire. They put on their display at conventions, at junior and senior high schools, to service clubs, church groups and conservation groups and colleges. Only the students are involved with talking on these trips--teachers only go along as chaperones. They show slides, movies, video-tapes, photo-displays and they demonstrate the use of HACH equipment and Millipore equipment, actually testing water from the taps for the people involved. Sometimes these tests are quite spectacular, especially the chloride tests what with the salting of highways heavily in our state and the resultant run-off into water systems; and (3) the Curriculum Development for Environmental Education program has produced several brochures to date and has held a series of meetings with teachers throughout New England and also conferences with State Department of Education key people. An Environmental Guide to Field Ecology was published in the fall of 1973 and is available for the teacher training phase (See Appendix). The guide gives approaches from junior high school to the secondary level (grade 12) for environmental testing procedures.

The above activities will continue with non-Federal support in the Manchester School System.

e. OEE/Program 1974-1975: Inservice Training - New England Schools

(1) Teacher Inservice Training Program provides an opportunity in eight sessions to demonstrate the use of testing equipment and to learn the mechanics of social ecology. For this activity, teachers are paid a small stipend to give up their Saturday to spend at least six hours for a total of seven or eight Saturdays. (See proposal Appendix for a detailed description of this project activity). They are taught (a) use of Millipore equipment, (b) HACH kits, (c) Brunton Compass and maps, (d) homemade equipment, (3) approach to Social Ecology, (f) how to start an ecology program at a school, and (g) field trip to their home town observing students using equipment they have just been trained

to use. Inservice training will involve schools in Rhode Island, Massachusetts, New Hampshire, Maine, and Vermont.

(2) Construction of Homemade Equipment provides the teachers with new resources for environmental testing. This feature of the project has been very popular with the teachers who cannot afford to purchase ecology testing and sampling equipment. The project provides samples of homemade equipment. Directions and construction guides are furnished to produce the twenty items from materials and community resources. Substitutes are made from leftover plywood, parachutes, and soda bottles. Secchi disks, plankton nets, dredges, and plant presses are created at the inservice training sessions. Despite their homey quality, these devices give accurate results. During the summer months, we intend to make a large supply of homemade equipment.

(3) Independent Study Program (St. Anselm's College) provides an opportunity for college students to explore and research the environmental problems affecting the Manchester Watershed; the college students support the curriculum development effort with their student-oriented research findings.

f. Project Staffing

The following describes the responsibility, staffing, and the project direction for the above activities:

The Project Administrator, Mr. James W. Morrison, Assistant to the President, St. Anselm's College, is responsible for the over-all project planning and management, including the Independent Student Study and Teacher Training Program. Each of the project components are operated as follows: (1) Mr. James A. Hall, Chairman, Science Department, West High School, Director of the West High School demonstration activities, including the assignment of instructional resources from nearby colleges and high schools; and Mr. William Ewert, Science Consultant (Environmental Education) to the New Hampshire State Board of Education, provides the major leadership for the curriculum development work in conjunction with these science consultants: (2) Superintendent of Instruction, Henry J. McLaughlin, Manchester School System, is individually responsible for the over-all guidance of the Community Education Program in cooperation with the Project Administrator, James W. Morrison.

a. Massachusetts: Ray Gehling
b. Rhode Island: "Red" French, Science, Env. Education
c. Vermont: John Stevens
d. Maine: Wallace Lafountain

Inservice environmental education programs will be coordinated with the science consultants in order to meet the greatest need (community, teacher interest, etc.) The Appendix includes local high schools and science chairman already contacted.

NEW ENGLAND INSERVICE ENVIRONMENTAL EDUCATION*

OUTLINE

I. How to Introduce Ecology into your School

This is an overview wherein the instructor describes the ways environmental studies and ecology units can be introduced into the classroom, formally or informally. During this first session, the instructor also covers real and imaginary pit falls or obstacles. Also covered in the area of parental and administrative cooperation.

II. The Use of HACH Kits in Chemical Testing

In this session a master chemist lectures and demonstrates the use of these excellent tools of ecology. Coverage is also given to reactions and simplified for the non-chemist. Six or seven kits will be used covering a wide range of tests. The last hour is given over to the teachers using the kits themselves under the direct supervision of three or four instructors.

III. Millipore Membrane Filtration Techniques

This class is both a lecture and demonstration session in the use of Millipore Equipment in microbiological testing. Emphasis will be placed upon coliform detection with coverage of total counts and the molds and fungi. The very excellent kit, "Experiments in Microbiology" by Millipore will be used. The instructors of this session, plus holding regular masters degrees in science, are both Clinical Medical Technologists with years of experience in this field.

IV. A Field Trip to your Local Water Department

In this four-hour field trip, selected students from West High School's Advanced Ecology Class (all second year ecology students and involved in independent research) demonstrate the use of both HACH kits and Millipore equipment in the field. They make it look so simple any non-science teacher can return to the classroom with complete confidence in his or her ability to handle this equipment.

*See Appendix for detailed program.

V. Maps, Graphs, Charts, and the Brunton Compass

In this valuable session a master of Earth Science illustrates the use of maps, how to read them, their need, and how to prepare them for field tools. Graphs and charts are considered as methods of dissemination of data and coverage will be given to the easy read-out varities. The Brunton Compass is covered as a vital tool on extended trips in dense woods and also as a substitute for the transit in minor plot layouts.

VI. Social Ecology--The Overriding Theme

The instructors of this program and the administrators of the Manchester Public School System all feel Social Ecology must be an overriding theme, if apathy is to be combated, and adverse political intervention is to be overcome. Ecolory, or Environmental Education cannot get off the ground without this consideration.

VII. Homemade Equipment

This class is conducted by several of Manchester's Industrial Arts teachers, illustrating how a school, short of finances, can also have an ecology program.

In addition to these individuals, there are several advisory committees which assist the project:

1. <u>West High School Demonstration Program</u>

James W. Morrison, Assistant to the President, St. Anselm's College
James A. Hall, Chairman Science Department, West High School
James G. Noucas, Assistant Superintendent, Manchester School System
William A. Burns, Principal, Central High School
Leonard Foley, Principal, Memorial High School
Charles J. Quinn, Principal, West High School

2. <u>Curriculum Development</u>

William B. Ewert, Consultant, State of New Hampshire, Department of Education
Robert L. Brunelle, Deputy Commissioner, State of New Hampshire, Department of Education
James W. Morrison, Assistant to the President, St. Anselm's College
James G. Noucas, Assistant Superintendent, Manchester School System
James A. Hall, Chairman Science Department, West High School

<u>Selected High School Teachers and Others</u>

Angwin, David, West High School
Angwin, Timothy, West High School
Cheetham, Thomas, West High School
Connelly, Prof. Raymond, New England College
Demers, Raymond, West High School
Dobrowolski, Frederick, West High School
Eaton, Estelle, Hillside Junior High School
Fortin, Sheila, Southside Junior High School
Graveline, Irene, Parkside Junior High School
Gray, Frances, West High School
Guenther, Francis X., Central High School
Hall, Jon, West High School
Hodgdon, Prof. Albion, University of New Hampshire
Hutchins, John, Hanover High School

Jutras, William, Central High School
Klaubert, Susan, West High School
Lyons, Donna, West High School
Nelson, Donald R., Southside Junior High School
Sabean, Betty, West High School
Tartsa, Alex, West High School
Walkins, Michael, Jr., West High School

3. Community Awareness Education Program

Clarence L. Ahlgren, PE, Superintendent, Manchester Water Works
William E. Ewert, Consultant, State of New Hampshire, Department of Education
James A. Hall, Chairman, Science Department, West High School
Laurence Kelly, Attorney, "Citizens for a Cleaner Manchester"
Henry J. McLaughlin, Superintendent, Manchester School System
James W. Morrison, Assistant to the President, St. Anselm's College

Selected Resource Personnel

Clarence L. Ahlgren, PE, Superintendent, Manchester Water Works
Paul Boffinger, Society for Protection of New Hampshire Forests
Leslie S. Clark, Education Director, Society for the Protection of New Hampshire Forests
Bernard W. Corson, State of New Hampshire, Fish and Game Department
James A. Hall, Chairman, Science Department, West High School
Albion Hodgdon, PhD, University of New Hampshire

4. College Independent Studies Program (Advisors)

Riley, Rev. Placidus, OSB, Dean, St. Anselm's College
Damour, Paul, Chemistry Department, St. Anselm's College
Monier, Claira, Geography Dept., St. Anselm's College
Weber, Sr. Christopher, Education & Psychology Department, St. Anselm's College

Each of the committees will meet as project matters require.

5. NEW HAMPSHIRE HIGH SCHOOL TEACHER CONTACTS*

School/District	Department Chairman
**Concord High School Concord, New Hampshire	Mr. Lee Wilder
**Bishop Brady High School Concord, New Hampshire	
Hopkinton High School Hopkinton, New Hampshire	Mr. Kulbacki
Pembroke Academy Pembroke, New Hampshire	Mr. Frye
Tilton-Northfield High School Tilton, New Hampshire	Mr. Atherton
Franklin High School Franklin, New Hampshire	Mr. Tonkin
Plymouth High School Plymouth, New Hampshire	Mr. Sherburn Ramsey
Linwood High School Lincoln-Woodstock, New Hampshire	Mr. Ray Corkum
Alvirne High School Hudson, New Hampshire	Mr. McIntire
**Nashua High School Nashua, New Hampshire	Mr. Marko Scheer
Merrimack High School Merrimack, New Hampshire	Mr. Tom Robinson
Lowell High School Lowell, Massachusetts	Dr. Walter Gondalski
Lawrence High School Lawrence, Massachusetts	Mr. John Casey
Ashland High School Ashland, New Hampshire	Mr. David Conboy

Merrimack Valley High School Pennacook, New Hampshire	Mr. Charles Carr
Laconia High School Laconia, New Hampshire	Mr. John Cote
Newfound-Bristol High School Newfound, New Hampshire	Mr. Tim Mahurin
Milford Area Sr. High School Milford, New Hampshire	Mr. Timothy O'Connell
Methuen Jr. High School Methuen, Massachusetts	Mr. Paul Bourque
Keene High School Keene, New Hampshire	
Monadnock Regional Swanzey, New Hampshire	
Hanover High School Hanover, New Hampshire	Mr. John Hutchinson
**Conway High School Conway, New Hampshire	Mr. Charles Knox
**Manchester School Districts Manchester, New Hampshire	Mr. James A. Hall

* This list represents high school teacher coordinators for the ecology training program.

**Inservice Programs, 1973.

ENVIRONMENTAL STUDIES REPORT

USOE/OEE Environmental Education Grant to St. Anselm's College and Manchester Public Schools

1. Need Assessment

Today, at the national secondary high school level, lip service is the principal action given to the environmental sciences. Few schools list ecology in their curriculum and in those cases where it is taught, it is interdisciplinary, taught within a biology course in most cases for a week, or two weeks in rare cases.

A research group in Denver, Colorado has been trying, and have in fact made some progress in the area of upper elementary and at the junior high level. However, they fall short at the senior high school level and leave the students in a state of boredom.

Another organization, funded by NSF, in Tennessee is making electronic testing equipment from basic electronic testing components. This is a step in the right direction because they are working in the field using their testing equipment to teach the youngsters ecology in a real life situation. There is a drawback, however. Every school does not have access to the basic electrical components needed. In some cases they do not have the money to buy them and in other cases there are no free parts available. Many schoold do not have teachers who have electrical backgrounds or even basic comprehension into the electric field. Many of the schools who do teach environmental sciences, in fact the greater amount, are teaching from the classroom, therefore missing the real classroom, the "great outdoors".

Another area of short comings is in the area of Social Ecology. If apathy is to be overcome at a national level then all hard core ecology or environmental courses must be softened up by flavoring them with at least a "pinch" of social ecology. To get proper dissemination of our ecological facts social barriers must be weakened.

Field testing in many cases is limited to a temperature reading and a talk by the teacher along with a collection of a few plants and a pH reading. There are a great many texts in ecology, but for the few exceptions where formal ecology is taught, ecology is presented from a few newspaper clippings, an occasional paperback or magazine article. A true representation of the ecosystem is devoid in most cases.

Few teachers have been trained in ecology and many are afraid to venture into this field for various reasons. One outstanding reason that has been echoed over and over has been, "If it is a field course--and I have never been on a field trip--I wouldn't know what to do." Another has been, "The testing equipment is too refined and I have a poor chemistry background." Many look at textbooks and do not understand the language with their general education and thus give up.

Manuals were needed dealing with general ecology in the following areas: (a) how to introduce ecology into your school either formally or interdisciplinary; (b) pictorials illustrating homemade equipment, how to make it, its uses, and the major sources for free materials and what students in the school can best produce a given piece, i.e., plankton nets made in the Home Economics Department or plant presses in the Industrial Arts Department, or in the absence of either of the above, at home with someone's help, or in the Science Department. Smaller units were also needed on ideas to use in compilation of the data, what we do with it, and social implications. Team teaching situations with the social science teachers and students, by science teachers and students, plus others, need to be constructed. Use of simplified testing other than homemade equipment such as HACH kits, LaMotte kits, Millipore equipment and other types should be mentioned in the manual. The Environmental Studies Program at St. Anselm's College in cooperation with the Manchester Public Schools has met the above need.

For the past three years the teachers from New Hampshire's public schools have been involved in training their students in ecological studies using the Merrimack River and the Manchester Watershed as the classroom or laboratory. It is a fantastically polluted river. It has been listed as one of the nation's top ten most dirtiest rivers. During this time, the Manchester teachers became aware that $210 million has been proposed for the EPA clean-up of the Merrimack River. These teachers noted with great pleasure how much the students loved the outdoor studies program and the much greater degree of success they were having with the students as compared to those in other classes back in the school classroom.

The students were not just interested in the actual water testing but also in the socio-economic aspects facing their community and the State of New Hampshire. The teachers were coming into contact with other teachers in the state and were becoming aware that their program was unique. Many teachers expressed a desire to become involved in environmental studies, but alluded to lack of knowledge in the use of ecological testing equipment and correct approaches to field trips.

A small survey in 1971 was conducted under the leadership of Professor James W. Morrison of St. Anselm's College, assisted by several high and junior high school teachers. It attempted to discover how many schools were involved in ecology or environmental studies programs. If "yes" what they were doing--if "no", why not? The answers were for the greater part (except for three schools with formal ecology classes) NONE. A few said a week was set aside in biology to give lip service to ecology. Mostly these were indoor classes. One school said they had three days in social sciences in coverage of ecology as a social issue.

With this information the teachers of Manchester who were working under an Office of Education Environmental Grant (P.L. 916) decided to offer a training program to teachers with emphasis on use of environmental testing equipment and homemade equipment. It started in Manchester with about 40 teachers being trained in the use of HACH kits, Millipore equipment, Secchi disks, dissolved oxygen bottles, etc. A unit on social ecology was also included plus several Saturday field trips and a unit on how to introduce ecology into your school--formally or informally. It was an instant hit. Word spread and we were asked to bring our team to Nashua, New Hampshire where teachers from the nearby towns came and the classes were taught at Nashua High School. Three re-certification credits were granted by the State Department of Education.

The enthusiastic response from the Nashua area teachers was heartwarming. Their students begged for an ecology program, and in 1974 they have one. It was impressive to see National Merit Honor Students working along side of borderline retarded students. They got along well and the slow learned from the fast, and sometimes it was the other way around. We have been requested to bring our teaching unit to eight other regions statewide. To date, we have reached in five regions about 400 teachers with environmental studies curriculum approach.

This year, however, our emphasis has been on the homemade equipment, as this was by and far the most interesting phase of the program and illicited the greatest response. We hope to be able to tie these teachers in with others all along the Merrimack River, passing on information, materials, and new discoveries, equipment and all factors that will lead to a great improvement in environmental field studies programs, a model for a new curricula, and the finest teaching for the students involved. As these students will vote next year and the next few years to follow, it is hoped we can set the correct guidelines that will lead to and enhance their future leadership as they take over the reins of government from we, their teachers. We hope to produce an additional manual with series of units built around each piece of equipment and its use and how to make it. We would like to distribute these educational materials to all who desire it, in the hope that other teachers in other places around New England particularly, can have the fun we had, and learn as we have learned from our students.

II. Signs of Progress and Success

We feel we have really been doing something in the Environmental Studies Program and the comments we have received from all over New England testifies to the fact we have been. We have developed separate items to test water with, that are all of such simplicity and scope, that any teacher can understand its use and function with simple directions and also with a simple diagram can make the equipment himself or have his/her students make the items better still, themselves.

One of our students was selected to represent New England from the SCENE (Student Coalition Environment, New England), to the UNESCO Conference at Chicago on the basis of his homemade equipment display and coverage of same at the Boston Museum of Science.

We have made and used in the field "homemade" four pieces of botanical equipment plus three pieces of soil testing equipment and several items for testing for air pollution. We have used these all with our students in the field and in the laboratories, and find in some cases they are superior to the purchased equipment. In all cases they served our needs with a great accuracy. They have shown the way to some schools who now have ecology courses and field trips they never had before. They have reduced costs for school systems and many individual schools in the Manchester area.

We are now testing in the field, the place our students most love to be--out where the action is--in ponds, lakes, streams, rivers, brooks, air, in all areas of our city, from the tops of roofs, to back alleys and over the river. We have been in the forest ecosystem in a nearby college and studied plants in all areas. Our soil studies have ranged from the soil of the football field, forest soil, to the bottom of the river and detritus from the bottom of the pond. Using our homemade equipment, we have taught meaningful ecological principals to students and adults. We have shared our knowledge with others, and other schools. We have invited parents and civic leaders, state officials, clergy, and college professors on our field trips. We have been in national publications and even received clippings from a Paris newspaper about action our students were involved in.

Using the results of our HACH kit tests and Millipore equipment testing along with standard chemical procedures and some very excellent photography (all by the students) a package was put together and given to a group of lawyers who represent a Society for a Cleaner Manchester. They used this in court and got the first conviction ever under the Harbors and Rivers Refuse Act of 1899. Our students and teachers were given credit for getting the package needed to convict. They were acclaimed by the lawyers in the press; the conviction went AP with worldwide coverage.

Manchester is a city of about 100,000 people and straddles the Merrimack River, listed as one of the nation's ten dirtiest rivers. It is the center of a growth boom listed for the immediate future, wherein this area will grow to 300,000 people. Water problems will result, deficit factors will exist, so it is natural that we use this great outdoor laboratory to the fullest to enlighten the youth of our city.

We would like to spread the method we have found so effective, a curriculum that works, to all youths up and down the Merrimack River and on to other dirty rivers nationally. We would like further for our methods to be tried in clean rivers and forests and on both good and bad soil by all youths of our nation.

The State Education Department in New Hampshire, State Environmental Education Council, and the supervisory units across the state, all cooperate with us and lend encouragement. We have worked hard and long to achieve this position. We now need a financial assist to get our show on the road nationally. Colleges have been more than generous of time and labor. Professors have dedicated themselves to the advancement of our project as they feel it is right and effective. We have consultants not only at colleges and universities, but in all state conservation and antipollution departments. Private industry has also produced a wide range of consultants free of cost.

We promote interest (noteably at the high school and junior high school level) by using our equipment samples and starting each school on a special project, using one or two pieces of homemade equipment. First, they produce their own or any variation they feel better, or both. Then they build a series of field units around each piece of equipment they have been assigned to work on. (See Appendix).

These experimental field projects will run through the school year, and as they are completed, they can be issued a sample piece of equipment from a group in another town along the river, and that group will take theirs if they are ready and complete in their own studies. This can be conducted all up and down the river and across the state with teachers from all the various schools and towns eventually getting to use at least ten pieces of equipment, plus whatever they desire in the way of purchased equipment, i.e., HACH and/or LaMotte kits, and Millipore equipment. During this time the coordinators in each school will meet on pre-scheduled occasions and talk about their success and failures with the State Department of Education Science Consultant, Mr. William B. Ewert, and other curricular people from that department, along with professors from Dartmouth and St. Anselm's Colleges, University of New Hampshire, Keene and Plymouth State Colleges, and others; as well as Science Consultants from Maine, Vermont, Rhode Island and Massachusetts who will be involved in the New England inservice plans.

ENVIRONMENTAL STUDIES PROGRAM: 1971 - 1972
USOE/OEE Grant to St. Anselm's and Manchester Public Schools

III. Goals and Objectives

How did it all come about?

Since 1960 the writer of this report, and also the Educational Director of the grant, have been deeply involved in environmental affairs affecting the well-being of the city of Manchester, New Hampshire, in particular, and the state in general. With the arrival of "Earth Day" in 1970, a group of college professors and high school teachers formed a panel and after a two-weeks period of fan-fare by press, radio and television, plus word of mouth throughout our school system, we met at the National Guard Armory. Except for a few adults, the attendance was mostly comprised of children. It was a small group--under a hundred in all--and they were most apathetic. For the majority they chatted among themselves while the speakers on the panel tried to communicate. It was a failure to say the least. The professors and teachers were appalled and a conference was held by the panel at the early conclusion of the "Earth Day" exercises.

This writer decided to apply for a grant under Title III. The grant was written, but was not funded due to lack of funds at the state agency to which it was submitted. However, the reviewers of the grant stated it was well written and most deserving of funding.

At this time Professor James W. Morrison, a Sociologist, who was deeply concerned with environmental trends, met with the author of this report at a drug conference. The Superintendent of Schools, Henry McLaughlin, knowing the feelings of both of us, suggested we look at the possibility of a joint funding through St. Anselm's College. Mr. Morrison knew of such a grant area and conferred with Fr. Placidus Riley, then president of St. Anselm's College. He approved and thus encouraged us to hold a series of conferences with various educators, and in particular William Ewert, Consultant to Science Education, State Department of Education, State of New Hampshire.

We talked to the chairmen of most state agencies, i.e., conservation agencies, and wrote and communicated with the chairmen and trustees of municipal water precincts. Finally, we arrived at a decision to write the grant. With our knowledge gleened from all our friends and associates and the people at the state level, we wrote the grant and submitted it to the Office of Education. Our project was funded by the Office of Education's Environmental Education (PL-91-516). It was jointly sponsored by St. Anselm's College and the Manchester Public School District. Mr. James Morrison of St. Anselm's College became the Project Administrator and James Hall of Manchester High School West became the Educational Director.

The Goals and Objectives were formulated, as mentioned, after conversing with fellow educators, state agencies, the State Department of Education, and the Superintendent of our local Water Works. Alerted by an increase in pollution of our watershed by our preliminary testing, and reports on our rapid increase of population in this area, we developed our goals and objectives. We borrowed some of our solid testing ideas from the "Tilton Report" and through contact with those who were involved in this project. Other ideas came from Mr. William Ewert of the State Department of Education. We took some techniques from Mr. Ronald Bailey and Mr. John Hutchins of the "Mink Brook Project" at Hanover High School, Hanover, New Hampshire. We feel that in the first year our objectives were too many and our sights were set too high.

The first year of the USOE Grant was one of "hustle and bus-tle", searching, new discoveries, recording, evaluating, and starting all over again. This was to be the first time ever that a formal ecology course was to be taught in the City of Manchester, New Hampshire. (It is the first time it has been taught as a formal course, full-time for an entire year, in the state of New Hampshire). Three or four schools had a fragmented interdisciplinary type unit of short duration. Principals and Assistant Principals, along with teachers, had to be sold on its value. The program was co-sponsored by St. Anselm's College and the Manchester Public School District and was comprised of the following units:

1. St. Anselm's Advanced Ecological Studies Program for High Ability Students

2. West High School Curriculum Development Program for Formal Ecology

3. West High School Civic Demonstration Unit

4. Community Awareness and Education Program

Before setting forth the functions of each of the above, I feel it only proper at this point to inform the readers of this report that we were trying to cover too much material and too large an area for a first year funding. One example that comes readily to mind is that our field laboratories were overused. The Manchester Watershed itself was 48 square miles and comprised of 8 ponds and one large lake (Massabesic) with 27 miles of shore-line. Add to this the countless brooks and two river, one of which we were attempting to cover for six miles (Merrimack River), which left us with a deficit of time to complete our goals. We found outselves with lack of time to complete vital educational concepts germaine to any good educational course involving environmental studies. Be-cause the Merrimack River was listed as one of the nation's 10 dirtiest rivers, and perhaps because we all felt a degree of guilt, we spent half of the first year in project "over-test" of that river.

In order to combat apathy and create affective concern, feel-ing for space ship earth, and real cognitive understanding, time must be spent with the students in rap sessions. They must be allowed to express themselves. Field testing can be overdone. It must be balanced with activities in other areas when dealing with students at the secondary and junior high school levels. Fortunately we found ourselves in time and through the four programs above, we laid the foundations for the next two years of Environmental Studies. We feel our program could be used as a national model. It has proved itself in a number of schools.

Design: (Reasons for selecting the four educational programs set forth above)

As stated elsewhere in this report, Manchester, New Hampshire is located on the banks of the Merrimack River, listed amont the "Ten Dirtiest Rivers" in the country. Yet, despite this, apathy was so obvious at the Earth Day 1970 assembly, that we felt action was needed in all areas.

1. St. Anselm's Advanced Ecological Studies Program for High Ability Students

It was natural that St. Anselm's College would be interested in a program for high ability students in this field. For years it has been recognized as a leader among New England Colleges in the Biological Sciences and for producing some of the nation's most outstanding scientists in all fields of scientific endeavor. The Advanced Ecology Program, for the first year, was headed by Dr. Paul Damour, who holds a PhD. in chemistry. He was assisted by Professors Roy Upham, Michael Dupre, John Feick, and Thomas Lee, all of St. Anselm's College. In addition to the above, several professors from the New Hampshire College and University Council were guest lecturers and consultants. Visiting lecturers from the various state agencies, concerned with environmental studies, helped to further enrich this program.

This program was designed to give the high ability student an introduction to ecology as it is taught at the college level. It introduced them to refined instrumentation and higher mathematical functions of ecology. Chemistry was designed to be challenging, yet exciting, for the students. They were taught that final answers are arrived at only through extensive study and with the most precise and exact methods of testing. The Sociology Department presented the Social Ecologist viewpoint and covered the complex methods of combating apathy leading to inquiry. The good Benedictine Fathers of the college, many holding PhD degrees, were present to give council and advice.

This program was extended for a second year and up-graded by the addition of staff professors from Economics, Urban Studies, and Political Studies Departments. Today, the products of this Advanced Studies Program are well represented in the colleges of our nation, and many have been signaled out as exceptional students and given early positions of merit and honor.

2. West High School Curriculum Development Program for Formal Ecology

Plans were laid in the spring of 1971 for the high school phase of the program. It was decided at that time it would be a formal approach to ecology and the course would be for a full year's duration with one credit upon completion. The entire staff at West High School were asked for input, along with the school administrators, superintendent and his staff, and members of the faculty at St. Anselm's College, University of New Hampshire, and New England College. Mr. William Ewert, State Department of Education and State Coordinator/Consultant in Science Education, was called upon many times for input. It was decided it would cover all areas of water, air, soil, terrestrial, marine, and esturine ecology. Because Manchester is an industrial city and apathy was evident among certain industrialists, and because we believe that Social Ecology is necessary in combating apathy, we decided to not only include Social Ecology into the course, but to make it an over-riding theme.

The development of attitudes and skills through factual knowledge and action leading to active concern was a prime consideration. It was felt this would lead to awareness and the students could go above knowledge and communicate at all levels. It was also felt that if this was a laboratory orientated course, with the field our laboratory, out in the nitty-gritty, outdoors where it was all taking place, a greater responsibility to land and man's place in the ecosystem would become more apparent. We felt if the student could get a sense of man's feelings and involvement, or his skills in action as to the critical issues involved, it would lead to critical thinking and problem solving to some degree in the areas of ecological, economical, political and social or consumer usage. We planned, through environmental encounters by all youths, to bring about change. They have the vote and seem more sensitive to environmental needs; therefore, in this experimental course we hoped to bring about change.

We wanted one course only for the first year, but ended up with two. Many students and parents were angry when they found out that scheduling was closed to Ecology I. Administration insisted money was a factor and the grant monies were all accounted for in the budget. We selected for the two calsses, a cross section from the student body; high ability students, average students, slow students, and even those who were flunking were asked for, and received. It was felt that because of the nature and diversity of the course, the slow could learn from the average and high ability students, and in some instances the average and high ability students could learn from the slow. We have seen this happen many time, and it is always with a feeling of warmth when a teacher is privileged to view such an instance.

In the Industrial Arts Department, for instance, the high grades went to the low ability students in the manufacturing of home-made ecology equipment, and not to the high ability student. This was repeated time and time again in the woods, on the lake, in a boat, and various other instanced. The students all studied from the same text (Odum's Fundamental of Ecology, 1971 edition, Saunders). For the slow student it was broken down and essence factors extracted and simplified. The same was done for all reference materials.

Early in the beginning days of the course, we got permission slips from the parents to allow their children to attend all field trips and to ride in cars driven by other students and teachers. We further got some parents to allow their sons and daughters to use their own or family car to bring other students to and from trips. The parents assumed all responsibility. We found this method cheaper than busses as we had so many field trips, all within 5 to 10 miles. Busses have a flat rate, plus the number riding, and a time factor. Selling teachers on letting their students out of Mathematics, English, French, or some other class, was a problem at first, but thanks to an understanding superintendent and school administrators who broke the ice with the teachers, few students lost out on long field trips.

Trips were made to the coast, mountains, forests, and ponds and lakes. Other trips were to industries along the river and on the seacoast. Tests of every type were employed on these trips, under the assistance of most capable teachers and cadet teachers who acted as chaperones. In many instances college professors were along, lecturing or demonstrating. Most water and soil testings were done with HACH kits or

LaMottes kits in the field, along with Millipore equipment. In most cases samples were returned to the laboratory and standard procedures were employed to check the validity of the commercial kits. Samples were split and some sent to the State Water Pollution Board or the Soil Conservation Department. We cooperated with the State Air Pollution Board and they installed a 66 pound air filtration unit on the roof of our school.

Most of the testing this first year was in and along the highly polluted Merrimack River and its tributaries. It was an eye opener, to say the least. Some of the students who made up part of the West High School Civic Demonstration Unit, through their excellent photography, (slides, video-tapes and movies) plus photographs, were able to get the first conviction ever, under the Harbors and Rivers Refuse Act of 1899. This came about when the Federal Attorney for our area, Mr. David Brock, Esq. saw a slide show presented by these youngsters at a public gathering. He asked the educational director of this grant for a viewing of all materials and a copy of all test results. He further told the director, if refused, he would supeonea it. (It was public knowledge and could not be refused). The superintendent was called and he also said it was public knowledge, paid for with Federal money, and to "release it." Mr. Brock won in court and the company, convicted of gross pollution of the Merrimack River, (Granite State Packing), appealed to a higher court and lost again. It finally went to the highest court in the state, and in a landmark decision the packing company lost again. This went out as an AP news release on a world-wide basis.

During the first year of this grant, teachers and students were harrassed by industrialists and police whenever they attempted to test in certain areas. We are proud to say they never gave in to pressure and continued, as good students always, in pursuit of excellence and knowledge to be used in their lifetime in bringing about needed change via the polls and the democratic process.

The project staff was well qualified to handle all aspects of our program. Of the fourteen science teachers at West High School over three-fourths of them have masters in their respective fields and most with credits beyond. The same applies to the teachers at the other four high schools that were involved on a less extensive plan. Those at the Junior High School level were selected from five Junior High Schools on ability to carry our project to their level, and we are proud of their results. Other high schools throughout the state were involved also, but reported through the West High School Program. There was, however, need for staff development training, as Ecology was a new field to most and knowledge was fragmented. We held a series of seminars the first year at West High School on weekends and evenings, training those who had never used HACH kits or Millipore equipment, and such.

Specialists were called in. When we covered plants we called Dr. Albion Hodgdon, Botany Department at the University of New Hampshire; for scoober diving and recovery of detritis we called in Professor Raymond Conelly of New England College's Biology Department. Mr. Conelly is a recognized expert and authority in this area. Some of our staff also taught. For instance Mr. David Angwin who holds a master's degree in Geology and the Earth Sciences taught map reading and the correct use of the Brunton Compass; Mr. Raymond Demers, a licensed Medical Technologist, taught Millipore techniques and microbiology; and Mr. James Morrison, former Professor Sociology at St. Anselm's College, taught a unit on Social Ecology in the Class and Community.

There are many areas of ecology one must consider in doing the environmental structure of a community. Extra help or experts in various fields must be contacted throughout the program. When we started to work on Manchester's beautiful watershed and Lake Massabesic, we became involved with new types of problems common to the waterworks people. The director and superintendent of Manchester's Water Works, along with his engineering staff, were of great assistance. Their business office, map and blueprint department, along with the sanitation engineers, were more than kind to our students, lending to their over all education. Some of the other agencies we went to seeking advice were: The New Hampshire Society for the Protection of Forests, headed by Paul Boffinger; The State Water Pollution Department, whose director William Houghton was a never ending source of information; the State Fish and Game Commission and its director Walter "Bucky" Corson and his fine staff added much to our program. There were many others at the state level and also at the local government levels. We borrowed maps, charts, articles, and photographs from the above groups and received gratis many publications, charts and varied data from each of the above listed organizations during the first year of the West High School Demonstration Unit's existence. Despite this we had to produce many forms of our own along with charts and graphs.

Ecological equipment was in short supply, and due to limited funds and a desire to make our students self-sufficient, we made a lot of our own water testing, soil, and air testing tools. Assistance in this area came from the Industrial Arts Department of West High School and the Biology Department of Hanover High School and Dartmouth College. Others who assisted were the Home Economics and Art Departments of West High School, the Botany Department of the University of New Hampshire, plus the wonderful cooperation of the students who also tried their hand at making equipment. We were way under on our estimate of financial needs; however, with the help of the above concerns and the most generous assistance of the Manchester School District and St. Anselm's College, we were able to stretch our dollars into a program that has really paid off.

In summary, the first year found the students of West High School's Curriculum Development Program for Formal Ecology testing water from the river, lake, ponds, and brooks, for the entire school year, even through the ice in winter. Soil testing and air testing were also conducted, but not to the extent of water testing. Plant identification and collecting and pressing were a popular unit and we feel it has done much to create love of nature in our students. Some actually feared the forest and were uneasy on entering the deep woods, but by the end of the course they all loved to work in the forest, and many made independent trips ontheir own throughout the year. There is a great need in this area as evidenced by the requests from the students for more ecology units.

Movies, guest speakers, visiting professors and various field trips completed the first year's activities. Most of the field trips were week-end affairs under the direction of West High School teachers, other high schools and junior high school teachers. Shorter trips were conducted after school, with walking trips to the river and around the school during class time.

This program started with two classes and blossomed into three classes of first year ecology, with one of second-year ecology at West High School during the second year. It also spread to Central and Memorial High Schools in Manchester, New Hampshire, and other schools throughout the state.

3. West High School Civic Demonstration Unit

By the middle of the 1971-1972 school year the students at West High School had produced a number of outstanding slides, 8MM movies, photographs and video-tapes. Most of these were on river pollution and were taken under the direction of a student photographer, Steven Hadlock. They showed every phase of the river, from sewers that just emptied on dry banks to those that emptied into the water; scenes from the packing company that was later to be fined in a court case that received world-wide coverage via AP news releases; "Blood River", the creek that started with a trickle of blood from the packing company over forty years ago, a mere rill, now a creek or river of blood 25 feet wide and 75 feet long, emptying its daily load of blood and fat, hay and paunch manure into the Merrimack River; the river's changing patterns and the banks covered with grease and fat, dried blood and hair, blown by the wind during storms to wipe out trees and plants, leaving behind denuded banks teaming with bacteria. Occasionally, near the water's edge, a whole paunch was photographed. Sludge formed by fat built-up in deep pools rotting in the sun, covered by a variety of molds, fungi and varying in color from black to bright greens and blues, fading to dull reds as they received new blood under various conditions. Litter was photographed in its many forms, from fly ash to discarded chemicals, or peas and corn from a soup plant, and even shopping carts pushed over the bridge by little hands, to litter the banks and even hang high up in trees. The city dump and back alleys were photographed plus algae blooms and oil slicks on our ponds and lakes. When it was finally put together in a carosel and showed first to the students at West High School, the students reacted with revulsion. One student vomitted--some had tears in their eyes--a petition was started.

The children talked and parents listened. Requests came in to see the show by service clubs, schools, and colleges. Among these was a request from the Superintendent of Schools for a showing to the entire school and aldermanic boards. The request had been made by Alderman Bossie, who had seen the show with a group of people from state agencies, i.e., Water Pollution Board, Conservationists, Health Department, etc. Mr. Bossie is also a State Senator and an active member of an organization called "Citizens for a Cleaner Manchester". He requested the superintendent for a showing to be held for the Board of Aldermen and School Committee men. We chose two students for this showing, as it was our policy that teachers were not allowed to talk at slide shows until after the students had made their presentation, and then teachers were called upon to speak. The city fathers were horrified! The students had brought the river to them. They had brought that part of the river the city fathers had never seen, like the insides of via-ducts long ago abandoned, but with sneak sewers of industry entering them. Real money savers! Inside giant sewers, along slimy banks, around bends, just out of sight of man, all the gore and filfth that made our river one of the "top ten on the filfth parade".

The students got a standing ovation and received a commendation. The chairman of the Science Department also received a commendation from the School Board, and word began to spread statewide. Requests became so constant for showings that the secretaries at West High School and St. Anselm's College could not do their work because of telephone calls. The Superintendent of Schools decided a telephone was needed at West High School just for these calls. One was installed in the science office, and now the teachers in classrooms on either side could not get their work done. Students in each class were hired to answer the telephone and do the bookings. Over two hundred showings were put on by the student unit and twenty by the teachers. (Service clubs, i.e., Elks, Knights of Columbus, Sporting and Conservation Clubs, Trout Unlimited, etc.). Many of these saw the show and in the case of Trout Unlimited over ten chapters asked for and saw the show. Finally this organization invited the West High School Civic Demonstration Unit across state lines for a showing to their national chapter, at the Mariotta Hotel in Newton, Massachusetts. The students stole the show--the Curt Gowdy Show was a flop. The unit once more received a citation, this time from the National Chapter of Trout Unlimited. For the rest of the year they continued the shows in high schools, junior high schools, colleges and universities across the state and throughout New England.

The students added HACH kits and Millipore equipment to the show and went back through the same schools and clubs showing how to test for pollutants in town water or wells. They were educating teachers as well as students and also parents. Teachers were hungry for this knowledge and requests were more frequent now from teachers. We developed six groups of students: one group that could do weekend shows (these students did not work); one group that could go after school or evenings (this group only had jobs on weekends); the last group were seniors who had cars and were scheduled for classes so they had three or four periods off during the day. This group showed mostly in the city to our thirty schools and seven colleges; however, on occasion we would request a teacher to release a student from a class other than science and the teacher would comply, in order that our students could take the show out-of-town to put on an assembly at a school or college. The word continued to spread and these students became well known throughout New England.

Requests now poured in asking for us to give them details on how we started environmental studies at our school. What was the best way to approach it? We never had enough money to do everything requested. We developed a writing team of students to answer letters and at this time our teachers involved with the community awareness program, termed the Community Awareness and Education Program, swung into action and started to build a brochure under the direction of our Administrator, Professor James W. Morrison of St. Anselm's College. Three art teachers from West High School, Southside and Hillside Junior High Schools, three science teachers, West High School's Demonstration Units photographers, and a few art and science students started putting it all together.

At about this time, our students took part in a three-day show at the Sheraton-Wayfarer Motor Inn Convention Center. This show was sponsored by the New Hampshire Teachers Association, and teachers arrived from all over the New England states. Gail Griffith came in from Boulder, Colorado and was the guest of the West High School group and the keynote speaker. Again, the students won the hearts of all and amazed the teachers of science with their knowledge of ecology. Two different groups at the show wrote articles on their demonstrations. One was the New Hampshire Outdoorsman and the other was the New Hampshire Educational Association. Their article made the Journal of Education, the NEA National Publication. Newspaper articles were also written and the West High School unit took all honors.

By now, the Civic Demonstration Unit teachers were lecturing throughout the New England States. Teachers from throughout New England were requesting permission to visit West High School and these requests were met. Teachers from the Civic unit acted as hosts and showed them through West High School and took them on field trips. ("Blood River" was a favorite place to shock them). St. Anselm's was more than cooperative and arranged for many of these visits, as they were still receiving calls at the Grant Administrator's Office. If it were not for a most and understanding Principal at West High School and a most benevolent Superintendent of Public Schools in Manchester, this program could have failed.

By now, Attorneys Bossie and Kelley of "Citizens for a Cleaner Manchester", using evidence gleened by the West High School Demonstration Unit, had won a court victory and announced to the citizens of Manchester, via press and radio, that any money they got from the conviction would be shared with the students at West High School to continue their good work. This started requests from women's groups: Garden Clubs, Church Clubs, Civic Improvement Groups, PTA, Boy Scouts, Conservation Commissions and others, until it was impossible to cover them all. Commendations and citations continued to flow in and our people were now in demand as speakers. Professor Morrison, Administrator of the Grant, and James Hall, Director of Education under the Grant, were forced into action as speakers. They elected to talk to teacher groups to take the strain off the Civic Group and to get out vital information to the teachers throughout the state.

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IV. As the first year of the grant drew to a conclusion, a review of our notes and comments by fellow educators and our own observations, convinced us funding was needed for another year. One factor stood out most clearly: the teachers of Manchester, and the State of New Hampshire, were clamoring for education in the field of Environmental Studies. It was further evident colleges were not filling that bill and the State Department of Education was only giving lip-service to this area. The second factor that left its impression upon us was the complete absence of ecological or environmental testing equipment. We had noticed in every instance where our students were demonstrating, teachers were always interested in our few pieces of homemade equipment. They were asking for plans on how to make the equipment.

In over 200 showings of HACH kits and Millipore equipment we only ran into three schools with HACH kits, and they were the smaller kits. We ran into two schools with Millipore equipment. Nevertheless, they all asked, "How can we get training in the use of this equipment?" They liked the idea of the cook-book method employed by these kits and the easy pictorial progression. They felt they could bring in students without a chemistry background and potential drop-outs, because they could be involved in a hands-on project, and arrive at most accurate answers to pollution and environmental problems, due to the unique approach of these kits with premeasured chemicals. They rightfully surmised their students would have a sence of accomplishment and feel they were of value.

Knowing that most of these schools couldn't afford to buy the kits, we decided to develop more homemade equipment, if funded the second year, and look for methods to bypass the kits, yet keep the students involved and help them feel what they were doing was worthwhile. We also knew we could hold the interest of our students outdoors in the field, river, pond, or lake. Classroom lectures to students who have "missed the boat" in elementary schools, who could not read or spell, and who could write but a few meager lines, soon fell asleep. We saw this in many instances and heard many teachers say, "What can I do for him?" We showed them a rejuvinated youngster on our field trips. These students were so hungry for knowledge they had a tendency to hog the equipment.

By now, the program at West High School was recognized as the official information center for environmental studies in the State of New Hampshire. This was causing some embarrassement as we were running out of money, and just the stamps for returning data requested was of a considerable amount. Messages to return telephone calls pushed up the phone bills at the Superintendent's Office, St. Anselm's College, and especially at West High School. A conference was held with the President of the college, Superintendent of Schools, and the teachers involved. It was decided to try for refunding.

We were refunded for the second year and thus we come to the second chapter, or year, of increased involvement.

We started off the second year in a better position in that we were organized and had learned from last year's mistakes. We knew what to use in the textbook and what we could pass up. We had our labs organized so we were not losing valuable time and they were arranged to give maximum input to the chapter or the field trip under consideration. Added to this we knew where to go on our field trips, the shortest route to get there and other timesaving factors. It was not 'hit or miss' as it had been in our earlier days. Above and beyond this we now had a new course, Ecology II, made up of old familiar faces--last year's Ecology I students. They were to become aides, demonstrators, proctors, and in their independent studies program, they became the scouts for new territory and the nucleus for our new tutor program.

At the conclusion of each unit, upon announcement of an upcomming test, all those with problems could go to an Ecology II student and get a refresher or review. Only "A" and "B" students from Ecology I were allowed to take Ecology II. We had also grown from two classes of Ecology I to three classes, so from our beginning of two ecology classes, we now had four.

Ecology I students from last year had put the word out that it was interesting, a "do-it-yourself" course and a fun course. We were in trouble! The Guidance and Curriculum Coordinator took the easy way out and slated students to ecology upon request. Ecology teachers and the Science Department were accused of a massive recruiting program. One teacher openly accused the program director of recruiting directly from his class. His class had fallen from its usual 25 to 15. Pressure was applied and the Curriculum Coordinator closed further entrance to ecology classes. Now, parents became involved. They demanded their children be allowed to enter ecology. Juggling and reshuffling took place in direct proportion to applied pressures. As a result of this it became evident to this writer that educational change is needed in many areas. Who will be first to 'rock the boat'?

One of the first things we did to start the year off was to develop a few more pieces of home-made equipment. Each piece we developed had a unit built around it. In some cases, two or three units were built around one piece of equipment. For example: Plankton nets cost anywhere from $12.95 for cheaper muslin types to $21.95 for the more expensive silk ones designed to hold mannoplankton. For a class of 24 students there should be four of each type or three students to a net. For the smaller schools in those communities without industry and where most of their citizens work in other cities and towns, there is barely enough money to keep the schools open with a seat for each student. From this you can see where $139.60 (what it would cost to buy these items) would be considered expensive, wasteful and poor business management, looking through the eyes of a small town selectman or school committee man. We were able to produce them for the following amounts.

The muslin type holding net or macroplankton: our cost was about 15¢ per net. The ring of the net was made from old coat hangers (free) that the students brought from home. The thread was donated by the Home Economics Department who also did the sewing (free). The muslin was our only cost. This was purchased from the remnant shop and ran us about 15¢ per net. NOTE: We probably could have gotten the muslin for nothing if we had contacted the students' parents and asked for remnants; however, we were in a hurry and eager to produce the first nets so we splurged and bought it.

The vile and vile holder, or retainer, at the end of the net were both made from discarded pill bottles and plastic viles that were cut down and used as a holding ring. This was sewn in so that a ridge was formed and the whole vile could be slipped through it with a little pressure. Elastics hold it in place in the water. Instead of $51.80 for this item (cost of 4) our cost was 60¢. The net for nannoplankton or microplankton was made from parachute silk (donated by Pease Air Force Base--worn-out parachutes). Here again we used coat hangers for rings and thread was donated by the Home Economics Department who also did the sewing. Medicine bottles, pill viles and small test tubes from the Science Department were again used and despite the fact these cost more in the scientific catalogs, we produced these for only 20¢ each. Our big cost here was the retriver line (1/4" marine nylon) plus a spinning hasp. We have since found a cheaper source.

The following will outline what we use each net for at West High School.

1. <u>Macroplankton (muslin net): A Study of Metamorphic Forms</u>

In this experiment, the students after studying a unit on metamorphisis among insects, are taken to a shallow section of a brook and told to observe and record all life forms seen in the brook in its natural undisturbed state. If anything sighted is known by the students in another form, they are to record it in quotation marks after the specimen seen, on their prepared sheets, i.e., Helgramite - "Dobson Fly". Next, large rocks are placed across the brook, blocking the water (daming). Four nets are placed into position and rocks removed in these areas. The nets will now float downstream to their entire length with the flow of the current. Four students with boots on or old sneakers to protect their feet, using birch bushes (small trees) sweep the bottom of the brook from upstream, walking toward the nets. Four other students follow them moving large rocks and relocating them. One more sweep and the nets are collected and all rocks replaced as they were on our arrival. Speciments are now separated and classified on the banks of the brook, weather permitting, or taken back to the laboratory and classified. Thus, our students see and feel the different metamorphic forms of animals they are familiar with instead of a flat unimaginative diagram from a textbook. An appreciation of a brook as an ecosystem and the vital food chain are thus brought into better perspective.

2. Macroplankton (muslin net): A Study of an Aquatic Food Chain

This experiment is designed to make the student aware of the abundance of aquatic forms and scope of the food chain in an aquatic ecosystem. Both types of nets are used in this experiment. When they have finished with the muslin net (which is all they have been introduced to at this point) and classified all forms, both plant and animal, and listed them on prepared sheets, we then introduce them to the Nanoplankton or microplankton silk net.

Procedure: Take the students to a pond that has a good littoral zone (shallow section near shore) and working in water no deeper than up to your knees, construct a dam of rocks or other materials. (pre-assembled boards may be used). Place the macroplankton, or coarse muslin nets, in place as in the brook project above. Select good bushy alders or young birches, or bring garden rakes with you. Repeat the sweeping procedure as above, collect and classify. Ask the students if they think the sampling is enough to get a true picture of the food chain. Take the silk net and go out in a boat or rubber raft with a couple of students that are good swimmers and toll it behind the boat in water that appears clean and free of any forms. Crisscross back and forth making four or five passes. Bring the net in and examine the mass collected both macroscopically and microscopically. (Regular student microscope and bridge table can be brought along for this, weather permitting.)

Examine all forms under low and high power objectives at site or take it back to the lab for more extensive coverage. Examine mucus-like content as well as the water. Move into the rap session and discuss the issues. NOTE: This lab must be extended to the classroom for adequate coverage, i.e., centrifuge isolation and for those fortunate enough to have Millipore equipment membrane filtration techniques may be employed to isolate the smallest of phytoplankton or zooplankton. Also, it is recommended that microbial assay be included at this time to show the ultimate extension of the food chain with the exception of virus and chemicals. (In absence of a boat, long handles can be added to nets and used off deep banks of pond).

3. Nannoplankton (microplankton nets)

Using the Secchi discs determine the compensation level (depth to which photosynthesis extends). (NOTE: This must be in a pond or lake and within the Lentic Zone. This is the zone next to the Littoral Zone on the horizontal plane). Using a silk net with a long pole collect at all levels of the area to which photosynthesis extends. Examine and classify the specimens. Place a plastic bag around a clean silk net and secure it tight enough that water cannot enter by means of elastics. Lower it to the depth at which photosynthesis does not take place (below compensation level), using another pole with a knife attached, cut the elastic, and allow water to enter the net as you make sure your net stays at the correct level. This can be done by marking your pole in liters, meters, or whatever measurement you desire. Collect and examine. Discuss and rap. Do a dissolved oxygen at both levels, temperatures, and CO_2 test. Discuss--rap session.

We continued with the home-made equipment during the second year trying new pieces and new design. As we contacted other science teachers throughout the state, we got new ideas and modified and added new types, until by the end of the second year we had 10 functional pieces that we were using often on our field trips. These will be listed at the end of this report with brief coverage of their use.

During this, our second year, we held our first series of classes for teachers within the Manchester Public School District and those towns bordering Manchester, New Hampshire. The response was heartwarming. We had intended to train only 30 at first, based upon four from each of the six senior high schools in the city plus two from a private high school and one from each of the four towns bordering Manchester. We had to discard this plan as ten from West High alone insisted upon entrance to the course. Some of the junior high schools we had not even counted in our plans came up with two or three each. We ended up with forty-six in the first class. It was held at West High School and three (3) certification credits were given by the State Board of Education.

The first session was conducted by the director of the program and the administrator of the grant. It covered "How to Introduce Environmental Studies into your School Formally or Interdesciplinary." This included all phases from the approach to the Superintendent to the Principal. It covered forms and permission slips to be used with parents, teachers, and administration. A most important section was how to combat apathy among teachers who seemed reluctant to the school allowing the course. An overview of the year's program was handed out at this time, ranging from the formal class lectures from the text and references to the field trips and laboratories. This was a three-hour session with a half-hour coffee break.

The second class was coverage of HACH kits by the chemistry teacher at West High School. The ease of usage of these kits was demonstrated along with standard chemical procedures. This material lasted for the first two hours. The last hour was given to a hand-on lab session that was so popular that we later switched the lab session to two hours and the lecture to one hour by passing out materials on the lecture in advance. All sessions had a half hour coffee break to exchange ideas.

The third session was on the use of Millipore equipment by one of West High School's Ecology teacher. Two hours were given to the various tests that can be performed with Millipore Membrane Filtration techniques in a hands-on lab. The next hour was a lecture on standard microbial techniques and cautionary measures to be employed with students.

The fourth session was coverage of the Brunton compass and reading of topographic maps by a member of West High School's Earth Science Department.

The fifth session was a field trip to Manchester's Water Works Department, where actual testing was done by the teachers, putting into action what they had learned. There was also a tour of the facilities and an appreciative tour of beautiful Massabesic Lake. This was a four-hour session.

The sixth and last session was a slide show and video-tape show of the Merrimack River, by the West High School Civic Demonstration Unit. A rap session followed, and equipment made by the students was loaned along with other commercial pieces of testing equipment. This was rotated on a two-day loan basis, and each teacher that borrowed equipment had to take out at least 10 students from his school on a weekend or after school for two nights and use the equipment in the field.

By now we had completed our brochure in its final form and mailed it out to all high schools in New Hampshire and nearby Massachusetts cities. Some junior high schools were also included. Copies were sent to colleges and state and local agencies who had helped and lent us encouragement. The telephones were really ringing at West High School, St. Anselm's College, and at the school administration office. Requests were for teacher training, slide shows, video-tape shows, demonstration of HACH kits and Millipore equipment, home-made equipment, and many questions that apply to introducing ecology into a school. Service clubs who had seen it before, and new ones, colleges and schools, were all after the same thing--West High School's vibrant Environmental Studies Program. Meanwhile, our West High Demonstration Unit was still grinding away and the Civic Demonstration Unit had altered it's slide show. They felt it was too bloody, too much pollution, so they added slides taken at Kinnikum Pond, a small polar pond surrounded by a glaciated bog, filled with rare and beautiful flowers. This pond lies in an 1800 acre swamp, Kinnikum Swamp, part of Manchester's 48-mile watershed. These slides were added to arouse an appreciation and love for nature, and to offer a choice--protect it or lose it. The show got instant rave notices, and people wanted copies of the slides.

At this time we sent a team from the Ecology II class, along with the Civic Demonstration Unit students, to the Museum of Science in Boston, Massachusetts to present our program to SCENE members (Student Coalition Environment New England). The Demonstration Unit stole the show and one of our students, Steven Hadlock, an Ecology II student, was chosen by the judges to sit at the head table along with Barry Commoner. This same student was later elected by the educational director to represent New England at the UNESCO show at Chicago. Steve was the only student from New England and one of ten from all over America who joined 10 students from foreign countries. He stole the show at Chicago and so impressed the Director of show, Mr. Mansfield Smith, that he still communicates with Steve, and rates him one of his good friends. One youngster from Surry, South-End London, was so impressed he received permission and returned to New Hampshire with Steven Hadlock. We naturally put him in with a group of Manchester West High School's students and Nashua High School students at a highly polluted Salmon Brook in Nashua, N. H., in a joint testing program of Nashua, Hollis, Milford, and Manchester, N. H. Neither teachers or students knew we had a foreigner in our midst as he acted like our other students and was doing exactly as they were, until a teacher from Nashua asked him, "What school are you from, son?" He replied, "Surry South-End." His accent was a dead give-away. This youngster returned to England and gave to what would correspond to our National Education a blast that rocked Staid Olde England. He pointed out how at least one spot in the United States, taught the right way, out in the great outdoors, where it all took place, was West High School of Manchester, N. H. We have just received notice he is being sent back to the State of New Hampshire, and West High School, to do a study of our methods.

Our Demonstration Unit has by now put on many showings throughout the State, in every setting from the State Teachers Convention to Conservation Conventions, and for the first time we are getting some organizations to pick up the food bill in order to stretch our dollars. One such outfit to do this was the Deerhead Fish and Game Sportsmans Club of Hooksett, N. H. Another was the Nashua Conservation Commission Annual Show at Salmon Brook in Nashua, N. H. By now we had a new class of teachers in the city of Nashua, N. H. In all, there were thirty-five to start with and four dropped out, leaving thirty-one to complete the course. Again, the State Board of Education granted three credits toward certification for teachers. The same plan was followed at Manchester in the fall of the year, except that we included two field trips. One was conducted at Massabesic Lake in Manchester, N. H. with Manchester high school students doing the testing under the direction of Mr. Francis Guenther of Central High School. The next one was held at Nashua High School and Salmon Brook under the direction of Mr. Marco Sheer, Chairman of Nashua High School's Science Department. From these two classes we now had the knowledge and the plans for the next four classes to be trained in our third year of funding.

Brochures were being returned now and telephone calls along with visits to our school from all over New England was taking place. A check with our school curriculum coordinator showed that pre-scheduled students already made up five ecology classes, a gain of one over this year. He had stopped any more enrollments into the course at that time, early April. Students and parents were angry once more, but Manchester, N. H. had been dealt a blow by the Federal Courts. Our "Dual Enrollment Program" was declared illegal. Parochial schools folded up enmass, and the public schools were hit hard with increased enrollment. Manchester couldn't afford another class. It is ironical, but true--Congress and the Courts had dealt education another blow. Our students who had graduated from the first class were now in college, and many were recognized as too advanced for their classes, so were given independent study or moved up to higher level courses. So as we applied for the third year of funding, our fingers were crossed. We had a mission to teach teachers across the state, and get them into the only classroom--outdoors.

Our School Superintendent has to be the most generous man alive, to let us take the money out of our school district into others in order to train teachers not from his schools. He, Like President Placidus Riley of St. Anselm's College, is a man of great vision, saw the greater values to the state and nation, and gave his generous stamp of approval. We were funded for the third year and this brings our paper to the next and most important section.

We applied for and received our funding for the third year. Because we were intensifying our teacher training, we were given $2,500. more than we had in the previous year. Teacher training was to take up much of the time of West High School's Curriculum Development Unit. Meanwhile, the West High Demonstration Unit and the Civic Demonstration Units were most active. They now had two years of knowhow that they had inherited from the graduates and past Units. The Demonstration Unit had by now, all but left the Merrimack River, and were instead concentrating on Manchester's beautiful watershed.

We had three teams a day checking those areas known to be polluted and five Ecology II students double-checking the Eco. I students, graphing all the final readings. During this time we conducted field trips in Terrestrial Ecology. We were starting to see a new trend. The students were thirsty for knowledge of plants and animals. During the first two years when the Merrimack River was in the headlines, and lawsuits were everyday reading matter, interest was high and students couldn't wait to get to the river. During the past two years they have heard from fellow students of their ventures on the river, read of the $38 million dollar treatment plant now under construction, and the $8 million dollar airation plant newly completed on Lake Shore Drive in Manchester. They have a feeling we are on the road to recovery in water problems on a state-wide basis and express confidence in their ability as tomorrow's voters to continue this trend to fruition. We hope they are not over-confident!

Their enthusiasm for knowledge of the forests, to know the types of trees and plants, is admirable, and excites the educators of Manchester and the State of New Hampshire. We are about ready to turn them loose in a real terrestrial adventure, wherein they will study the forest in all its aspects, from the molds, fungi and other decomposers, that make the forest soil, to classification and building a herbarium for the school. We still continue with "Odum-Fundamentals of Ecology", giving the essence factors that comprise our major ecosystems and types of ecosystems, leading to an understanding of homeostasis (Natures Balance) things in their proper order.

The Demonstration Unit has put on many showings of our new and improved slide show to colleges, high schools, Junior high schools, and upper elementary schools. They have attended conventions and put the show on at service clubs and to conservation commissions and many other groups. They have spread the word--set the guidelines for an improved ecosystem. We are now looking toward new horizons developing in the adult community, through the students, an appreciation of nature, via bank displays, posters, pressed plants and preserved specimens.

This year we dropped the Advanced Environmental Studies Group at St. Anselm's College and have brought in its place a multitude of campus activities involving the college students. (This will be discussed later under a separate unit).

Starting in the summer of 1973 we took all the diagrams, designs, blueprints and drafts of homemade equipment that we had collected from our teachers at the city schools and across the state, and turned them over to Mr. Richard Klaxton of the West High School Industrial Arts Department. He was requested to revise, perfect and submit new ideas to Mr. James Hall of West High School and Mr. James Morrison of St. Anselm's College. Mr. Klaxton produced a pamphlet with ten pieces and started production with a group of Industrial Arts students, of the 1st modles early in June. He incorperated ideas submitted by teachers from all across the state and modified these with assistance from other members of the Industrial Arts staff and the Science Department at West High School. Once an item was accepted in its final form, it was duplicated from 25 to 50 times during the summer, to be given away throughout the State as we met with and trained teachers in how to introduce and develop an environmental studies program in their schools.

The equipment that was produced were: 50 D.O. bottles or water samplers (quarts); 50 D.O. bottles (small--pints); 50 Secchi Discs (metal); 10 Secchi Discs (wooden); 25 plankton nets (mullin); 10 plankton nets (silk); 25 vasculums (wood frame, plastic sides) 50 soil samplers (pyrefoam); 15 back-packs (wood frame, plastic sides) 50 field plant presses (softwood); 10 plant presses (hardwood); and 15 laboratory plant presses (screw and rod types). Some of these cost us more than we would normally have paid to produce, because school let out and they had to be finished during the summer. We never had all the students to bring in free materials, but needing them for our first classes of teachers in the fall, we were forced into summer production. We wanted to leave one or two sets of each type with each school in order that they would have a model to go by and also get off to a good start.

Our first teacher training class of the school year was held at Hillside Junior High School in Manchester, N. H. It was composed of teachers from Goffstown High School, Londonderry Junior High School, Memorial High School, Southside Junior High School, Hillside Junior High School, Parkside Junior High School, and West High School all in Manchester, and Merrimack Senior High School, Merrimack, N. H. Thirty-three teachers signed up for the course. Mrs. Mona Greenstreet of Hillside Junior High School was the coordinator for the host school. The teachers were allowed four recertification credits by Superintendent Henry McLaughlin of the Manchester School District, because under a new State Law, superintendents were responsible for certification credits and not the State, as had been the case last year. Other superintendents followed suit for those teachers attending from the other towns. The schedules of the classes are enclosed. I feel it only proper to state here that all classes ran over the three hours. Interest was most high, and the teachers were lavish in their praise of the West High School teachers' teaching the courses.

At the conclusion of the classes the host school was given a piece of each homemade equipment article and selected items were given to other schools. All were given a copy of our Environmental Studies Guide that had now been produced in mimeograph form. These guides contained the pamphlet on construction of homemade equipment. This particular class, "Homemade equipment" was without a doubt the most enjoyed by the teachers and seemed to hold greater interest for the teachers. The superintendent and principals received telephone calls of thanks from most of the participating teachers. We taught a few more who had missed because of illness or other reasons at West High School after school hours, using a couple of our former students from Ecology II who were now in college as instructors.

Our next class was at Kennett Senior High School in North Conway, N. H. Charles Knox was our coordinator and did an outstanding job in that position. These people were hungry for knowledge and experience in the environmental studies field. They were concerned about their community and surrounding areas. Tourist have been buying land there and some forms of pollution are becoming evident. One particular area was Pease Porrige Pond, a small pond that has experienced rapid construction of summer cottages during the past three years. Among the teachers taking the course was the local Doctor of Medicine. He was suspicious of this pond as a result of the coliform potential from the septic tanks of all this new construction. His fears were well founded. Samples revealed coliform in the range of 4000 per hundred milliliter. We repeated this using Millipore Membrane filters and endo-media coded for coliform. The teachers were right on the money! They were proud of their new microbiological techniques, but saddened at the condition of Pease Porrige Pond, and vowed change was in the making. Thirty teachers signed up for this course, and we could have signed up 50 more. Some of them came from Maine, just across the border. The Maine teachers wondered if we could come over to that state and run a class also. A shortage of funds would have resulted, so we had to turn them down.

The Conway and teachers from surrounding towns were most grateful and asked if we could come and give them coverage of the terristrial ecosystem of their area. We can understand their request. It was a most beautiful area of mountains, mountain lakes and beautiful cinifers, sprinkled with beech, ash, hickory, birch, hornbeam, and stately oaks. It was surprising to find so many with so little knowledge of their area as to species and functional aspects. The coordinator says this exists because of their isolation, and it is hard to get instructors to travel north above Plymouth. One teacher, Tom Ford, travelled all the way from Littleton to attend the course at Conway. This teacher was a contributor to our homemade equipment program. He improved upon our D.O. bottle (water sampler). We used the same program here that we put on at Hillside Junior High School in Manchester, N. H.

It was a rough schedule for the West High School instructors, as they had to leave the school by 3:00 PM as it is 100 miles to Conway, N. H., and our first class always started at 6:00 PM. It was late when these teachers got home because ice forms on the slopes and turns, running off the mountain in the cool of evening, making the roads slippery. The Superintendent of Schools in the Conway area, Mr. David Appleton, was most appreciative and bought his senior high school a HACH kit and some Millipore equipment. They have since implemented an Environmental Studies Program and we at West High School were honored in being asked to critique their program. It is a great program! Superintendent Appleton expressed a desire for us to include his principals of the elementary schools as they were teaching principals of upper classes. We were sorry to refuse, but we find it most difficult to handle more than thirty teachers at a time, as ours in a hand-on type program.

This whole area and surrounding Maine communities need our training. Due to their isolated position, they have been neglected in many areas of environmental education. Yet this type area is the last frontier of rugged beauty, in the Northeast region. But then even in the metropolitan areas of Manchester and Nashua, there is still great need, and requests for further training are many. There are hundreds of teachers in these areas all urgently needing training in environmental studies.

We next moved to Concord, N. H. and Mr. Lee Wilder was the coordinator. Again, about 30 teachers were signed up and took the course. Once more the superintendent and his entire staff, along with the principals, were most grateful and cooperative. This is another school that has introduced Ecology, along with Nashua and Conway, N. H. and other schools we have had the pleasure of offering our course to. The Concord Waterworks made available their source of water supply and cooperated in our testing program. The schedule was the same as Conway and other schools. They now have both HACH kits and Millipore equipment and have started homemade equipment programs.

Exeter, N. H., on the coast, was our next training area with teachers from Salem, Dover, Hampton, and surrounding N. H. towns attending. Once again we could have had 100 or more teachers. Requests came in from Portsmouth, Rye, Rochester, Somersworth, N. H. and Kittery, Maine, but due to funds we were limited. These people are most desirous of training in Esturine Ecology, as an atomic plant is on the drawing board for Seabrook, N. H. just downstream from them, and an oil refinery at Durham Point just upstream from them. They are in the middle, on a beautiful esturary within New Hampshire's 17 mile coastline (the shortest in the nation). Many of them are lobster fishermen, shell fishermen, and fisherman, and are rightfully concerned about what happens to their coastline with these power plants. We have three instructors at West High School well trained in estuarine ecology and would love nothing better than to share our knowledge with these fine people of the coast.

As it is now we have given a series of lectures to the Seabrook Anti-pollution League and have two of our advanced ecology students (now in college) still advising the people in this area. Many of the people in this area are clam-diggers and never went past the 6th grade. They are fine and very warm-hearted people, but can't cope with politicians and power companies. Their teachers need training in how to act and what to teach in the area of estuarine ecology.

One of our students, Deborah LaFrenier (who had won the State Speaking Contest and also the State Literary Contest) wrote a letter to the editor of New Hampshire's most right-wing newspaper, pointing out the dangers of a power plant at Seabrook, N. H. She used references from the world's authorities on esturaries. It was in fact, a most scholarly memo to the editors. There were many letters to the editor that day, but Debbie was the only writer to get the black pen treatment. She was called an "Eco-Nut!" I can still see her tears of anger that so moved me that I forgot all educational protocal and assured her she had her "A" for the year. (She was an "A" student anyway). Today she is president of her class in college and a leader in the environmental movement.

Another classmate of hers, Sonia Madgziasz, is a freshman at another college, and has been excused from the formal course, as the professors feel she is advanced above the other students in freshman ecology. She has been assigned to independent research at Seabrook, N. H. because of her vast knowledge of esturine ecology. We are indeed proud of both of these students.

We feel the Federal money spent in New Hampshire is well spent as we look at the students (our only product) we have turned out, and their attempts to educate people 50 miles from their homes. Other students are following in their footsteps, and others must be so trained, for it is only through enlightment of the real issue applying to our ecosystem, our biosphere, that we can muster the needed votes to turn back pollution and ignorance.

To date, we have trained over two hundred teachers across the the state in a formal program, leading to implementation of environmental studies program. Our emphasis has been, for the greater part, ecological studies of ponds and lakes. There is a great need for coverage of terrestrial ecosystems, and how they influence and interact with the wetlands. In addition to these 200 teachers, we have given informal education to groups that have visited us at West High School, or those we have called on for one-day stands. Our Demonstration Units have further added to the total amount and taught fundamentals of ecology as a result of the Office of Education's Environmental Education Grant.

Our teacher and citizen training programs are most innovative to say the least.

Hundreds of citizens have been taught in this area as many of the conservation associations have had our students back four or five times with HACH kits, homemade equipment, etc., for the enlightment of their membership. One such group is the Piscataquog Fish and Game Club; the Piscataquog Chapter of Trout Unlimited is another. Notre Dame College of Manchester, N. H. has had our Presentation Unit at their college four times for its biology and ecology classes. Another college that has had multiple use of this group is New Hampshire College. Despite this we haven't scratched the surface. The city of Manchester has 900 public school teachers alone, not counting private and parochial schools; Nashua has 600 teachers in private schools, and since we have shown our slides there and trained some forty teachers in that town and surrounding area, the amount of requests for further training is phenomonal. The word is now being spread by these teachers, conservation groups, and citizens. This is evident as we get requests from all over New England now, and occasionally from other parts of the country, as our brochures are passed on and teachers move. We feel our program can be used as a national model. If we could receive adequate funding, we could have members of our staff enter the large inner cities, and give them a nucleus to grow from in environmental studies.

One great thing about our program has been the cooperation of our Industrial Arts, Home Economics, Social Science, and Art Departments, all team-teaching or helping to produce homemade equipment, so we could get the show on the road. We feel this method should be spread, especially to the poorer districts of our state, and to those of other states. It has been a real source of pleasure to have also had cooperation from practically every State Agency we approached. The colleges and universities have always come through in what ways they could when we called for assistance.

Regarding the strengths and weaknesses of our program, they are as follows:

Strengths

1. A well-trained staff of teachers from West High School and other schools within the state.

2. Cooperative State and Federal agencies sympathetic to our program.

3. A need (craving) for knowledge in environmental studies at all levels.

4. A state whose principal cities are industrialized and polluted and only now becoming aware of needed reform.

5. Cooperation within the host school-team teaching, and high interest in ecology.

6. A state that is rural and noted for its beauty of forests, lakes and streams, and just awakening to its urgent need for education in environmental studies to conserve its beauties.

7. A most sympathetic state and local teachers' organization.

8. A most generous Superintendent of Schools in Manchester who is understanding and permissive and who happens to be teamed with a host college president of the same qualities.

9. Our evaluation tool, a questionnaire sheet, that allows teachers to tell us what they think, and from this, we are constantly able to improve.

10. Federal funding without which we would not have a program.

11. Many and varied types of ecosystems as natural laboratories.

Weaknesses

1. A newspaper that doesn't always see through the eyes of environmentalists.

2. A gasoline shortage that limits our spreading of knowledge via teacher interaction.

3. A lack of certain equipment, i.e., boat, environmental testing equipment.

4. Industrialists who see us as a threat and try to discourage our movements by threats and police harrassment.

5. Insufficient funds to produce the impact we would desire at both state and national levels.

6. A state so structured that it is 50th in State Aid to Education.

HOMEMADE ENVIRONMENTAL TESTING EQUIPMENT

ITS USE AND FUNCTION

Vasculum

In the art of pressing plants it is most important that in those instances when one is returning to the herbarium or laboratory with the plants from the field, that they be kept in as fresh a condition as possible. The most efficient and least combersome method in use for the past 50 years has been the use of a vasculum.

The vasculum has traditionally been either a square metal box about 1½' long, 5 to 6" wide, and 5 to 6" deep. Usually it is metal such as heavy gauge galvanized sheet metal, or in recent years some form of vinal or plastic. Some are rolled to form a tube somewhat like a stovepipe, only slightly oval with a more-or-less flattened bottom. All, however, feature a lift-up cover on top, with a simple hasp of some type as a lock, along with a strap and buckle that is adjustable to ones shoulder. They are leak-proof unless turned upside down. In order to keep the plants moist one may place a wet sponge in the vasculum before leaving the laboratory, or if one is going to an area where there is sphagnum (peat moss) this can be put into the vasculum (be sure it is wet) and it will keep the plants in good condition until your return or for a day or two. Two or three fistsfull should be enough.

Our vasculums, as indicated in the diagram, are of wood frames (shelacked with marine spar varnish) over which we have placed a cover of sturdy plastic sheeting or vinal materials. It is lighter than most vasculums, thus, easier to carry. Prune your woody plants well and you will be able to carry more and have less work back at the laboratory. Follow your laboratory exercise accompanying the plant press projects for further directions and guidance.

Laboratory Plant Press

The laboratory plant press is different than the field press, in that it is larger and heavier. Another difference is the absence of straps. In the place of straps it has two large threaded rods passing through the base of the press on either side, and the top or press cover has two holes on each side to line up with these two rods.

Once the top is in place and lowered to the topmost cardboard ventilator, thumb screws of a large variety (such as found on spare tires) are screwed down as tight as you can get them. Periodically (every three or four hours) tighten them again for perfect pressing.

This press is designed for the heavy type plants (trees, roots, fiberous plants) that need greater pressure. It is also handy when you have too many for a regular press and you wish to keep the collection together all in one press. In those schools where there is a shortage of presses for the field, the field presses may be emptied into one of these types, as they hold two regular presses of plants.

NOTE: You still must observe all standard techniques, such as pruning correctly, avoiding knots, and the proper positioning of the plants, for a perfect press. This information is to be found in all good herbarium books and also often included in botany and classification manuals. Our diagrams for the construction of this piece of equipment is included.

Field Plant Press

The field plant press is the most common and most widely used press by the botanist, because of its lightness and its construction. (Diagram for construction included). It is comprised of five basic components as follows: a top and a base (lattice like) structures, usually of hardwood slats and pop rivits (sometimes pine is used and staples); a series of perforated or ventilated (honeycombed) cardboard ventilators, (see diagram); a series of blotters (may be purchased from batonical supply houses) or simply cut from old desk blotters to size indicated in press diagram; one section of newspaper folded to receive the plants; and a set of straps similar to those used by mailmen (buckles with thumb release).

An Experiment (or project) Using the Vasculum and the Field Press

Plan your trip in advance. Go to the area you have selected and spot the specimens you wish to give coverage to. Mark them with a ribbon, tape, or paint if permitted. Draw a sketch of the area and number your stations for easy retracing of the route. Make sure your identifications are correct. If in doubt, use your keys available.

NOTE: This may be done by advanced students who you know are trustworthy.

Alert your class of the upcoming trip and what type of clothing would be best to wear, considering the terraine and weather conditions.

Get out the presses, vasculum, pruners, and necessary identification keys. It is good to run a practice laboratory making sure all students understand what each item is used for, or its place in the press, as to position. A few plants carefully selected the afternoon before the practice laboratory and placed in a vasculum along with some sphagnum moss or a sponge (wet) or both will suffice for this lab, and pay off in the field in time saved and errors avoided. Be sure to include a plant with a good thick root, a smooth section of stem or trunk, and some twigs. Have some sections with knots on them. Get leaves, buds, bark, fruit or nuts, samara or any part that can be used for identification. (Leave some leaves out overnight).

Show the student the vasculum and let them note the sphagnum and sponge and the fact the plants are still moist and healthy, despite being picked overnight. Show them some leaves you left out overnight--brittle and poor for pressing. Show them how it is carried by its strap over the shoulder. Select a stem and split it with your pruners or pocket knife (emphasising proper technique to avoid cutting oneself). Smooth the cut side so it will lay flat and even in the press. If there is a small knot, cut it off (explain why to the students) making each section about five to eight inches long, depending on structures you wish to save. Take the other half of this section and split it once more so the bark and some of the wood is gone leaving a flat section with the heartwood exposed. (Explain that some trees are easily recognized by the heartwood, i.e., nut trees all have a coiled spring-like center, etc.). Prepare the root by splitting it in half to show the center wood. Take a thin slice from this area and also a section from the outer portion of the root. Now take and snip off the long tapering end of the root with the root hairs attached and wash gently to keep root hairs in tact. Select the leaf, buds, nuts, seeds or whatever else you plan to include in identification of your chosen specimen, and prepare them for the press.

Lay the bottom of your press (with raised horizontal bars) down in a well cleared area. Place a ventilated cardboard on top of this (lined up with the sides) and place a dry blotting paper on top. Take one complete sheet from a newspaper and fold it as it is folded on the newstand (line it up with the blotter) and open it to receive the plants. Start at the top and place your stems, root sections, then your twigs. Lay them flat and even (like one does when mounting the plants). Be sure you don't crowd the plant sections. It is better to go to another setup or section with the flowers and leaves as they are delicate and often a slipping piece of wood or root can tear or split leaves and flowers. Prepare pods and seed holders so seeds are not lost. After they are spread out in their proper places close the newspaper and lay a top blotter over it. On each sheet write the name of the plant, both genus and species if you know them, plus the common name. Next, put the area you collected in and conditions, i.e., ditch-wet-moist, dry bank, cinder bed, railroad tracks, etc. Put down the name of the town, and if from a swamp or brook with a name, list it. The date is now written across the sheet and it is closed. Follow this with the top vented cardboard and follow this sequence until you have filled the press with ten to fifteen plants, depending on size and amounts for each spread. Place the top or press cover in place and line up the straps equal distance from the ends of the press. Start them from under the press about four inches or so from the ends, bring them to the top and buckle them. With an even steady pull apply pressure, first on one side than on the other, until the straps are as tight as you can get them. (Standing on the press helps). Rapid drying under moderate yet sufficient pressure is the secret of success in plant preservation.

Place the press above a radiator with moderate heat, or if in a hot room on a shelf, and adjust your pressure from about 25 pounds gradually to 50 pounds or even up to a hundred pounds, if needed, with woody plants. The dryer sheets and blotting papers should be changed twice daily, whenever possible, or whenever they are damp to the touch. These should not be reused until are well dried. The protective newspapers should not be changed until plants are thoroughly pressed. The time required varies with the season and the succulence of the plant. Four to five days is usually sufficient.

Explain all this to your students with as much visual and hands-on experience as possible. You are now ready to go into the field with your charges and have each collect under supervision, stressing good conservation practices and techniques. Have some presses filled in the field following the guidelines set forth in this exercise, weather permitting. Return some plants to the laboratory for corrective measures and for a unit on the laboratory plant press.

Once the students have collected and pressed their specimens and have them dried they are now ready for mounting them as permanent mounts. Many botanical books give methods to follow and materials to use. We feel individual preferences must be allowed also, or else we stifle expression of true art.

HAVE A GOOD TRIP!

NOTE: While in the field be sure you haver permission to collect in the chosen area. All land belongs to someone. Do not allow limbs, branches, etc. to be broken off. Pruners and trimming only will be tolerated, unless the tree is down. Do not mark or needlessly cut a tree or ever allow a tree to be girdled. Stay on the paths with your students except when you go to a tree or plant off the path. Then, form a single line to avoid trampling the area. Return single file. Students will not do these things unless you make it a rule with teeth in it. Respect of good conservation practices are learned (not always from parents). It is your job to teach it.

APPENDIX

INTERIM REPORT

ENVIRONMENTAL STUDIES PROGRAM*

ST. ANSELM'S COLLEGE - MANCHESTER, NEW HAMPSHIRE

Since becoming recipients of an Office of Education Grant and the introduction of a formal ecology course at West High School, the Manchester Public School System has gained immensely in Environmental Education. The Manchester Public School System, and its co-sponsor St. Anselm's College, have worked diligently to spread environmental education not only within Manchester, but throughout the state. Beginning in September of 1971 with one course in ecology in the city, it spread to eight courses, four of which are at West High School, in addition to one advanced or Ecology II also located at West High School.

Enthusiasm for this new course is extremely high. In fact, it is so high that it is causing concern in the curriculum coordinator's office. Youngsters are trying to drop courses that they are half through after hearing the students from ecology talk about the wonderful field trips they have been on.

The "West High School Ecological Presentation Unit," with its slide shows, movie video-tape shows, and it's chemical and microbiological display and demonstration shows, was presented 154 times last year. They traveled to colleges, universities, high schools, junior high schools, upper elementary schools, Fish & Game Clubs, sportsmen's and conservation groups. They put their show on to civic organizations, service clubs, aldermanic and school boards. The show went on the road to conventions, seminars, book shows, and even before church groups, and many others. They have been commended by a greatful city and have made national press coverage in an AP syndicated article. Their evidence was responsible for the first conviction under the Harbors and Rivers Act of 1899. The concern who took the case, ("The Citizens for a Cleaner Manchester") to court and who sent the Federal Attorney to West High School for the evidence that got the conviction, received $750. for their

*James W. Morrison, Project Administrator
James A. Hall, Program Director

share of the fine. They stated through their lawyer that they would give most of it to the ecology students at West High School to continue their good work.

There are few places the students have not been, if it meant gaining a little more knowledge about Manchester and New Hampshire as an ecosystem. They have been in bogs, swamps, dense forests, rivers, ponds, lakes, brooks, and down to the sea. Their enthusiasm never dampens; they never stint, and each one does much--much more than his fair share. If we were not convinced before, the teachers of Manchester are surely convinced now, "The Real Classroom is Outdoors," out where the action is. If you want to turn your youngsters on, turn them out! Outdoors!

In the ecology classes we are continuing to teach the heterogenous groupings, and the slow learners are still learning from the high ability students. It is quite common at West High School to see a National Merit Honor Student and a slow-borderline retarded student with their heads together. Cliques have departed and everyone is accepted into any and all groups.

The Inservice Teacher Training Group is constantly training new teachers. The classes are about twenty teachers to a class, and as fast as one is finished, a new group is ready. We just finished with a group of twenty, and twenty-six are now waiting--23 from one school, and three from another who just missed the last class when we did their school. The teachers who teach the teachers are from West High School's Science Department. They are all veterans from last year's ecology grant, USOE-6-0-71-4620.

We are extending the teaching of environmental testing procedures to the entire state as long as money holds out. The demand is great and the need is greater! This part of the grant and program is covered under its own heading in another section of this report (see brochure). The testing program at West High School and the new schools (10 in all) who have joined them, have moved from the river for the greater part, and are most actively involved in the testing of the waters in Manchester's 46 mile (square miles) of watershed. However, before we started on the watershed, we spent a few weeks on the river. Mr. James W. Morrison of St. Anselm's College, Administrator of the grant, and Mr. James A. Hall, Director of the science programs representing the Manchester School

System, both felt in view of the fact that the Merrimack is still one of America's ten dirtiest rivers, and insofar as we received so much recent publicity due to last year's action on the river, it would be advisable to go back with students who are new and were not involved last year. The shocking effect is good in "kicking off" the new program and building social values. It offers the chance to really get on with social ecology which has been a constant theme of our program.

We are now, however, off the river, except the Advanced Ecology II class who monitors on a weekly basis in the event a spectacular event occurs; for instance, when a well known knitting mill was fined on two counts for putting coal-tar products into the river in massive amounts along with anilian-dyes and chromium. Our students have been reading from the Environmental Protection Agency Pamphlets and comparing these with the State of New Hampshire Water Quality Standards Manual. They have become interested in what constitutes potable water, and what is meant by a class "B" river or body of water as compared with a class "C" body of water. What should each look like physically and chemically? They found both sources to be nearly identical. It seems these reports were taken from the old U. S. Department of Health Water Standards Manual of 1946. It is the thought of the students and the teachers that these reports should be updated. We feel we can do this with modern improved techniques and controls. The State of New Hampshire standards say a class "C" river will have at least 5ppm of dissolved oxygen. Time and time again, the ecology students from the various schools in this city received 3ppm or lower. On a number of occasions, they got 1ppm for several days in a row.

We have built through ecological testing and social ecology concern for our ecosystem. This we consider important if they are voting tomorrow. Most of them are voting as they are seniors and juniors just turning eighteen. One problem that we encounter is to keep the students from waving the green flag of ecology too violently. We must, as educators in an industrial city, do this because of the right-wing pressures from the industrialists, who tends to "poo-poo" youthful endeavors and usually admonish them with the suggestion they partake of the proverbial "grain of salt." On the other hand, we have the extreme left-wing press trying to inflame them to more overt action. It is a balancing act for teachers. How far can we go without causing loss of enthusiasm?

This year we have added two new laboratory books to ecology classes; (a) Freshwater Ecology, and (b) Environmental Pollution, both published by Prentice-Hall. Another great source of motivation to Ecology I students are the Ecology II students new at West High School this year. They work as laboratory instructors and help iron out technical wrinkles. To date our students have been featured in Today's Education, which is the National Education Association's official publication. They appeared in the New Hampshire Outdoorsman and were mentioned in many press releases. They were guests and manned the booth for the Deerhead Club of Hooksett, New Hampshire at the National Fish & Game Show held at Concord, New Hampshire in October, 1972.

APPENDIX

ECOLOGY I:

ECOLOGY ENVIRONMENT OF MANCHESTER*

I. Social Ecology

A. Attitudes and Skills

1. Knowledge (factual)
2. Affective concern
3. Action-functions

B. Awareness

1. Go above knowledge
2. Nitty-gritty
3. Communicate

C. Responsibility

1. To the land--to spaceship earth--influence upon environment
2. Man's feelings and involvement--his skills in action

D. Skills

1. Critical thinking
2. Critical issues involved

E. Problem Solving

1. Ecologically
2. Economically
3. Politically
4. Social or all areas of consumer usage

*Curriculum outline for West High School Ecology I classes, 1972-1973. The Ecology II (Advanced Environmental Studies) curriculum follows this report.

F. Environmental Encounters
(by all youth to bring about change)

1. Ask informed people questions
2. Committees of citizens, teachers, youth, administrators, resource people, and environmental consultants

G. Pattern the Project after Tried and True Methods, and Other Successful Projects

1. The Tilton School Water Pollution Program
2. Utilize all available literature of importance
3. Encourage students with useful materials from U.S.O.E. projects on the environment

II. <u>Respect for Your Own Environment</u>

1. As it should be
2. Population explosion--as it is
3. Advanced reading, projects, term papers, book reports
4. Guest lecturers, movies, slides, field trips

III. <u>Inter-Government Relations</u>

1. Published facts
2. Seminar for public and invited consultants
3. Evaluation of the program

IV. <u>Manchester as an Ecosystem</u>

1. Scope and diversity
2. Interrelationships
3. The environmental complex
4. The organism
5. Areas of specialization, geography, geology, fauna and flora
6. Deviations from the norm, energy loss, ecological entrophy
7. Ecological implications

V. The Curriculum Approach

A. Units on Air, Water, Soil, Geography, Geology, Plants, and Animals

Scope and Diversity - Air

1. Air/air composition; usage-pollution, depletion, ecological effect
   Collect fallout samples, examine, discussion
   Photography: burning dumps, smoke stacks, exhausts, trucks, busses, motors, etc.
   Observations: early morning and evenings
   A comparison of various areas by fallout filters, observations, record
2. The organism man--tie in and relate--conclusions
3. The organism plant--tie in and relate--conclusions
4. Films on air pollution
5. Term paper on air pollution
6. Microbiological unit on polluted air
7. Field trips
8. Building a lecture series with colored slides
9. Tobacco--fume fixation of lungs--filteration techniques
10. Evaluation

NOTE: It will take one and a half months to complete the above unit. This will involve two labs a week plus four field trips.

B. Water

1. Water composition, pH, salinity, usages, pollution, depletion, ecological effects
2. Collect samples, rivers, lake, ponds, streams, brooks, run-off, rain, tap water at home, at school, and from public buildings
3. Microscopic examinations, chemical examination, i.e., salinity, pH, chlorides
4. Microbiological unit--culture, growth, stain, etc.
5. The organism man--tie in and relate--conclusions
6. The organism plant--tie in and relate--conclusions
7. Films on water pollution
8. Photography: lake, pond, river, canal, brooks, streams, wells, and sewers

9. Term paper on water pollution
10. Field trips
11. Building a lecture series with colored slides
12. Evaluation
13. Lecture series

NOTE: It will take one and one-half months to complete this unit, and will have two labs a week plus four field trips.

C. Soil

1. Composition, pH, usage, pollution, depletion-ecological effects
2. Collect samples of forest, lawns, gardens, bogs, swamps, riverbeds, field, errosion banks, industrial areas, farms, etc.
3. Fauna and flora, bacteria, molds, fungi, pesticides, poisons, fertility
4. Microscopic examination and macro-examination using U.S. Department of Agriculture sieves
5. Microbiological unit: nitrogen fixing bacteria, subtillis, sulphur bacteria, molds, slime molds, philobulus, worms, etc.
6. Gasses: ammonia, methane, nitrous oxide and other damaging gasseous compounds
7. Photographic unit
8. Films on soil pollution and poisoning
9. Building a lecture series with colored slides
10. Field trips
11. Term papers
12. Guest lecturers from colleges and universities
13. The organism man--tie in and relate--conclusions
14. The organism plant--tie in and relate--conclusions
15. Evaluation

NOTE: It will take two months to complete this unit and it will also have two labs a week plus field trips.

D. Geography and Geology

1. Composition, structure, usage, pollution, ecological effect, depletion, location, accessibility, maps, charts and graphs

2. Collect samples from mountains, gravel pits, riverbeds, soil, ledges, mines, pits, etc.
3. Fauna and flora, i.e., blue-green algae, lichens, mosses, bacteria, molds, and plants
4. Micro and macro examinations
5. Chemical examinations
6. Photographic unit
7. Films
8. Field trips
9. Guest lecturers from colleges, universities, and other resource people
10. Building a lecture series with colored slides
11. Term papers
12. The organism man--tie in--conclusions
13. The organism plant--tie in--conclusions
14. Manchester's place on earth (Reference: Manchester on the Merrimack)
15. Beauty a factor
16. Evaluation

NOTE: It will take two months to complete this unit and it will have two lab days a week plus field trips and lecture series.

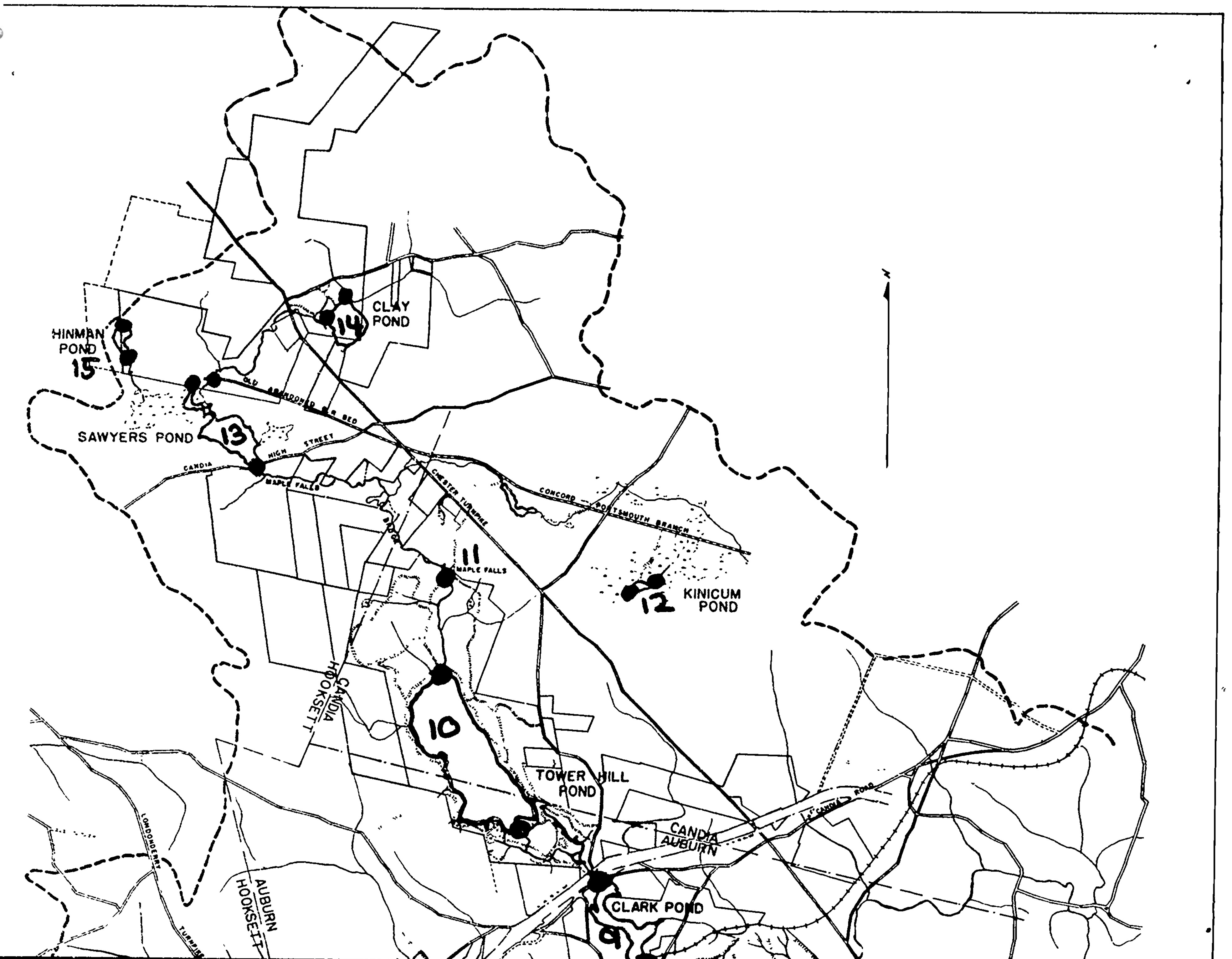
E. Plants

1. Ecological importance
2. Balance of nature-cyclicphotophosphorlation
3. Photosynthesis
4. Energy cycle, ABP, ATP, o_2, CO_2, carbon
5. Pollution and depletion
6. Pestisides, DDT, etc.
7. Watershed
8. Food
9. Competitions
10. Chlorophyll and chromotography
11. Photography
12. Films
13. Field trips
14. Term papers
15. Guest lecturers
16. Taxonomic units, soft woods, hard woods, bushes and shrubs
17. Taxonomic units, bog plants, swamp, lake, pond, field, forest, mountain plants

18. Taxonomic unit--marine plants
19. Techniques in plant pressing and preservation of plants
20. Conservation
21. The organism man--tie in--conclusions
22. Evaluations

NOTE: This unit will take two and one half months to complete and will have two labs a week plus field trips and guest lecturers.

It is the hope of all science teachers at West High School, that after the tie-in of the above units from the ecological point of view and heavy emphasis on conservation, that the students will be able to utilize the slides and give a series of lectures to the community and to fellow students as a community service.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CLAY POND
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SAWYERS POND
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OLD ABANDONED R.R. BED
HIGH STREET
CANDIA
MAPLE FALLS
CHESTER TURNPIKE
CONCORD — PORTSMOUTH BRANCH
11
MAPLE FALLS
KINICUM POND
12
CANDIA
HOOKSETT
10
TOWER HILL POND
CANDIA
AUBURN
CLARK POND
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TURNPIKE
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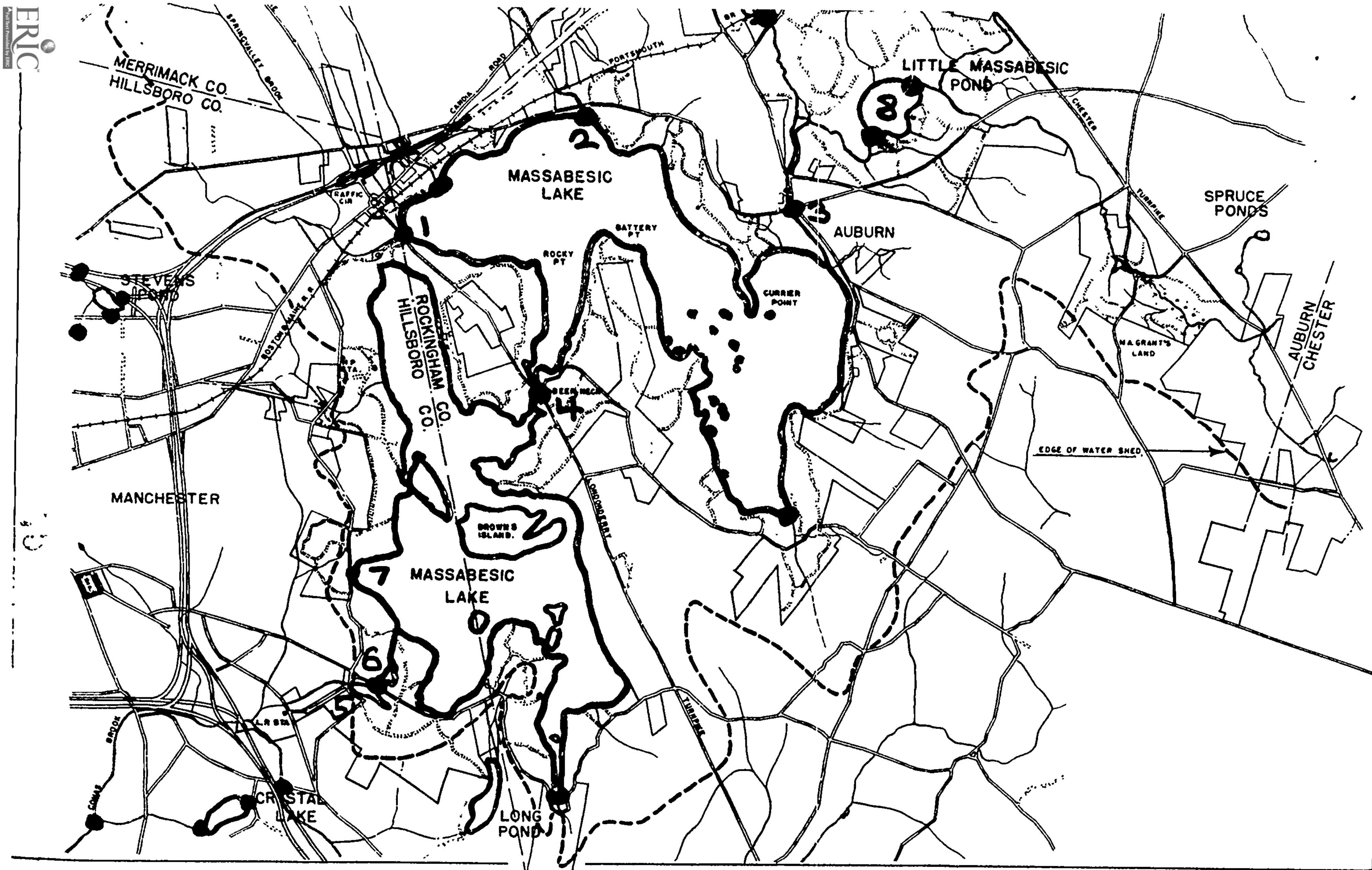


MANCHESTER WATER WORKS LAND

IN

MANCHESTER, CANDIA, AUBURN, AND HOOKSETT

1½ INCHS = 1 MILE

0 1000 2000 3000

DRAWN BY L.A.D 1941
REVISED BY L.A.D. 1949
REVISED BY L.A.D. 1957
REVISED BY H.J.O. 1967

MONITORING STATIONS*

1. Springvalley Brook

This station is located on Candia Road, where the dead end Street, Springvalley starts, just across the Candia Road. It is a rather long brook meandering through two counties, Merrimack and Hillsborough. It parallels the Londonderry Turnpike to the traffic circle at Lake Massabesic and then curves downward toward Springvalley Street. Here it continues in a rather straight fashion, somewhat resembling a canal, until it approaches and enters the lake. At this point it curves back upward. There is another branch of this brook at Springvalley Street that crosses under Candia Road and heads back in the direction from whence it came for some distance. In its approach to Massabesic it cuts through a meadow and swampy area. The brook was 1 to 2 feet deep near the road and got a little deeper as it approached the lake. The flora was scroungy with lots of shrubs, like bushes. There were a few Populas tremaloides, some Myrica gale, two bunches of Red Osier and a few pepper bushes. They must have several septic tanks entering this area, as coliform is always present. Recently we noted discoloration, typical of feces running through the ice. Our coliform counts usually run 100 but have gone as high as 350 per 100/Ml. This area is referred to as a diversionary ditch. It has been confirmed that septic tanks that are faulty do get some seepage through this area. The soil is rather tight and poor in this entire area, as evidenced by the struggle plants have in seeding in. Species diversity is not to be found in this area.

2. Auburn Park

Located on Hooksett Road near Bunker Hill Road. It is a community boat landing, and the flora is reduced to a grassy bank. It is flat and level and supports a few white pines plus an occasional American Elm. During the summer there were a few duck-weed observed and a small cluster of pickerel weed.

*U.S.O.E. teacher training locations for field trips.

3. Griffin Brook

This brook is about 20 feet wide at the collection point, which is where it passes under a bridge at the juncture of Raymond Road and Hooksett Road. This is often referred to as Sucker Brook by the natives of the area. It is a continuation of Clark Pond Brook and Little Massabesic Brook; it is a short brook. The flora in the area is poor. There are a few Typha latifolia and these seem to be the plant of most abundance. They extend in sparse fashion all the way out to the lake proper. Crossing the small cement bridge were a few white posts minus the usual cable. A few pines both Pinus alba, a Popular and scrub make up the rest of the flora, except for weeds, Oenothera biennis (The Evening Primrose), and Verbascum Thapsus (Common Mullein) and one cluster of Solanum dulcamara (Nightshade).

4. Deerneck Brook

The Londonderry Turnpike passes through this area and our collection site lies under a cement bridge with asphalt topping. It is heavily travelled and the flora of the area is poor due to trampling it gets, as this is a favorite fishing spot for many. Barberis vulgaris or common barbary was quite prevalent as its spines keep even fishermen away. Myrica gale, Verbascum Thapsus (valvet mullein), Vaccinium corymbosum (highbush-blueberry), Betula populifolia (grey-birch), and also B. papyrifera, were among some of the other more common forms noted here. This area frequently has a few coliform, but not alarmingly so. Last year our highest count was 136 per 100/Ml. Animal activity, as well as human, is high in this area.

5. The Basin

Next to Johnson Beach and also surrounded by a cyclone fence. It lies under a large stone bridge on Lakeshore Drive, and in view of the Low Power Pumping Station. Stones line the banks as a retaining wall. Ignorant people crossing the bridge frequently toss their 'six-pac' over the bridge.

6. The Mill Pond

This is a continuation of the basin where a canal has been dredged and leads to a small round pond about 500 yards away.

It is reached by returning to Johnson's Beach and crossing an old iron bridge with wooden planking. (A bit on the dangerous side). The flora here is the same as Johnson's Beach, except that when you get into the pond area the typical pond flora is quite abundant. A few Pinus rigida were seen (pitch-pine) near the pond.

7. Johnson's Beach

This station is a flat grassy vale with a powerline crossing it. It is located on Lakeshore Drive, just above the Low Power Station. It is almost at lake level, except for a small banking of about one foot. There is a small stone retaining wall at this spot. The area is lined with Pinus alba (white pine) and some Pinus resinosa (Red or Norway Pines). Other forms include Qurques rubrum (red-oak), Q. alba (white oak), Vitis labrusca (fox-grape), Myrica gale (sweet-gale). A few scattered shrubs dotted the area. Near the road is a cyclone fence and a pipe across the entrance with a Waterworks paint symbol on it.

8. Little Massabesic

A small pond in an advanced stage of eutrophication, which partly accounts for high coliform count on Griffin Brook at times. (Note--this brook on some maps is called Sucker Brook). There are two alternate collection sites as indicated by the red dots.

9. Clark Pond

A partially disrupted ecosystem with fluctuating water levels. It is located near the highway and often has a high salt concentration. Two alternate sampling sites.

10. Tower Hill Pond

Storage pond--clean and protected. It is in a beautiful setting with a variety of hard wood trees. Two alternate sites on either end of the pond.

11. Maple Falls Brook

Farm land borders this brook and some runoff causes fluctuating coliform levels. Highest levels recorded here. It is a rapid running brook that floods in the spring and is a part of the 1800 acre Kinnikum swamp.

12. Kinnikum Pond

A glaciated pond and nestled in a basin surrounded by black spruce, Larch, and an extensive bog. Pitcher plants and sundew abound along with three varieties of sphagnum moss. Wild ducks are often noted on the pond and a heavy population of frogs in spring and summer. The yellow grass flower and the white grass flower, both relics of the ice age, are found here also. Mary varieties of Viburnham and blueberry along with vast fern glades make this a botonical paradise.

13. Sawyers Pond

Now part of Dube's pond, a man-made pond that has flooded Sawyer's Pond extensively. Button bush, and leather-leaf abound. Two sites for sampling on an alternating basis.

14. Clay Pond

Located in Candia, New Hampshire, it is a pond of great beauty. It is rich in fauna and flora. The water is clear and free of odor or taste. A very clean spot.

15. Hinman Pond

A very small pond with access only by snowmobile in the winter. It is the most remote part of the Manchester watershed. Two alternate collection sites.

Environmental Studies Program
U.S.Office of Education Grant
#OEG-0-73-5422

St. Anselm's College
in Cooperation with the
Manchester Public Schools

ENVIRONMENTAL STUDIES GUIDE

ENVIRONMENTAL STUDIES PROGRAM
ST. ANSELM'S COLLEGE - MANCHESTER PUBLIC SCHOOLS

HIGH SCHOOL ECOLOGY CURRICULUM*

The planet on which humans live, the only planet as being capable of sustaining life, may very well be true. We do know that when the astronauts cleared the far side of the moon, they let out expressions of great joy because the first thing they sighted was Mother Earth. It was not like Browning's, "Off in the Northeast Distance, Dawned Gibralta, Grand and Grey." No! Their hearts swelled to the most beautiful "Blue Orb" man has ever laid eyes upon. This is history. What man, woman or child has not thrilled to reproductions of their photography? The beautiful blue orb, with its fleecy white cloud cover and the color contrast of ocean, sea, lakes, mountains, and all that make our world a place of beauty, instead of the barren grey that meets the eye of the astronaut approaching the moon. How long will it take man to duplicate the moon colors?

Back here on earth, our slice of the "blue orb", America the Beautiful--for how long? "From sea to shining sea." Oh! Is that right? We have heard rumors! "The Pacific is Terrific and the Atlantic 'ain't' what it's cracked up to be." That's right! The Pacific is in a terrific state of cultural etrophication, from oil spills, sewerage, chemicals and other man made affluents. The Atlantic--the poor Atlantic! Oxygen content down 12% and dropping, New York sewerage combined with Texas oil and chemicals from the entire eastern seaboard, have sounded the Cheney-Stokes** Can man turn back the evil-tides of man in time to prevent eco-catastrophy? It is our fervent hope and desire that we can, and to this end dedicate this guide. This is not a panacea; it is a guide where we hope teachers and students together, can find the approach best suited to their own phenomonology and their own niche. We hope it leads to greater concern and much more action in an attempt to improve the environment.

* By James A. Hall, West High School, Manchester, NH
**Death Rattle.
Draft: March 1, 1973

THE APPROACH TO THE GUIDE

Although this guide will contain the quite often traditional ten chapters, it is be no means traditional, nor is it intended to be. Rather, it is hoped that it will be a new and innovative approach. With this in mind, we introduce the "Mini-Chapter." The "Mini-Chapter" is an approach wherein, many chapters, never less than three, are so grouped that a teacher, any teacher, but in particular those who are harrassed by double sessions, short modular runs and overloaded classes, can lift out a section, knowing he can finish that unit without a major break. Thus, he can be working on Chapter One, Mini-Chapter A, "Climates of the World." He does not have to make a checkmark, or any particular note of where he left off. He merely decides how much time he wishes to spend with that mini-chapter, and sets it up in that manner. Then he has more time if he desires to consult just those references that pertain to the unit under consideration. He can stop here and introduce maps, graphs, charts, movies, or perhaps a field trip to a weather station. At the conclusion of Mini-Chapter A he can move on to Mini-Chapter B, "World Vegetation," or he might wish to skip that temporarily and proceed to Mini-Chapter D, "Weather Bureau Records and Interpretation," or perhaps Mini-Chapter F, the "Hydrologic Cycle," and to return later to one of the other Mini-Chapters missed.

References will be found in the back part of the guide by categories, i.e., movies, slides, books, magazines, articles, and places. Equipment needed or recommended will be listed at the end of each chapter along with the necessary chemicals and supplies. There is coverage of equipment needs within the instruction sheet to the students, section B. This area is concerned, however, with methods of improvision in the absence of the needed items. This section also covers the need and use of a day-by-day log, and the forms available or that can be reproduced at little cost. Another important area of coverage is the permission slips and their use. For any Ecology or Environmental Education Class to function correctly and with efficiency, the instructions set forth in these sections must be adhered to without exception.

INSTRUCTION SHEETS TO THE STUDENTS

THE DAILY LOG

It has been said that a teacher without a lesson plan is like a ship without a rudder (to drift to and fro--to toss hither and yon--devoid of rhyme or reason). We must have a purpose in life; we must be headed in a direction or on a course (that we can use as a guide), that has some degree of certainty built in. We can turn back to this course on occasion to check our bearings and our progression.

There is a parable whose source is probably lost in antiquity, but it still applies to the modern student of today and modern man:

> "The old man, tired of his journey across the great plains, stopped as evening approached, and built a fire to cook his evening meal upon. He filled the coffee pot with water, and added coffee, set it over the fire and got out his fry-pan, thinking of the tasty prairie hen eggs, and saltback he would soon partake of. When he returned to the fire, he discovered that his fire was too small and there was no room for the fry-pan. He went in search of buffalo chips with which to enlarge his fire. When he returned he discovered a spark had ignited grass some distance from the main fire. Oh, well! I might as well put the chips on that fire and fry the eggs and saltfack over there. So he put the chips on the second fire and started his eggs frying. Then he discovered there was not enough room to fry the sourdough bread. But wait, another spark had started yet a third fire, so with a few hastily collected buffalo chips he prepared his fire for the bread. He had just finished this chore when the coffee boiled over, and while he was running to care for this, his saltback and eggs started to burn. Smelling the burning food he raced back to the eggs. By now, the coffee had boiled over and put out one fire, and his eggs and saltback were charred. As he lifted the fry-pan from the fire he smelled burning bread and grass. His

bread fire had blazed up and spread into the nearby high grass. He now had a prairie fire going and everything was out of control."

Let us not let our journey into the science of ecology get out of hand. Let us instead keep our field trips and our laboratory sessions orderly and under control at all times.

To do this you must follow a few well laid plans and stick to them. First is the Daily Log. This can be an elaborate book professionally lined and laid out, or a plain notebook that you line yourselves or, better still, a Day-to-Day Log that is compiled of neatly ruled sheets, that can be removed and slipped to a string over the blackboard as needed and for a quick reference back to improve the forward thrust. These sheets would contain headings over blocks for specific data and possibly a side column with other important data. As an example, whenever you work outside on a field trip, even if it is just in back of the schoolhouse, we record among other things, (a) wind velocity, air temperature, cloud coverage, i.e., hazy, sunny, overcast, and climatic conditions as rain, snow, sleet, mist, and physical conditions such as dew, wetness of soil, dryness and vegetation or perhaps a listing of fauna and flora both; (b) on a lake, pond, or river, wave action, and factors such as substrate as well as temperature of the water, fauna and flora. These are all important to a good report if it is to be valid and of use to the fullest measure. The log should list the name of the instructor and the period or class involved, in the upper left-hand corner at the top of the page, plus the date, time of day, and the year. In the right-hand upper corner, list the climatic conditions and the area by name. Example: Steven's Pond, Manchester, New Hampshire, sunny, clear, temperature 70°F, wind, 5 MPH south/westerly. Under each column on the sheet, fill in the data as requested. These sheets become a permanent record to refer back to during the project and in months and years to come.

Graph sheets and various diagrams may be drawn and duplicated and attached to each sheet by staples. Mini-reports and necessary comments may also be added on the reverse of the log-sheet, in which case you should write "See Over" or "See Reverse Side of this Sheet--Important Data" in red ink at the bottom of the log-sheet.

If collections were made, type of collection, or specimen should be noted on the sheet and disposition or results of examination of this specimen recorded. Finally, prepare enough sheets so you have a work sheet, and one you can reproduce neatly after you are through recording the necessary information. What good are the sheets if others cannot read them, or if they are sloppy, blurred, water stained, etc.

EQUIPMENT NEEDS

Quite naturally, the needs will vary with the type of environmental education a person is covering at a given time. It is also obvious, that certain equipment is a vital need at certain times of the year, whereas you could go without or substitute at another season. For example, rubber boots in the winter if you are studying water pollution of a lake, whereas in summer, an old pair of tennis shoes will suffice. There are, however, certain items that one should always have in a good ecology course. Listed below are some of the more important, placed under the area you would use them in.

Water Pollution Studies: Rubber boots, (an old pair of sneakers in warm weather), clipboard and paper to write upon, necessary charts or graphs, a good ball point pen and a #2 pencil, insect repellent, sunburn lotion, plankton net, dissolved oxygen sampler (DO bottle), carrying case with necessary bottles for each case or type of study to be conducted, necessary chemicals to run the tests desired, a hand portable colorimeter, droppers and pippettes, graduated flasks, thermometers both C^{o} and F^{o}, a boat of some kind if possible (perhaps a boat can be rented or borrowed), a Secci disk, depth line, tape measure, meter stick, funnel and colored bottles to return water to the laboratory. This is not by far a complete listing; however, it is more than enough to get the show on the road. True, if you have the money, you can buy HACH kits and everything is included for chemical testing of water. Also, Millipore equipment may be purchased if you are looking for the greatest degree of accuracy in the microbial ecology of water studies. But, at the end of this section, it is our desire to list how certain basic items can be made, along with some crude drawings of these items and materials in their construction.

Air Pollution Equipment: Again, much of this equipment can be made or you can purchase the more professional type of equipment from a number of sources.

First, a particle sampler, a device where the atmosphere can be introduced with force bringing along with it the various size particles. This can be constructed of various materials using filters of everything from cheesecloth to parachute silk. Some may employ fine copper and brass mesh screening, depending upon the type of particles to be collected. Fans can be used, circulators, or motors, anything to pull or force the air onto the screens or filters. Large size tin cans with a variety of filters can be used for fall-out matter. Another important devise is some form of a gas sampler. Chemical samplers are the most efficient types and again may be purchased or made.

Cloud chambers and Inversion chambers are also important devices in understanding smog movement and natural cycles. Another device that is of value in detecting certain pollutants that destroy rubber and other fabrics is the Louvered Shelter, which also may be made in the laboratory. The U. S. Public Health Service has a device that determines air pollution levels. It is a rather high-volume type of a sampler that employs fiberglass filters that entraps the particles for analysis--this may be copies with ther permission. Another item of value, and one that has long been made in the schools of America, is the ozone generator. Many books give their version of how to make this equipment.

A useful item(s) in any good air pollution course is a variety of good cameras to collect on film rare moments or common occurences. There are many devices in use today, but we will let it suffice with a coverage of those less expensive to make and those that will illustrate a point of contention clearly. Diagrams will appear at the end of this section, and references where the equipment may be purchased.

Soil Pollution Equipment: Department of Agriculture sieves, good spade to take samples with, pestiside and herbicides kits (to detect such as 2, 4-D, 2, 4, 5-T), soil bacteria kits (culture media specific for soil organisms), media specific for biotic communities common to soil (molds, fungi), core borer or soil sampler (profile in the rough and traces seepage), water samplers and filters for run-off water and underground water.

Equipment for monitoring soil pollution is, for the greater part, non-existent and you may use those that are used in other testing procedures as they apply.

PERMISSION SLIPS

Permission slips are most important and should be taken care of whenever it is practical during the first week of school. One such type would be a typewritten form for the students to take home. The parents would sign a statement giving the student permission to attend all field trips in ecology class for the year. It could be made out by the teacher or the principal, or both. It could read as follows:

> "I, Mr./Mrs. ____________, do hereby give permission for my son/daughter ____________ to attend all field trips to be conducted by the ecology class for the rest of the school year. I further assume all responsibility for his/her welfare while on these trips. I further agree that I will not hold the school responsible for any injury, illness, or accidents that might befall my child as a result of one of these trips. It is understood that the teacher(s) in charge will make every attempt to keep things under control and avoid excessive dangers."
>
> Signed ________________________
>
> Address ________________________

This is a preferred slip when it can meet with approval as it is a "one shot" deal. However, some principals and some parents want a slip for each occasion. One merely modifies the above slip to fit the need. Prepare the slips well in advance, as the teacher usually has one or two slow students who have to be reminded to return the permission slip. If a student fails to bring in a slip, the teacher should, under no conditons, allow him to go on the field trip. Put him in a study-hall or give him a library slip. The only other recourse would be to have someone in the Guidance Office call the parent and get verbal permission. This is, however, most undesirable.

Another form of permission slip is the requesting of students to be excused from a class. This is rather ticklish as some people consider their course high above all others in the school and will "kill the deal" unless the teacher interceeds in behalf of the student. Usually all teachers have one trip planned for the year so a gentle hint is in order. One hand washes the other--give and you shall receive. This is important to break the ice, otherwise a teacher might commit him or herself before other teachers that they will not comply with the student's request. Principals quite often will back off and say, "My hands are tied. What can I do? She is a fine teacher, dedicated. I just cannot force her! Why don't you leave the student behind? You won't miss one." This could evoke a chain reaction. Parents are angry because their child was left behind and are angry at the other teacher for not giving permission, and the principal for not being firmer. If you break the ice first, then the student has easy sailing. In most cases, don't overlook study-hall teachers or homeroom teachers either, as now and then we find a sensitive one around.

The next type of permission slip is the one giving the student permission to use the family car, or his own car, as he is a minor. This slip should also have a statement that they further give him permission to carry other students in the car. Students without a car should have slips wherein the parents gives them permission to ride with other students. There will be other slips, and as they occur, the important thing is to give them some thought before you make them out and always get them out three or four days before the trip, in order to arm yourself with prodding time for the slow returnee. In controversial cases, try to break the ice yourself in as gentle a fashion as possible. At all cost, be amiable and do not leave a parent angry at you. After you receive the slips, file them with the department chairman and ask him to keep them until they are invalid.

DANGERS

Dangers exist everyday in the school, but field trips that are not under control can produce a real problem. Therefore, any teacher who is about to enter upon a field trip (assuming permission slips, etc. are in order) will first take a roll call and assign students to cars. This is best done when the names are written down and left with the principal or assistant principal, clearly stating which car each student is in. Inform them to walk (not run) down the stairs and out the door. Otherwise, there will be a stampede and the noise could provoke other teachers who are teaching--especially if they are inclined to look for trouble. You should also tell the students to get into the cars and line up in back of the teacher(s). No "burning of rubber", no horns, and no passing--follow the leader type of thing. Also before leaving, assign each student the equipment he is responsible for, and check to be sure everything is in order before leaving. Remember, they are excited. There is yet to be a student who did not love field trips.

If the field trip is to the lake, water dangers prevail. If in a boat, do not overload and observe all safety rules. Be sure to utilize your most competent and trained people, and be sure they are as concerned about safety as you are and are willing to enforce all rules. Be alert to broken glass, jagged tin cans or other such dangers, and caution students that to not comply with safety rules is a breach of technique, as the field trip is an extension of your class. To fail to comply is to fail the course. Keep a sharp eye out for poison plants--alert your students and be sure they become familiar with them. Before you leave, check to find out if anyone is allergic to weeds (if it is the season), if they are asthmatic they should not be asked to take the trip without a special permit slip from the parent or doctor. In fact, it is a good policy to review all dangers with the students before leaving a day or two in advance. Finally, if you are in dense woods, remember some people get turned around easily, so be sure the students all stay together or have a trained student with a compass assigned to each group when it is necessary to separate.

OVERVIEW OF AN ECOLOGY CURRICULUM*

The purpose of this paper is to supply the new teacher to ecological studies with an approach. This paper will be written using a standard ecology text as a guide. One does not have to feel obligated to use a text, as units or sections may be lifted out of any text, syllabus, pamphlet or other reference sources. Many paperback ecology books are to be found today and most contain the fundamentals one may seek.

It is important, however, that the student, early in the course, become familiar with the language of ecology as most authors use the classical ecological terms. If it is a full-year formal course as opposed to an interdisciplinary approach, then a text will be found invaluable. Whatever is used in the form of a book, it is hoped it will be used as a tool or aid and not as the major component of the course. Ecology is a course the students can "tune in and turn on to" if the field and laboratory approach is used. The real classroom is the great outdoors! The largest laboratories in the biosphere are outdoors! Outdoors is where the action is! Get the students out as much as possible.

In every school there is the teacher who stands out in NEGATIVISM, who stands by at staff meetings to throw cold water on any suggestion. Not to dwell upon the issue, but just to use an example--"Field trips! My God! What will you do with them in the winter? I think we are setting ourselves up for a lawsuite! The kids I've seen at this school are very poorly dressed and most of them would be candidates for a bout with pneumonia if taken on a field trip! Even in the spring or fall they will probably cut themselves on broken glass, prowling around in the woods, or one of them will drown out in the lake!"

Admittedly the above is the epitome of negativism; nevertheless, it was spoken in basically the above structure, by a teacher, in the presence of other teachers and administrators. Needless to say without prior ground work, i.e., talks with the superintendent, principals, department chairmen and even school-board members, in the face of an attact like that presented above, one would be shot down quickly, despite a well planned delivery and a quick rebuttal.

*Teacher's guide for Environmental Studies.

Ecology is needed--in fact, it is urgently needed. It was needed twenty years ago! Plan your talk with your principal and superintendent with coverage of all possible danger areas minimized. Talk to a few teachers who have good working programs and find out how they got around these obstacles. Today, most administrators are alert to the need of an ecology course or some form of ecological studies program. Give them a brief but meaningful coverage of the goals you hope to accomplish, the essence of what you hope to impart to your students, and at the same time assure them of your built-in safty factors. Have prominent citizens standing by to back you and endorse your proposal. Once you have their approval and are on your way to a m 'orable journey with your students, plan your program in order that you, as well as the students, may savor every moment of all nature has to offer you out in the "nitty-gritty" or back in the classroom.

Tuesday, September 4, 1973: Meet the class-introductions--rap session. Find out what your students know about ecology. What is their greatest area of interest? Get them all involved. Pick a local issue that is considered controversial. Ask them to return tomorrow with all the facts, ready to discuss the issues. List your requirements, i.e., a good looseleaf notebook, pencils, and pens. Find out what kind of protective clothing they have, such as rubbers, raincoats, gloves, overshoes, etc. Find out who might have a problem getting protective clothing.

Wednesday, September 5, 1973: Continue the rap session, encourage all students to talk. Get them enthusiastic for the course--tell them of a few of the interesting trips, labs, speakers, etc., they will enjoy during the course. Issue the text book or books and assign the preface or introduction as point for rap session on following day.
Note: Most ecology classes of a year's duration have laboratory classes on either Tuesday and Thursday, or Monday and Wednesday. This gives the teacher two classes back to back, and allows for local field trips nearby.

Thursday, September 6, 1973: (Period A) Coverage of the preface or introduction to the text. Give coverage to the subdivisions of ecology--its origin, derivation of the word ecology, and some key words and expressions for the notebook--words that are part of the language of ecology that we must know to continue our readings in environmental studies.
(Period B) A walk around the school grounds. Sensitivity session, a feeling for nature. Is the school ground an ecosystem? Part of an ecosystem? Are there many ecosystems on the school ground? Collection of data--notebook and pencils or pens are required.

Friday September 7, 1973: Chapter I, The Scope of Ecology. Develop the chapter; pull out the essence factors, having maximum involvement by the students. Tell them what terms should be in their notebooks and issues in the chapter you will be expecting back on recall. Plan a class discussion over the chapter for Monday asking the students to be ready to use the terminology of the chapter in their discussions.

Monday, September 10, 1973: (Period A) Class discussion of chapter I. Stress use of terms that apply in all rap sessions, leading to greater knowledge and ease of understanding in other readings and discussions.

<u>Tuesday, September 11, 1973</u>: (Period A) Develop the concept of <u>The Ecosystem</u> and assign Chapter II.
Note: In most texts this is in Chapter I or Chapter II.
(Period B) Take another stroll around the school yard and review local ecosystems.
Note: It is important at the onset to let your students know that the field trips and laboratories are extensions of the classroom and not a place for gaity or frivolity. Tell them they are being marked on participation, attentiveness and production. Stand by this statement and be firm in this area or your class will be doomed to failure, due to the immaturity of some and the newness, and informality of field trips.

<u>Wednesday, September 12, 1973</u>: (Period A) Continue Chapter II, <u>The Ecosystem</u>. Cover and stress the various trophic levels and the organic and inorganic components of an ecosystem. Emphasize the ecosystem from a functional standpoint, i.e., (1) energy circuits; (2) food chains; (3) diversity patterns in time and space; (4) nutriment cycles (biogeochemical); (5) control (cybernetics).

<u>Thursday, September 13, 1973</u>: (Periods A & B) Field trip to the pond or river. The pond (any pond small or large) is an excellent choice to re-enforce your lectures and coverage from the text, on establishing a mental picture of the pond as an ecosystem. Very early at the pond, the student will discover that all the components listed in the text as comprising an ecosystem are all present. The living or biotic, the nonliving or abiotic substances, the producer organisms, i.e., plants, plankton, etc., the microconsumer organisms and the macroconsumer organisms and of course the saprotrophic organisms or decomposers. Have the students look for each of the above components or illustrate its presence. This should be a relaxed trip, where the student confirms what the author has stated in the text. It will add greatly later to his appreciation of the text and set the stage for true research. It is a do-it-yourself world, and most of us live the greater part of our lives before we discover this or accept this fact. Let's stop crippling our students intellectually! Let them do it!

<u>Items Needed for Field Trips</u>:

1. If warm weather, old tennis shoes that can be thrown into the washing machine if soiled and no damage is done. If cold, rubbers or overshoes for foot protection.

Note: If possible, at least two or three students with hip length boots to assist teacher with collections in deeper water.

2. Insect repellent.

3. Collection equipment: small stoppered bottles, gallon plastic jugs, a vasculum to hold plants, i.e., algae and larger plants extending into the water, a shovel and a soil sampler, a camera (if possible) with colored film and a portable tape cassette.

This is all that is needed on the first trip as it is an introductory trip to field ecology. The collected items will be taken back to the school and placed in the refrigerator for Friday's class.

Transportation depends on what one has available. Some teachers plan a trip two weeks in advance and recruit parents with cars who give of their time, car, and gas. Others have fellow teachers assisting or in some cases, the principal will allow senior students with parental permission to drive the students, with all drivers following the teacher in the lead car. Some schools have busses or they are supplied by the School Department.

Friday, September 14, 1973: A microscopic analysis of the life present in the collected water, of both plant and animal forms should be the first order of the day.

Note: Make sure your students all understand the proper use of the microscope.

This can be done by one group of students while another group does scrapings on the plants and disections also looking for animal life and epiphytic forms of plant life. A third group can be working upon the soil. Standard references such as "Freshwater Ecology" by Prentice-Hall can be used for plant and water studies, or any other of the reference, i.e., "Freshwater Algae," U.S. Department of Health, Education and Welfare. The Environmental Protection Agency also has much free literature in this area. As to the soils, many texts and references are available at the public library, and from most soil services. (Even the crudest approach, diluting the soil with water and examining it under microscopy, will yield life forms to support the ecosystem concept). You will not be able to complete this all on Friday, so you can save what you have and continue on Monday, or have students volunteer to bring in fresh samples for Monday's continued analysis of life in a pond.

Monday, September 17, 1973: Continue analysis of life in the pond. Make lists for each type of life, plant or animal as

students find and classify them. Have them put these in their notebooks for future reference and to add to other finds at the same pond throughout the school year.
Homework assignment: have students, using their notes and only with the materials found at the pond or from the analysis of what was collected, write a paper, "The Pond is an Ecosystem." Defend the title by showing in what ways your pond conforms to the text's definition of an ecosystem. Paper due tomorrow, Tuesday September 18th.

Tuesday, September 18, 1973: Have selected students read their papers. Ask others to list some items they included that others left out. (This should take most of period A and perhaps into period B.
(Period B) Have a student come to the front of the class and give an oral report on what an ecosystem is comprised of. In the time left discuss other ecosystems briefly. Use examples such as a meadow, forest, field, desert, or the ocean.

Wednesday, September 19, 1973: A brief lecture on other ecosystems and coverage of homeostasis of the ecosystem. A good reference is Odum's "Fundamentals of Ecology, 1971 (Saunders, Philadelphia). Ask students to finish the chapter and announce the first test for Friday on chapters I and II, plus notes.

Thursday, September 20, 1973: Review and individual assistance to students who feel a need.
Note: Some students are shy, and if you can select, early in the year, bright students who wish to assist you on these individual help days as class tutors, you might save a youngster from not passing.

Friday, September 21, 1973: Test for the full period.

Monday, September 24, 1973: Review the test and announce the make-up day. Tie up any loose ends on the concept of an ecosystem.

Tuesday, September 25, 1973: (Period A) Lecture on the watershed unit, page 16, Odum. Include the biological control of the chemical environment and a brief coverage of production and decomposition in nature (Odum, Chapter II).
(Period B) Introduce concepts relating to energy in ecological systems. Develop concepts of food chains, food webs and trophic levels (Odum, page 63 to end of chapter III).

Wednesday, September 26, 1973: Continue food chains discussion with class imput on types, and how they are destroyed. (Lead to water pollution). Class should end with enthusiasm and eagerness to continue talk tomorrow.
Dirtiest river, pond, or lake is a good area to bring in during this session. Have students bring a jar or bottle of water from a dirty pond, or some other polluted body of water, for tomorrow's analysis in the lab.

Thursday, September 27, 1973: (Period A) An introduction to water testing.
Test #1 - Dissolved oxygen test (HACH kits recommended). If not available, go to the standard testing (Winkler method).
Test #2 - pH test, HACH kit, or standard methods.
(Period B) Significance--what does it tell us? Why are these tests important?
Homework: Write to the Environmental Protection Agency and ask for free copies of "Water Quality Standards"; have three students do this. Write to the State Water Pollution Board and ask for copies of the "State's Water Quality Standards"; have four students do this. Have five students write to the U.S. Department of Health, Education and Welfare asking for all free materials on water pollution. Have five students write to the Department of the Interior, Water Pollution Division, asking for all free materials on water pollution. Have the remainder of the class write to the State Soil Conservation Board for any materials they have on soil pollution. This is also a good source for maps of your area.

Friday, September 28, 1973: Continue water testing; introduce other tests; CO_2 HACH kit or standard methods; chloride; turbidity. Other good references for doing these tests other than standard methods would be "Freshwater Ecology" and "Environmental Pollution" by Prentice-Hall and the American Public Health Association, 1965. Standard methods, for examination of water and waste water including bottom sediments and sludge (12th edition), American Public Health Association, Inc., New York, page 769.

Monday, October 1, 1973: Guest speaker from the State Water Pollution Board.
Note: Require students to take notes and try to come up with some good questions at the conclusion of the guest speaker's talk.

Tuesday, October 2, 1973: (Period A) Continue water testing. Bring in water from same source as before.

Test #1 - Total acidity, free acid (acidity-alkalinity) HACH kit. Be sure to watch the students for technique. Although HACH kits are cookbook in approach, the students sometimes attempt to take short-cuts unless watched closely. Record all data and compare to EPA standards for meaningfulness.
Test #2 - (Period B) Phosphate test (meta-ortho & poly) HACH kits. Refer to EPA Water Quality Standards for the meaningfulness of this test. Assign the students to read pages 93, 94, and 95 in Odum "Fundamentals of Ecology", 1971. Discuss your results.

Wednesday, October 3, 1973: Develop chapter IV in Odum's "Fundamentals of Ecology". Emphasize the biogeochemical cycles, especially the nitrogen and phosphorus and the CO_2 cycle. Assign the chapter and announce quiz for Friday on chapters III and IV.

Thursday, October 4, 1973: Review essence factors on chapters III and IV. Allow time for tutorial and individual help in Period B.

Friday, October 5, 1973: Test on chapters III and IV, plus notes.

Monday, October 8, 1973: No school--Columbus Day.

Tuesday, October 9, 1973: (Period A) Discuss the test results. Develop chapter V in Odum, "Principles Pertaining to Limiting Factors."
(Period B) Main essence factors, Liebig's "Law of the Minimum," and Shelford's "Law of Tolerance." The major limiting factors: temperature; light; water; temperature and moisture acting together; atmospheric gases; biogenic salts, macro and micronutrients; currents and pressures; soil; fire as an ecological factor.

Wednesday, October 10, 1973: Movie "The River." Have students take notes for discussion.

Thursday, October 11, 1973: (Period A) Rap session on the film "The River." How does it compare with our own river? Who is to blame that the Merrimack River is one of the ten dirtiest or most polluted river in America?
(Period B) Guest speaker from West High School's Social Science Department. (Mr. Roy ??). Possibly Professor Michael Dupre of St. Anselm's College Sociology Department.

Friday, October 12, 1973: Analysis of the speaker's talk. Assign chapter IX from Odum, "Development and Evolution of the Ecosystem." Develop the chapter. Essence factors: ecological succession; climax stages; food chains and food webs; nutrient cycling; over all homeostasis; ectocrine theory of succession; concept of the climax; human ecology; pulse stability; detritus agriculture.

Monday, October 15, 1973: Continue with chapter IX from Odum's "Fundamentals of Ecology" 1971 edition.

Tuesday, October 16, 1973: (Periods A & B) Field trip to the river (walk).
Tests: air temperature, water temperature, turbidity, dissolved oxygen, wind velocity, time of day, date, month, etc.
Note: We are starting now with the accurate recording of all data. Up until now the students have been testing with HACH kits and other methods, but have only been trained to get an accurate test reading for a specific test. From this point on all factors that have interplay or that alter in any manner must be recorded. The above listed tests will always be recorded from now on plus whatever tests the teacher assigns them.
CAUTION: The river is dirty and has a high coliform count. Make sure all understand and use extreme caution. Clean all instruments after the tests yourself. Repeat--do not let the students clean the instruments until after they have had a lab session on the proper handling of contaminated tools and instruments. Bring water back and refrigerate it at 40°F until Wednesday.

Wednesday, October 17, 1973: Discuss the river water tests. Run the remaining tests and introduce the students to Millipore membrane filtration techniques by using the Millipore experiments in the microbiology test kit. Demonstrate the kit and do a petri dish on coliform. Explain the media used and the reason for the reaction. Standard microbiology techniques may be used. Regular agar and petri dishes.

Thursday, October 18, 1973: (Period A) Check the Millipore petri dishes for coliform, set up a grid and count the colonies. Subculture to various media and large regular petri dishes. Do a slant with a stab for gas bacillus in four tubes and streak the other plates. Run a gram stain from the petri by Millipore. Read under oil immersion. Explain your demonstration as you proceed.
(Period B) A special demonstration lecture on how to handle glassware and equipment that is higher contaminated with bacteria or poisons. Assign chapter XI "Freshwater Ecology", Odum.

Friday, October 19, 1973: No school - teachers' convention.

Monday, October 22, 1973: Develop Chapter XI, "Freshwater Ecology."

Tuesday, October 23, 1973: Walking trip to the Merrimack River, both periods. Testing and observing (lotic-running water) in accordance with Chapter XI. Complete tests not run on prior trip; chromium, sulfa, silicon and detergent. Complete the usual field trip forms; location, date, time, temperature, wind, physical and chemical conditions to the degree time allows. Record all data taken.

Wednesday, October 24, 1973: Continue Chapter XI in Odum. Cover the major niches based on their position in the energy or food chain. Autotrophs, producers, heterotrophs: phagotrophs (macroconsumers) herbivores, predators, parasites, etc., saprotrophs (microconsumers) decomposers-fungi and bacteria. Announce quiz - "Laboratory a Practical with HACH kits." Be prepared to do three 'your choice.'

Thursday, October 25, 1973: (Period A) Lab quiz on HACH kits. Student is allowed to select the three he wishes to do but must realize the next three will be the choice of the teacher.
(Period B) Continue the lab quiz.

Friday, October 26, 1973: Finish the lab quiz using HACH kits.

Monday, October 29, 1973: Continue Chapter XI, Odum. A coverage of organisms as to their life form or life habitat, i.e., Benthos-Periphyton (Aufwuchs), plankton, nekton, neuston. Finally, classify them as to region or subhabitat, i.e., littoral zone, limnetic zone, profundal zone; as for streams as to rapids or pool.

Tuesday, October 30, 1973: (Periods A & B) To Stevens Pond to view the various zones and subhabitats and some of the organisms. Compare what we find and contrast with the authors' listing.

Wednesday, October 31, 1973: A review of Chapter XI to date, and a review of our discoveries at Stevens Pond.

Thursday, November 1, 1973: (Period A) Continue with Chapter XI, Freshwater Biota (flora and fauna). Lentic Communities, pages 303 to 309.
(Period B) Review HACH kit tests--final HACH kit quiz, teacher's choice. Individual assistance to those in need, tutors assisting.

Friday, November 2, 1973: Final lab quiz on HACH kits. Full period.
Note: Water samples have been tested by three science teachers in AM prior to the tests. Allowances for temperature changes, etc.

Monday, November 5, 1973: Continue Chapter XI, types of lakes, stratification, impoundments, ponds, lotic (running water communities), currents, substrates, springs, zonation in streams.

Tuesday, November 6, 1973: (Period A) Complete the chapter. Announce a review for Wednesday and a test covering Chapter XI for Thursday.
(Period B) Film, The Death of a Marsh from the West High School Science Film Library.

Wednesday, November 7, 1973: Review Chapter XI. Assistance to those in need--tutors assisting.

Thursday, November 8, 1973: Test on Chapter XI, periods A & B.

Friday, November 9, 1973: Review the test and announce make-up day. Give the students the guidelines for the first term paper. Title is World-Wide Pollution. Paper is to be eight to ten typewritten pages, or twelve to fifteen hand-written pages. Due January 31, 1974.
Required reading is: The Population Bomb by Paul Ehrlich, 1968, Ballantine Books, Inc.; Silent Spring by Rachel Carson, 1962, Houghton Mifflin Co., Boston; The Environmental Handbook and your text, Fundamentals of Ecology, Odum, 1971.

Monday, November 12, 1973: No school. Veterans Day, formerly Armistice Day.

Tuesday, November 13, 1973: (Period A) Start a new unit on pollution (water, air soil). What is the scope? have students rap--find out depth of their knowledge on this area. Have them bring in an article for tomorrow.
(Period B) A stroll around the school grounds. Do we have pollution at our school? What forms? What can we do?

Wednesday, November 14, 1973: Continue the rap sessions on pollution.

Thursday, November 15, 1973: (Period A) Guest speaker from the Fish and Game Department. Title, "Pollution and its Effect on our Wildlife."
(Period B) Rap with the speaker.

Friday, November 16, 1973: Lecture by Mr. Hall on air pollution, health factors, economic factors.

Monday, November 19, 1973: Speaker on "Air Pollution in New Hampshire" from the State Air Pollution Board. Rap with the speaker.

Tuesday, November 20, 1973: (Period A) Film on air pollution. (Period B) Rap session on air pollution, busses, mills, other forms.

Wednesday, November 21, 1973: Final rap session on pollution.

Thursday & Friday, November 22 & 23, 1973: No school. Thanksgiving recess.

Monday, November 26, 1973: Introduce the students to "Marine Ecology", Chapter XII, Odum. Develop coverage of the eight major features of the sea.

Tuesday, November 27, 1973: (Period A) Film, "The Restless Sea." (Period B) Continuation of "The Restless Sea."

Wednesday, November 28, 1973: Rap session on the film and the sea in general.

Thursday, November 29, 1973: (Period A) Continue Chapter XII, "Marine Biota and Zonation in the Sea."
(Period B) A quantitative study of plankton and the communities of the marine environment. Announce a review for tomorrow.

Friday, November 30, 1973: Review all of Chapter XII to date. Announce a quiz for Monday. Tutors assistance and individual aid.

Monday, December 3, 1973: Quiz on Chapter XII to date, pages 324 to 343.

Tuesday, December 4, 1973: (Period A) Continue Chapter XII. Develop marine sediment profile, mangroves, coral reefs, and communities of the oceanic region.
(Period B) Finish Chapter XII "Marine Ecology."
Announce field trip for Saturday to the University of New Hampshire, for those who wish to attend, to the oceanography set-up at Durham Point. Bus leaves West High School parking lot at 8:00 AM and arrive at Durham Point at 9:00 AM. Tour and lecture 9:30 AM to 11:00 AM. 11:00 AM, bus to Dover Point, arriving at

11:20 AM. Lunch. (Bring your own lunch). 12:20 PM, a view of the esturary, weather permitting. Depart for Manchester at 1:30 PM, arriving 2:30 PM in the West High School parking lot.

Wednesday, December 5, 1973: Selected readings from Scientific American, a special issue on the oceans.

Thursday, December 6, 1973: (Period A) Guest speaker from the University of New Hampshire's Marine Biology Department. (Period B) Students rap with the speaker.

Friday, December 7, 1973: Review Chapter XII for final test. Tutors and individual assistance. Announce test for Tuesday. Periods A and B.

Monday, December 10, 1973: Continue review of Chapter XII.

Tuesday, December 11, 1973: Test on Chapter XII, both periods.

Wednesday, December 12, 1973: Review the test results. Announce the make-up day. Assign Chapter XIII "Estuarine Ecology". Develop the chapter. (a) define estuary, (b) types, (c) biota and productivity.

Thursday, December 13, 1973: (Period A) Continue Chapter XIII "Estuarine Ecology". (a) food production potential, zonation, (b) emerging new systems.
(Period B) Second showing of the film "Death of a Marsh."

Friday, December 14, 1973: Continue Chapter XIII. Slides of the Hampton Estuary.

Monday, December 17, 1973: Rap session on the Hampton marsh. Pros and cons on an atomic power plant to be located upon the Hampton Estuary at Seabrook, New Hampshire.

Tuesday, December 18, 1973: (Period A) Speaker from the New Hampshire Public Service Company on the power crisis and why Seabrook is the right choice.
(Period B) Students in rebuttal. Rap session.

Wednesday, December 19, 1973: Guest speaker, Dr. Albion Hodgdon from the University of New Hampshire's Department of Botany. Topic, The Plant Life of the Hampton Estuary.

Thursday, December 20, 1973: Review Chapter XIII "Estuarine Ecology". Announce test for Friday. Tutors for individual assistance.

Friday, December 21, 1973: Quiz on Chapter XIII "Estuarine Ecology".

Last day of school until January 2, 1974. Christmas Vacation.

Wednesday, January 2, 1974: Develop Chapter XIV, "Terrestrial Ecosystem." (a) determining factors as to the nature of the terrestrial ecosystem; moisture, temperature, circulation of air and mixing of gases, soil, geographical barriers to free movement, light, and interaction of communities; (b) the terrestrial biota and biogeographical regions; (c) general structure of terrestrial communities.

Thursday, January 3, 1974: Continue Chapter XIV and review the above factors.

Friday, January 4, 1974: The Soil Subsystem (as far as page 374). Announce field trip for Tuesday, January 8, weather permitting, to Harvard's Petersham Forest.

Monday, January 7, 1974: A review of Field Trip Needs; (1) camera for slides, (2) 8mm movie camera, (3) clip boards, pens and pencils, (4) proper clothing, (5) meeting time, (6) requirements, (7) lunches, (8) do and don't. Announce review of the "Terrestrial Ecosystem" as far as page 374 for quiz on Thursday.

Tuesday, January 8, 1974: Field trip to Harvard Petersham Forest. A forest ecosystem under winter conditions.

Wednesday, January 9, 1974: Finish review. Discuss field trip.

Thursday, January 10, 1974: Quiz on Chapter XIV to date, as far as page 374, "The Vegetation Subsystem."

Friday, January 11, 1974: Start "The Vegetation Subsystem" and develop same. Announce makeup day and assist those having problems.

Monday, January 14, 1974: The Permeants of the Terrestrial Ecosystem. Distribution of Major Terrestrial Communities. The Biomes.

Tuesday, January 15, 1974: Continue the chapter: (1) Tundra, (2) Northern Coniferous Biomes, (3) Moist Temperate (Mesothermal) Coniferous Forest Biome, Temperate Deciduous Forest Biomes, Broad-leaved Evergreen Subtropical Forest Biomes, (4) Temperate Grassland Biomes, Tropical Savanna Biomes, (5) Desert Biomes.

Wednesday, January 16, 1974: Chaparral Biomes, Pinon-Juniper Biome, Tropical Rain Forest Biomes, Tropical Scrub and Deciduous Forest Biomes.

Thursday, January 17, 1974: Finish the chapter: Zonation in Mountains, and Importance of the Historical Approach.

Friday, January 18, 1974: Start a general review of Chapter XIV, "The Terrestrial Ecosystem". Tutors give assistance to those who have problems.

Monday, January 21, 1974: Continue the review and cover the short section pages 405-407 (Odum) "Applications and Technology". Announce test for tomorrow, Tuesday, on the entire chapter.

Tuesday, January 22, 1974: Test on Chapter XIV, "The Terrestrial Ecosystem".

Wednesday, January 23, 1974: Review the test and assist those who have had problems.

Thursday, January 24, 1974: Start Chapter XV, "Resources". Conservation of Natural Resources in General; (1) Mineral Resources, (2) Agricultural and Forestry, (3) Wildlife Management.

Friday, January 25, 1974: Continue Chapter XV (Odum). (1) Aquaculture, (2) Range Management.

Monday, January 28, 1974: Desalination and weather modifications.

Tuesday, January 29, 1974: A review of the hydrologic cycle.

Wednesday, January 30, 1974: Review Chapter XV (Odum). Announce test for Thursday.

Thursday, January 31, 1974: Test. Both periods, A and B.

Friday, February 1, 1974: Review test--tutors assisting.

Monday, February 4, 1974: Pollution and environmental health, Chapter XVI (Odum), "Fundamentals of Ecology". Develop the chapter; (1) the cost of pollution, (2) the kinds of pollution.

Tuesday, February 5, 1974: (Periods A & B) Rap session with the Economics class.

Wednesday, February 6, 1974: Continue Chapter XVI on the phases of waste treatment: primary treatment, secondary, tertiary; the strategy of waste management and control.

Thursday, February 7, 1974: Monitoring pollution and environmental law.

Friday, February 8, 1974: Problem areas, insecticides, herbicides, noise pollution.
Announce test on Chapter XVI for Monday, February 11. Review, tutors' assistance.

Monday, February 11, 1974: (Periods A & B) Test on Chapter XVI.

Tuesday, February 12, 1974: Sewage disposal plant.

Wednesday, February 13, 1974: Lecture by a class student on our own sewerage problems in Manchester, New Hampshire.

Thursday, February 14, 1974: (Periods A & B) To the Merrimack River--sewers along the river. Photography unit along.

Friday, February 15, 1974: Video tapes from a field trip last year on the Manchester sewer locations.

Last day of school until February 25, 1974. Winter Vacation.

Monday, February 25, 1974: Lecture on "Thermal Pollution" by Steven Hadlock, St. Anselm's College. Student presentation.

Tuesday, February 26, 1974: Movie on thermal pollution.

Wednesday, February 27, 1974: Guest speaker from the Public Service Company (Manchester) "Our Position".

Thursday, February 28, 1974: A review of thermal pollution. Announce oral quiz for Friday, February 29.

Friday, March 1, 1974: Oral quiz on thermal pollution.

Monday, March 4, 1974: Develop Chapter XVII in Odum, "Fundamentals of Ecology"; "Radiation Ecology," (1) review of nuclear concepts and terminology of importance to ecosystems, (2) types of ionizing radiations, (3) units of measurements.

Tuesday, March 5, 1974: Radionuclides (radioisotopes of ecological importance), comparative radiosensitivity.

Wednesday, March 6, 1974: Radiation effects at the ecosystem level.

Thursday, March 7, 1974: The fate of radionuclides in the environment. The fallout problem.

Friday, March 8, 1974: Waste disposal and future radioecological research. Announce review for Monday, March 11, on radiation ecology.

Monday, March 11, 1974: Review Chapter XVII, "Radiation Ecology". Assist needy students--tutor program in force. Announce test on Chapter XVII for Tuesday, March 12.

Tuesday, March 12, 1974: Test on Chapter XVII, "Radiation Ecology".

Wednesday, March 13, 1974: Work with Millipore kits; renew and familiarize each kit.

Thursday, March 14, 1974: Trip to the Merrimack River, continuing our seasonal monitoring. Equipment: Millipore kits. Experiments in microbiology.

Friday, March 15, 1974: Continue with Millipore equipment. Note increase in bacterial content in water collected yesterday. Rap.

Monday, March 18, 1974: Develop Chapter XIX, "Perspectives in Microbial Ecology"; (1) history, (2) the question of numbers-viable counts. Microscopy and total biomass measurements.

Tuesday, March 19, 1974: Trip to the Merrimack River. Collect and test samples.

Wednesday, March 20, 1974: Read the Petri dishes for past two days. Observe and record. Subculture: isolate select specimens.

Thursday, March 21, 1974: Continue Chapter XIX in Odum; the question of recognition, and the question of performance.

Friday, March 22, 1974: End product, chemical analysis, the question of rate of function.

Monday, March 25, 1974: Cell and energy relations; measurements of rates of activities. Summary. Announce review.

Tuesday, March 26, 1974: Review Chapter XIX in Odum, "Fundamentals of Ecology". Perspectives in microbial ecology.

Wednesday, March 27, 1974: Continue the review of Chapter XIX.

Thursday, March 28, 1974: A laboratory review of all Millipore equipment to date. Announce test for Friday, March 29.

Friday, March 29, 1974: Test on Chapter XIX--10 questions plus 5 lab questions.

Monday, April 1, 1974: Review test. Give makeup date for students. Announce Chapter XX, "Space Travel" in Odum's "Fundamentals of Ecology".

Tuesday, April 2, 1974: (1) types of life-support systems; (2) mechanical chemoregeneration (water and gases), (see Odum, pages 501-503); (3) bioregenerative system (photosynthetic and chemosynthetic).

Wednesday, April 3, 1974: The case for the multispecies life-support system.

Thursday, April 4, 1974: (1) exobiology, (2) the extrabiospheric environment. Gravity problems, radiation problems, absence of regular environmental pulse to entrain circadian and other biological "clocks" that coordinate all systems.

Friday, April 5, 1974: Review Chapter XX "Space Travel". Assistance given students via tutor program. Announce test for Monday, April 8.

Monday, April 8, 1974: Test on Chapter XX "Space Travel". Ask for volunteers to collect water at selected sites such as the Merrimack and Piscataquag Rivers, Stevens Pond, and Cohas Brook.

Tuesday, April 9, 1974: Start spring water testing program. Review the chapter on "Freshwater Ecology" in Odum, with emphasis on spring and fall turnover. Study the diagram on page 310. Collect samples from the Merrimack and Piscataquag Rivers, Stevens Pond, and Cohas Brook. Run the standard tests, and those indicated a need for, from completed tests. Run Millipore equipment tests.

Wednesday, April 10, 1974: Have students bring in fresh samples from the same source. Continue the tests. Refer to page 93 in Odum on PO_4 flux rate. Send sample to the University of New Hampshire for spectro-analysis infra-red range. Organize the scuba divers, under the direction of Mr. Robert Lenzi, for recovery of detritus and a report on conditions of the bottom. Field trip tomorrow, Thursday, April 11, for Periods A & B to Stevens Pond. Select the cars.

Thursday, April 11, 1974: Field trip to Stevens Pond.

Friday, April 12, 1974: No school. Good Friday. Volunteers to go with Mr. Demers, Mrs. Klaubert and Mr. Hall to Clay Pond for spring observations. Full day with all equipment.

Monday, April 15, 1974: Comments on the field trip; observations of petri dishes; coliform counts; and a look at the fungi dishes.

Tuesday, April 16, 1974: (Periods A & B) Back to the Merrimack River; D.O., chloride, turbidity, sulfate, sulfite, PO_4, detergents, chromium.

Wednesday, April 17, 1974: Review the river tests; reasons, concern, and a look at the Merrimack River Basin report #54. Rap.

Thursday, April 18, 1974: A look at the Anderson-Nichols Reports. Book #1, Merrimack River. Discuss the issues. Assign Book #2 for tomorrow's review.

Friday, April 19, 1974: A look at Book #2 by Anderson-Nichols Co., Inc., a report on Proposed Clean-up of the Merrimack River.

Last day of school until April 29, 1974. Spring Vacation.

Monday, April 29, 1974: Anderson-Nichols Report #3. Rap the issues.

Tuesday, April 30, 1974: Review the three reports and lead into Chapter XXI in Odum, "Toward an Applied Ecology". Discuss the issues.

Wednesday, May 1, 1973: Develop Chapter XXI in Odum's Fundamentals of Ecology "Toward an Applied Ecology". Announce guest speaker for tomorrow, Thursday, May 2.

Thursday, May 2, 1973: Guest speaker, Professor Michael Dupre, of St. Anselm's College. (If not available, Professor Claire Monier, St. Anselm's College). Topic, The Need for an Applied Human Ecology.

Friday, May 3, 1974: Continue Chapter XXI "Toward an Applied Ecology", The Population Ecology of Man.

Monday, May 6, 1974: Components for an applied human ecology.

Tuesday, May 7, 1974: To Stevens Pond to clean up the winter's litter and evidence of great need for an applied human ecology. Using boxes and bags, clean up the mess, i.e., beer bottles, cartons, wrappers, clothing, beer bottle stoppers, cans, etc. Notify the Highway Department for pick-up. Make notes for a rap session tomorrow.

Wednesday, May 8, 1974: Rap session. What evidence do you have from yesterday's trip to Stevens Pond that an applied ecology is urgent? Could this happen at Massabesic Lake and our water supply? How could we prevent this?

Thursday, May 9, 1974: Regional land-use planning (total planning). Environmental commissions.

Friday, May 10, 1974: Recycle, stringent conservation of all water and all mineral and biological resources. See pages 87, 410, and 411 in Odum's Fundamentals of Ecology.

Monday, May 13, 1974: Review on "Applied Ecology" for test on Tuesday, May 14. Tutor assistance.

Tuesday, May 14, 1974: (Periods A & B) Test on "Applied Ecology".

Wednesday, May 15, 1974: Announce spring field trip to Kinnikum Swamp for Thursday, May 23. Assign who carries what equipment. Caution students to come prepared, such as mosquito repellent, proper clothing, slacks or full length trousers, long sleeved upper garments, i.e., shirts, blouses, etc. Tell camera crew to get film ahead of time. Bring lunches, cold drinks, etc. What will we be looking for? Who will act as reporters? Assign.

Thursday, May 16, 1974: Taxonomic trip around the school and neighborhood. (Selected trees and shrubs). Collect, key press, and mount until Thursday, May 23 (field trip). Have students bring in plants from around home or from weekend collections.

Thursday, May 23, 1974: Field trip to Kinnikum Swamp. Invited guests, parents, administrators, plus civic officials, who desire to come.

Friday, May 24, 1974: Clean out the vasculums and set up the presses. Check the water samples and petri dishes. Film to be sent to photo-labs. Dark room teams to work!

Monday, May 27, 1974: Rap session on Kinnikum Swamp. Encrouchment--what about tomorrow?

Tuesday, May 28, 1974: Check the plant presses. Remove delicate materials that are ready and mount.

Wednesday, May 29, 1974: Clean up rest of plant presses. Mount.

Thursday, May 30, 1974: No school. Memorial Day.

Friday, May 31, 1974: Label all plants that are mounted. Use all references--check with the teachers.

Monday, June 3, 1974: Outline type of material that will be asked for on the final.

Tuesday, June 4, 1974: Continue outline guide for finals. Eight days until finals begin.

Wednesday, June 5, 1974 to Friday, June 14, 1974: Review, tutor program, private consultations with teacher. Putting it together.

Monday, June 17, 1974 through Wednesday, June 19, 1974: Assigned testing slots--TESTING--close out of marks.

-HAVE A GOOD SUMMER-

ENVIRONMENTAL STUDIES PROGRAM
ST. ANSELM'S COLLEGE - MANCHESTER PUBLIC SCHOOLS

HACH KITS*

HACH Chemical Company, whose main offices are in Ames, Iowa, has developed a number of test kits to be used in the classroom and in the field for the study of aquatic ecology. There are procedures available for the more popular tests such as carbon dioxide, dissolved oxygen, phosphates and nitrates, as well as analysis of many substances not frequently investigated. For any special tests, HACH can devise a procedure and chemicals on request. In addition, special combination test kits have been developed for specific needs such as wastewater treatment, swimming pools, and analysis of natural waters. At West High School, the purchase of kits has been limited to those that analyze water for constituents that would be harmful to life or to the balanced ecology of ponds, lakes and rivers.

The HACH kits have been found to be reliable, sturdy, and economical. The greatest assets of these kits are the simplified test methods. Contained in each kit is a step by step instruction card. The card is positioned in the kit cover. The student is thus not apt to misplace the card or to mutilate it thereby enabling the kit to be passed on intact to the next participant. For each step there is a specific reagent that is premeasured. Wherever possible, dry powdered reagents are used and packaged in individual polyethylene packets. These are opened by snipping the corner with a nail clipper. When liquid reagents are needed, a bottle with a calibrated dropper is enclosed. If the instruction card is carefully followed, the student will determine a quantitative measurement that he may interpret according to the background information obtained in the classroom. No previous chemical training is required. As a result, each student regardless of his science background, is activily involved in testing procedures.

The types of methods of analysis used in the kits involve color comparison by disc or ampule and drop count titration. In the color comparison method, HACH has developed a technique for visual color interpretation that almost completely eliminates the guess work. Continuous color discs have been made from sturdy, clear plastic with the color molded around the outer portion. The band is precisely graduated in color density beginning at zero color and progressing to maximum color.

*By Mrs. Frances Gray, West High School, Manchester, NH
Draft: March 1, 1973

The disc is placed in a color comparator that contains a sample with developed color and a colorless control. The disc is rotated in front of the control until the color is matched with the unknown sample. The units of concentration are then read directly from the disc. If the color developed is very light, there is a special color comparator that allows the visual comparison between disc and sample to be viewed lengthwise. This increases the sensitivity of the test by about five times.

The second method, drop count titration, is equally reliable and gives an accuracy of +5%. A graduated plastic measuring tube is used to obtain a specific amount of sample. This is placed in a mixing bottle and premeasured reagents are added to impart a color or to tie up interfering ions. The solution is titrated by a calibrated dropper that will give a color change when the substance being investigated is consumed. The scale reading contained in the kit provides the units for interpreting results. Again, the procedure is simple, direct, and with proper precautions can be followed by any student. Since the equipment for both procedures is minimal and small, field testing is done with ease and convenience.

The following kits have been used at West High School. The procedure, method of determination, read out of results, accuracy, time required for the test, and the precautions learned from experience in the field are summarized in the following paragraphs concerning each test kit used.

<u>Chloride Test Kit, Model 7-p</u>: The drop count method of analysis is used in this test. The titrating agent is a silver nitrate solution which is added to the sample using a special dropper. The indicator is a buffered chromate powder and is premeasured for each test in a polyethlyene packet called a Powder Pillow. One is used per test. The procedure is known as the Mohr Argentometric Method. The reaction is:

$$AgNO_3 + CL^- \rightarrow AgCL\downarrow + NO_3^-$$

$$2AgNO_3 + Na_2CrO_4 \rightarrow Ag_2CrO_4 + 2NaNO_3$$

The silver chromate is read and one drop of $AgNO_3$ in excess produces a read color to the sample and indicates the chloride has been consumed. The results are expressed in <u>parts per million</u> (ppm). One drop of reagent = 50 ppm.

The time for the test is about 2 minutes in four easy steps. The recommended standard for potable waters by U.S. public health service is a maximum chloride content of 250 mg/L because of the taste effects. In brewing soft drinks the content cannot exceed 275 mg/L because the amount is increased in the processing.

The precautions that should be observed in this test are those for any titrating procedure. Care should be taken that the dropper does not touch the sample bottle because of possible contamination. All equipment used in this test should be thoroughly cleaned and rinsed with dimineralized water, as chloride is a common constituent in all tap water.

Detergents Test Kit, Model DE-2: The method of analysis in this kit is comparison of a color developed in the sample to a color disc. The continuous color disc is graded in colors from yellow to deep blue green. The test takes advantage of the principle that anionic ABS and LAS detergents form a colored complex with the dye toluidine blue O. The color is concentrated by extracting the dye from the water with chloroform. The range that can be measured by this procedure is 0-1 ppm of LAS and ABS detergent.

The time required for the test is 8 minutes. Ten steps are involved to process and filter the water to remove interferring constituents. The main precautions are water contaminents that can be extracted by chloroform that may affect the color. The organic compounds in small plant life may be extracted by the chloroform. In selecting water for the test, note should be taken of surrounding vegetation. It may also be advisable to concentrate the water sample before testing as detergents tend to be readily diluted in a large body of water.

Detergents, even in small amounts, are objectionable because they produce foam in fresh water streams that does not look very pleasing. It is also thought that in more concentrated amounts, they may be harmful to aquatic life. When detergents are found in significant amounts, it is an indication that there is industrial or domestic pollution that could be potentially dangerous to higher forms of life.

Phosphate Test Kit Using Color Standard, Model PO-9A: This kit is designed simply to determine if phosphate is present between the range of 2 to 10 ppm. This range of phosphate is considered low, and is more an indication of plant and animal life breakdown than of industrial pollution or agricultural contamination due to run off of fertilizers and other chemicals used in farming. Testing for phosphate with this procedure over a period of time can give an indication of the decay and/or growth of aquatic life. If large amounts of phosphate are indicated, further testing for coliform and other forms of bacteria is necessary as the water could be contaminated from human and animal waste.

The method of analysis is reaction with ammonoum molybdate with stannous reduction.

The approximate equation for the reaction is as follows:

$$H_3PO_4+12(NH_4)_2MoO_4+21HNO_3 \rightarrow (NH_4)_3PO_4 \cdot 12MoO_3+21NH_4NO_3+12H_2O$$

In the HACH test kit the acid is NO + HNO_3.

HACH has developed a special formula called PHosVerIII that converts phosphate to acid form and provides a strongly acid reacting medium for the formation of ammonium phospho molydate. The PHosVerIII is a dry powder and contained in a powder pillow. The ammonium phospho molydate is then reduced by a stannous chloride solution that is stabilized and buffered. An intensely colored complex, molybdenum blue, is formed and is directly proportional in intensity to the amount of phosphorous present. If large amounts of phosphorous are present, then the color developed may be from yellow-green to yellow and the sample will have to be diluted. Two standard concentrations of developed color in sealed containers are contained in the kit for comparison. The test is especially good as it is not affected by a variation in time and temp.

pH Measurement, Model 17-N: The pH test is a measurement of the amount of acid or alkaline materials contained in the water. In this particular kit, the pH range measured is between 4 and 10. A pH of 7 is considered neutral. Below 7 is acid and above 7 alkaline. A unique color disc is used in a color comparator. The sample is treated with a drop of indicator solution. A color developes according to the hydrogen and hydroxyl concentration. A match is obtained between the colored sample and the prepared disc and the pH is read directly through the scale window of the comparator. The indicator solution is stable, will not freeze, and is sufficient for about 300 tests.

Dissolved Oxygen Test Kit and Water Sampler in Same Carrying Case, Model OX-10: The time proven Winkler method is the basis for this test. This method employs treatment of the sample with manganous sulfate, potassium hydroxide, and potassium iodide and finally with sulfuric acid. The initial precipitate of manganous hydroxide combines with dissolved oxygen to form a brown precipitate of manganic hydroxide. Upon acidification this forms manganic sulfate which acts as an oxidizing agent to release free iodine from potassium iodide. The iodine is complexed with staren solution and titrated with sodium thiosulfate. The iodine is stoichmetrically equivalent to the dissolved oxygen. The equations for these reactions are as follows:

1. $MnSO_4 + 2KOH \rightarrow Mn(OH)_2 + K_2SO_4$

2. $2Mn(OH)_2 + O_2 \rightarrow 2MnO(OH)_2$ (Brown ppt.)

3. $MnO(OH)_2 + 2H_2SO_4 \rightarrow Mn(SO_4)_2 + 3H_2O$

4. $Mn(SO_4)_2 + 2KI \rightarrow MNSO_4 + I_2 + K_2SO_4$

5. I_2 + Starch $\rightarrow$ Blue Complex

6. $I_2 + 2NA_2S_2O_3 \rightarrow NA_2S_4O_6 + 2NAI$ (Blue color disappears)

There are a number of interferences to the dissolved oxygen test, including oxidizing and reducing agents, nitrate ion, ferrous ion, and organic matter. HACH has modified the test by the Alsterberg Azide method to eliminate the nitrate interference, and has changed the chemicals to dry powder to eliminate the corrosive alkaline solution and the concentrated sulfuric acid. They have also developed a chemical called PAO that replaces the thiosulfate solution. This is especially helpful as this sulfate deteriorates quite rapidly and has to be constantly standardized. Identical results are obtained as compared with the usual liquid reagent method.

The test is conducted in a matter of minutes with five easy steps. One drop of reagent is equivalent to one ppm. Included in the test kit is a sample collecting bottle that allows one to collect samples at all depths of the body of water being investigated. This sampler can also be made from homemade equipment, and is another indication of the easy adaptability of the HACH kits.

The main precautions to be observed in this test are to avoid trapping atmospheric oxygen in the sample as reagents are mixed and to allow the sample to become warmed or sit in an open container for any length of time as dissolved oxygen will be lost. To determine the maximum amount of oxygen possible under given condition of temperature and pressure, the following equations can be used:

$0^{o} - 30^{o}$ C (Water)

$$ML/_L\ DO = \frac{(P-M) \times 0.678}{35 + T}$$

$30^{o} - 50^{o}$ C (Water)

$$ML/_L\ DO = \frac{(P-M) \times 0.827}{49 + T}$$

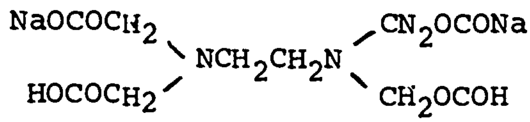
P = atmospheric pressure MM Hg
M = water vapor pressure at temp ^{o}C of atmosphere
T - Temp of water ^{o}C

Any strong deviation of the expected amount indicates water contamination.

<u>Acidity, Alkalinity, Carbon Dioxide, Dissolved Oxygen, Hardness and pH, Model AL-36-W-R</u>: This kit has been designed to meet the special needs of fish and wildlife conservation personnel and as such is highly adaptable to field testing by high school students. The method of determining acidity, alkalinity, and carbon dioxide is a simple drop count titration using phenolphthalein as an indicator. One drop of reagent for the carbon dioxide determination is equivalent to 5 ppm. For the acidity and alkalinity a new unit of measurement is used abbreviated as gpg and standing for grains per gallon. One drop in the acidity test is equivalent to .33 gpg or .133 gpg. In the alkalinity test, one drop is equivalent to 1 gpg or .4 gpg. The dissolved oxygen test is the same as the one described in Model Kit OX-10.

The pH is determined colorimetrically with universal indicator and comparing the color developed to the spot color disc in the 4-10 pH range.

To determine the hardness of the water an EDTA titration is employed. In this titration calcium and magnesium ions are chelated to disodium dihydrogen ethlenediamine tetraacetate.



The end point of the reaction is detected by means of Chrome Black T or Calmagite which has a red color in the presence of calcium and magnesium and a blue color when the cations are removed from solution. Excessive amounts of heavy metals can interfere. Where there is potential industrial waste this should be noted or if large amounts of mercury have been found to be present.

Direct Reading Engineer's Laboratory (DR-EL): This kit is battery powered and is completely portable. The kit contains a HACH developed colorimeter with precalibrated meter scales for direct read out, a unique buret and titration stand with precision screw plunger, and all necessary glassware and reagents. Included in this test kit is a booklet that gives specific instructions for each test, explanation of the apparatus, and detailed drawings to illustrate certain procedure techniques. This enables the most inexperienced student to participate and to get good accurate results. It is truly a simplified, convenient, accurate means of testing water in the field. The advantages of being able to test the water at its source are many. To the student it takes him out of the classroom to active participation in the environment in which he lives. In reporting test results it is preferable because of the many changes that can occur if water is transported or stored. As an example, iron and manganese will plate on the inside of the sample bottle and make it difficult to get an accurate test. Gases such as hydrogen sulfide, carbon dioxide, and chlorine may be lost to the air as the temperature of the water changes.

The tests that are possible with this kit are listed on the following pages. In many cases a single powder formulation is all that is necessary. A color is developed and measured on the colorimenter. Where the drop count titration method is employed the buret is used and the appropriate indicator supplied. Most of the chemical reactions are the same as in the smaller kits but the results can be reported more accurately as a scale reading is used instead of a color disc or a buret is used instead of a dropper. Where the chemical reactions are known and are different, they will be included in the listing. The time required for each test is minimal and the results are reported as ppm or gpg.

Acidity, Free and Total

Standard titration procedure.

Alkalinity

Standard titration procedure.

Bromine

Orthotolidine method. Colorimetric Range 0.2 mg/L.
A yellow color develops if bromine and/or chlorine are present.
Chlorine and bromine are reported together.

Carbon Dioxide

Standard titration procedure.

Chloride

Mercuric nitrate titration. Dilute mercuric nitrate solution is added to an acidified sample in the presence of mixed diphenylcarbazone bromophenol blue indicator. The mecuric ion reacts with the chloride ion forming a precipitate. The end point of the reaction is the formation of the blue-violet mercury diphenylcarbazone complex when the chloride has been consumed.

Chlorine

See above as for Bromine.

Chromate, Sodium

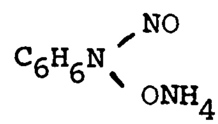
Yellow in color; direct reading in the colorimeter.

Chromium

One ChromaVer Powder Pillow containing diphenylcarbohydrazide is added. A pink color develops in the presence of the chromium and can be measured in the colorimeter.

Copper

Cuprethol Method. This consists of the addition of a powder pillow containing the ammonium salt of N-nitrosophenylhydroxylamine:



This complexes with copper and iron to form a yellow color. If iron is present in high concentrations, it must be removed by the addition of ammonium fluoride.

Fluoride

SPADNS method. The SPADNS reagent is a zirconyl due that complexes with the fluoride to produce a color measured in the colorimeter. This reagent is very tolerant of interferring ions.

Calcium Hardness and Total Hardness

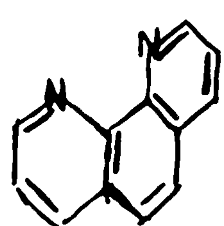
Standard EDTA titration method.

Hydrogen Sulfide

Acidification of sample and prepicitation of the sulfide on lead acetate paper.

Iron

Simplified Phenenthroline Method. In this case iron complexes with phenenthroline ⟶ to produce an orange color and can be determined colormetrically.



PHENENTHROLINE

Manganese

The manganese is oxidized to permanganate ion in a buffered acid solution by periodic acid (HIO_4). The iodic acid is added as a sodium salt from a powder pillow. The test must be conducted at a cool temperature because at 110 degrees centrigrade periodic acid decomposes to I_2O_5, water and oxygen.

Nitrate Nitrogen

This analysis is made by reduction of the nitrate to nitrite with cadmium and the procedure is the same as for nitrite.

Nitrite Nitrogen

The diazotization method of analysis is used which is the coupling of 1-Naphthylamine-Sulfanilic acid in the presence of nitrous acid to produce a pink colored complex that can be determined colorimetrically.

Oxygen Dissolved

The modified Winkler method.

pH Wide Range

Colorimetric range 4.0-10.0.

Phosphate

Ammonium molybdate with stanneous reduction.

Silica

The method of analysis is colorimetric with the development of a blue color with a silica I reagent. For this to be effective any phosphate must be removed by the addition of oxalic acid. The reason is that the silica reagent contains a molybdate ion to develop the color and would be affected by the presence of phosphorous. This method is known as the heteropoly blue method, and is a standard procedure for silica.

Sulfate

Insoluble sulfates form a turbid solution and can be read directly for turbidity in the colorimeter.

Turbidity

Absorption method with the use of the colorimeter.

The size of the kit measures 24" by 8" by 10" and weighs only 28 lbs. Because of its compact size and efficiency, everything must be placed in the kit in proper order and kept clean and uncontaminated. The instruction booklet that comes with the kit is thorough and gives more than adequate precautions and instructions. The only aspect not specifically stressed is the careful observance of students that they keep the equipment clean, follow each step as specified, omitting none, and do not contaminate liquid reagents by interchanging droppers or putting them down in contaminated areas. If careful laboratory techniques and correct recording of date in permanent notebooks is stressed, the student is capable of getting consistent, accurate results and all class results of the same measurements should check.

Ecology has been an important issue in recent years as the interdependence of life has become more evident. The extinction or overproduction of any form of life drastically effects all living organisms. It is the concern and responsibility of every citizen to keep his environment habitable. The ecology courses at the high school level that inform and educate the student towards this end are paving the way for a more healthful environment for tomorrow. For this reason, the course must be available to all students regardless of ability or scientific background. It is fortunate that manufacturing companies, realizing this need, have developed techniques and methods of analysis that make such a course possible. The HACH kits are a prime example of what can be accomplished in the classroom with students of limited scientific training. The techniques are simple, methods short, and results instantaneous with little or no mathematical calculations. The equipment is compact and easy to manage so that the student may leave the classroom and activily investigate the environment in which he lives. This keeps him interested and concerned because his investigations affect him personally. By obtaining a series of test results over a period of time from the same area, environmental changes and their effect are dramatically impressed upon the student. At the same time, the kits also provide the opportunity for the more gifted and talented pupil to study his environment in depth, to do independent research, to further his knowledge of chemistry and analytical methods, and most important to actively inform his community of the findings of his investigations. This involvement of school and community is very important today and cannot help but be beneficial to both parties. It is hoped that more high schools will incorporate such programs so that all students may be educated to the needs of their environment in the academic atmosphere that promotes careful scientific investigation of facts as a means of controlling pollution instead of irrational emotionalism. In time we may all enjoy a better tomorrow.

ENVIRONMENTAL STUDIES PROGRAM
ST. ANSELM'S COLLEGE - MANCHESTER PUBLIC SCHOOLS

MILLIPORE[R] EQUIPMENT IN THE CLASSROOM

I. Introduction

Millipore[R] is a type of filter which can be used to remove any small particles from a sample. It can take spores, dust, and smoke from the air as well as bacteria, algae, and fungus from soil and water. These particles on the filter can then be grown for identification if they are living; examined under the microscope while still on the filter; or put in solution for chemical analysis. Because of Millipore's[R] exacting ability to remove nearly any particle from a sample, it has many uses in testing air, water, and soil in the biology and ecology classrooms.

Millipore[R] filters are different from the conventional filter paper used in biology and chemistry. The conventional filters are strands of cellulose woven together to remove large colloidal particles. The Millipore[R] filter is a sheet of solid material with many holes of uniform size punched through it. These filters are made with holes of various sizes to capture different types materials. The pore sizes are measured in microns (1 micron = 1 millionth of a meter or 1 thousandth of a millimeter) abbreviated by the Greek letter μ. The pore size of the filter designates the name of that filter. Hence, a 3 μ filter will allow only partilces smaller than 3 μ to pass through it. The graph below shows some of the common filter sizes and compares them to items in common experience.[1]

Filters	Pore Size	Will Trap Anything Larger Than:
5 μ	5 μ	red blood cells
1.20 μ	1.2 μ	yeast cells
0.45 μ	0.45 μ	tobacco smoke
0.22 μ	0.22 μ	all bacteria
0.05 μ	0.05 μ	lamp black
0.025 μ	0.025 μ	polio virus

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[1]Millipore Corporation, Millipore[R] Experiments in Environmental Biology (Bedford, Mass., 1969), p. 7.

Draft: March 1, 1973

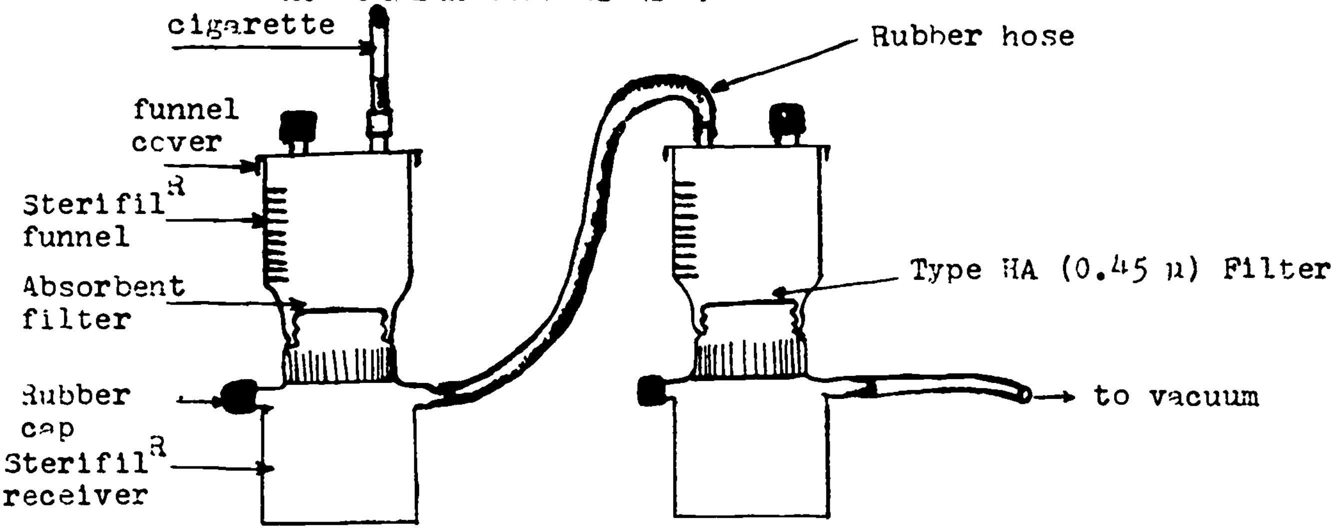
Because Millipore[R] filters have extremely small pore sizes, they can be used to sterilize liquids. By passing the water to be sterilized through a Millipore[R] filter with 0.1 u pores, all bacteria will be trapped on the filter and the filtrate can then be considered sterile. Many liquids are sterilized by this method, especially those susceptible to heat destruction such as vaccines, antibiotics, drugs for injection, and beverages of all kinds.

The rest of this chapter is laboratory oriented. By allowing the students to observe and experience the many aspects of the Millipore[R] equipment, they will be better prepared to design their own laboratory investigation which is the climax of this chapter. Since practical experience is a better teacher than most people, it is very important that the instructor answer as few questions as possible concerning the outcome of any experiment. To this end, it is suggested that the instructor explain technique and theory for each lab and then help students to attain proficiency with each technique. There are charts and questions which will lead the students to their own conclusions. This along with group discussions to clarify misconceptions should cause all students to become proficient in the use of the equipment. Do not discourage students helping students in any aspect of this chapter since they will often listen more willingly to their peers.

Finally, there are two reminders. Before this unit is attempted, the instructor must be completely familiar with the techniques of the Millipore[R] equipment. These labs are set up on the assumption that the instructor is familiar with all necessary Millipore[R] techniques. Familiarity can be gained by reading any one of the excellent manuals put out by the Millipore[R] Corporation. One is Millipore[R] Experiments in Environmental Microbiology. The Millipore[R] company also holds seminars for teachers in the use of their equipment. To find out more about these manuals or seminars write to Millipore Corporation, Bedford, Massachusetts, 01730. Second, the problems at the end of each section should not be attempted until all work in the chapter has been completed. Then one of these problems should be undertaken by each student with consideration given to their interests and abilities.

II. Introductory Demonstration

A. Explanatory Diagram



B. Purpose

The Millipore® Sterifil System® can be used in conjunction with a cigarette to demonstrate the ability of the Millipore® filter to remove very small particles from the air.

C. Procedure (see diagram above)

1. Rig two Sterifil Systems® in a series. Attach to a vacuum pump as indicated in diagram.
2. Place an absorbent filter from the sterile envelope in the first Sterifil®.
3. Place a 0.45 μ Millipore® filter in the second Sterifil®.
4. Attach a two inch length of rubber tubing to the top of Sterifil® one and place a cigarette in it.
5. Turn on the vacuum pump and light the cigarette.
6. Allow the cigarette to burn until the pressure on the filter reaches approximately 10 psi as indicated by the vacuum pump. If you exceed this, the Millipore® filter may collapse.

D. Discussion

1. Show how small particles have passed through the ordinary absorbent filter and are all trapped on <u>one</u> side of the Millipore® filter.

2. What are the chemicals trapped by the filter?

E. Problem

An investigation can be made by interested students concerning the relative amounts of materials passed off by different brands of cigarettes. This can be done by comparing the color density and weight of Millipore[R] filters which have collected smoke from various brands.

III. Analyzing Air Pollution

A. Background Information

It is relatively easy to collect air borne particles. No sterile technique is required since a spore on your apparatus most likely came from the air. However, care must be taken to ensure no carryover of bacteria from a previous exercise. To accomplish this, wash out the Sterifil[R] filter holder with 95% ethanol.

For this experiment to be completely successful, a rather extensive field trip is required. If this is not practical, a student may collect the samples over a week-end, and then along with the class analyze the samples obtained.

To collect an air sample, remove the cover and rubber stopper from the Sterifil[R] filter holder. Install a 0.8 u filter. Attach the tube at the base of the Sterifil[R] filter holder to a vacuum pump in order to draw air through the filter.

If a precise quantity of air is to be measured, it is best to install an aerosol adapter and limiting orifice attachment to the filter holder. (This item is available from Millipore Corporation.) However, it is usually adequate to simply draw the same vacuum pressure for the same amount of time. In the case of heavily contaminated air, draw for a fraction of the time and multiply by the reciprocal. For example, suppose the normal filtering time were thirty minutes but the air was heavily contaminated. You could draw for ten minutes, 1/3 of 30, and multiply your answer by 3. The volume of air drawn through the filter is approximately 1 liter per minute per inch of vacuum pressure. Notice that all measurements must include the quantity of air and contaminants measured. For example, 1 gram contaminant/10 cu. ft. air.

B. Procedure

1. Draw several samples of air from various sources. Note time and vacuum pressure in order to figure volume of air sampled.
2. In the lab one set of filters can be tested for bacterial growth by placing them in Millipore[R] sterile petri dishes. A total count media is available from Millipore[R] Corporation. Follow procedure in Millipore[R] Experiments in Environmental Microbiology.
3. Where the amount of contaminatnts is small, the particles on the filter can be counted under the low power of a microscope. Count several squares and use the formula below to figure the total count. There are 145 squares on each fiter, thus:

$$\text{Total count} = \frac{145}{\text{Number of Squares counted}} \times \text{Sample count}$$

4. If the amount of contaminants is large, a gravimetric determination of total contaminants can be run. This is done by weighing the filter before and after filtration. The difference in weight is the amount of contaminants. A similar type of determination can be done by comparing the colors of the filters: the darker the filter, the heavier the contamination.
5. Because the filter material is completely inert, chemical analysis can also be done on many of the contaminants trapped on it. Below are a few tests for various chemicals commonly encountered. The analysis can be made directly on the filter for the first two chemicals. For the rest, the contaminant must be washed from the filter with distilled water. Then add the testing reagent.

Contaminant	Testing Reagent	Results
lead	Tetrahydroxy Quinone	red
iron	KSCN	red
sulfate	Barium Nitrate	white↓
sulfite	Sulfuric Acid conc.	SO_2↑
sulfide	Sulfuric Acid conc.	lead acetate paper-black
nitrate	add $FeSO_4$ and H_2SO_4	brown ring

C. Questions and Problems

1. Make a set of graphs to compare air from various sources as to bacterial count, contaminant weight, and chemical composition of contaminants. Put the amounts on the Y axis and the various types of samples on the X axis. A separate chart will be required for each contaminant identified.
2. Why must you always know the amount of air drawn through the filter?
3. A colorimetric test is done by arranging filters in order of color density as an indication of the amount of contaminants. How might you verify a colorimetric test?
4. Identify as many sources as possible for each contaminant found.
5. Why should amounts of all contaminants be measured in the same units, i.e., contaminants/liter or contaminants/cu. ft.?

D. Other Investigations

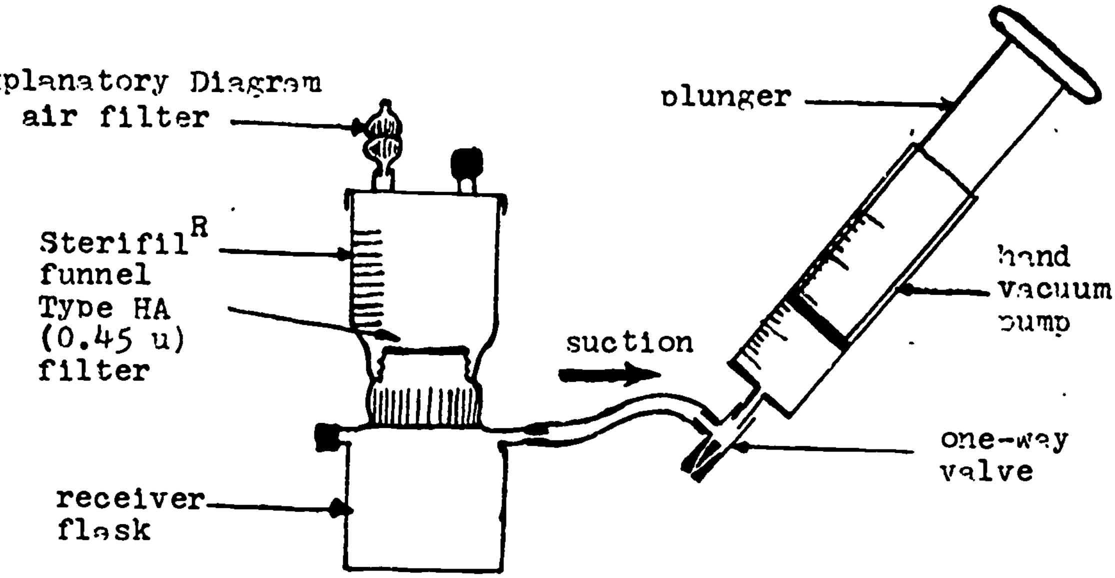
1. Analyze the exhaust from various types of cars and trucks.
2. In the spring, try taking pollen counts from various locations. Compare your results with those given by the local weather forecaster.
3. Analyze the smoke fumes from various types of fuels: gasoline, turpentine, diesel oil, high sulfur furnace oil, coal, and natural gas. CAUTION: You should not attempt to burn these fuels in the lab. It will be necessary to find a source which uses each of these fuels and measure the exhaust from them. For example, diesel oil smoke can be obtained from the exhaust of a diesel truck.

IV. Analysis of Water Sediments

A. Background Information

Sediment in water can originate from many places. It may be due to high water, timber cut off upstream, factory effluents, or mining operations. Large amounts of suspended material in the water can be dangerous because it stops sunlight from reaching bottom vegetation, restricting photosynthesis, and suffocating aquatic animals. Fish also may die from clogged gills and suffocation much like miners working around dust.

B. Explanatory Diagram



C. Procedure

1. To compare water from several different sources, take water samples of the same volume and filter them with suction through a Millipore[R] HA 0.45 μ filter held in the Sterifil[R] holder. (see diagram above). If the water is excessively murky, dilute your sample making certain the dilution factor is recorded.
2. The filters may now be analyzed in a number of ways.
   a. Colorimetric: Filters may be arranged in decending order of color density and a relative determination of sediment content can be made. The darker the filter is, the more sediment suspended in the sample.
   b. Gravimetric: The dry filter should be weighed before filtering. To determine total suspended solids:

      [Wt. of dry filter after test] - [Wt. of dry filter before test] = Weight solids

      Make certain to report all your results in the same units. For example, mg solids/ liter H_2O.
   c. Dissolved Solids: Filter as you did above putting the filtrate into a pre-weighed porcelain evaporating dish. Evaporate the water by using a bunsen burner or a heat lamp. Make certain to lay a watch glass over the dish to trap flying salts.

      [Wt. of dish, watch glass after evaporating] - [Wt. of dish, watch glass, before evaporating] = Weight dissolved solids

d. Inorganic solids: Clean and heat a porcelain crucible in a furnace to 750° C. Allow it to cool and weigh it to the nearest 0.05 mg. Place the filter with the contaminants in the crucible and wet it with ethyl alcohol. Ignite the filter, when the fire is out, cover it and place it in a muffle furnace at 750° C. for 20 minutes.Reweigh. The organic sediment and filter will have been burned away releasing CO_2 and H_2O.

$$\begin{bmatrix}\text{Wt. crucible,}\\\text{cover after}\\\text{being ashed}\end{bmatrix} - \begin{bmatrix}\text{Wt. crucible,}\\\text{cover before}\\\text{being ashed}\end{bmatrix} = \begin{matrix}\text{Weight of}\\\text{inorganic}\\\text{solids}\end{matrix}$$

All values should be calculated using the same volume of water. For example, mg./ liter, g/ liter.

D. Questions

1. Why should all measurements be calculated in terms of the same volume?
2. Why should excessively murky water be diluted before filtering?
3. Why is the colorimetric test said to be relative?
4. How could you make the colorimetric test quantitative?
5. Why are only organic contaminants removed by ashing?
6. How can dissolved solids pass through the Millipore[R] filter?

E. Problems

1. Test the dispersion of pollutants as they travel downstream from their source. Sample the water at one hundred feet intervals for 1,000 feet.
2. Test the amount of sediments in various types of streams, ponds, lakes, and the ocean.
3. Test for phosphates in water by adding 20 ml. of a saturated solution of Calcium hydroxide to 100 ml. of water which has already been filtered to remove sediment. Collect the Calcium phosphate on a Millipore[R] Type HA 0.45 μ filter and check gravimetrically.
4. Test for sulfate as for phoshate. Use 20 ml. of saturated Barium nitrate as the precipitating agent.

V. Analysis of Water for Living Components (Bacteria, Algae, and Fungi)

A. Background Information

1. Millipore[R] equipment is especially well-adapted to removing micro-organisms from water. The company provides a complete supply of pre-sterilized and measured media. However, it is much less expensive to make your own media, sterilize it, and bottle it. Various media that you can make are listed at the end of this section.
2. When doing any of the following experiments, make certain to use sterile technique outlined in Millipore[R] Experiments in Environmental Microbiology, pp. 7-16.
3. Handling media: For all of these media a general technique should be followed. Using sterile Millipore[R] petri dishes, open only on one side, and using flamed forceps, slip a 47mm. absorbent pad in the bottom of the dish. Break open the desired media vial with the Millipore[R] breaking tool; the vial neck should be sterilized before this is done. Pour this media onto the pad through the raised edge of the petri dish. Then put a Millipore[R] filter, with spores, on top of the pad. Make certain there are no air bubbles between them. The media will be drawn to the surface of the filter by capillary action thus feeding any spores. When working in the field, a convenient way to begin incubation is to place the closed dish in a shirt pocket where your body temperature will begin growth. In the lab these dishes should be placed in an incubator at 37° C overnight.
4. Total count media contains the nutrients and chemicals for most bacteria to grow. Thus it will allow you to count most of the bacteria in a sample. This media may be obtained with or without Triphenyl Tetrazolium Chloride, an oxidyzing agent, which turns red when its oxygen is removed by an aerobic organism. These colonies thus appear red. You may substitute nutrient broth in any experiment calling for total count media.
5. Yeast and mold media contains chemicals to kill bacteria while allowing yeasts and molds to grow. This media is green but no color reaction occurs. Since most molds and yeasts are very light colored, they show up best on a black gridded filter Type HABG. You may substitute yeast extract broth in any experiment calling for yeast and mold media.

6. MF-Endo media is used to detect coliform bacteria from sewage. This bacteria produces an alderhyde which reacts with basic fuchin, a red chemical in the medium, and produces a "green sheen". Thus green colonies indicate coliform bacteria and sewage pollution on the MF-Endo media. Eosin methylene blue (EMB) may be substituted in any experiment calling for MF-Endo media. Coliform colonies on the EMB medium are either black or have black centers.

B. Procedure - Lab One

1. To demonstrate the abundance of microbes around us, have each student use several petri dishes with nutrient agar medium poured about 1/8"-1/4" thick on their bases. Using "scotch tape" as a transfer medium, have students touch anything around them with the tape, then touch the agar. Incubate these dishes at 37° C overnight and have students record various types of colonies found on a chart.

Colony	Color	Shape	Texture	Smell	Diagram	Relat. # covered
#1	yellow	round	shiny	dead fish		
#2	white	irregular	cottony	none		2

CAUTION: All microbes should be treated as disease causing organisms.

2. Questions

a. Where did all the bacteria on the culture dishes come from?
b. What does each colony represent originally?
c. What limits the growth of the colony?
d. What causes the smell of the various bacteria?
e. If a single bacteria could mature and divide every half hour, how many cells would there be produced from one spore in 24 hours? 48 hours?
f. In what way are deadly bacteria not as successful as symbiotic individuals?
g. What conditions are necessary to kill all bacterial spores? Be specific.
h. Why haven't bacteria taken over the whole world?

C. Procedure - Lab Two

1. Analyze samples of water from various sources using each of the types of media mentioned under "Background Information".
2. Millipore[R] filters, besides being able to show individual colonies which can be put on charts as in Lab One, can also be observed under the microscope by several methods.
   a. Remove colonies with a transfer loop to a microscope slide.
   b. Put a colony on a slide and add immersion oil and observe them directly since the oil causes the filter to have the same refractive index as glass and thus be transparent.

3. Questions

   a. Make a list of bacteria. Include: name, sources, diseases caused, and economic significance.
   b. What does an excess of bacteria in water cause?
   c. Do these tests allow for the growth of all bacteria present? Why or why not?
   d. Why do bacteria grow only on the tops of the filters?
   e. Explain how to isolate one type of colony from a mixture of colonies.
   f. Find a medium designed to grow specific bacteria. Explain why it works.
   g. Explain how to grow anaerobic bacteria.
   h. What are some "natural" controls of bacteria? Make a chart showing name of organism and controlling agent.

D. Procedure - Lab Three

1. Algae in water can be measured by a colorimetric comparison. Bear in mind that accurate comparisons can only be made when equal volumes of water are measured.
2. Algae count: To take an accurate count of the numbers of algae in water, filter between 10-50 ml. of water depending on the water color. Green water means much algae and a smaller sample should be taken.
   a. Filter the sample of water with a Sterifil[R] filter apparatus containing a .45 μ filter.

b. Dry the filter in air and place on a microscope slide; clear with immersion oil. The filter may be cut to fit.

c. Under the scanning lens of the microscope, count the number of cells in 10 squares and use this to find the total count. Since there are 145 squares on the entire filter, the following formula can be used to calculate total algae.

$$\text{Total algae} = \frac{145 \text{ squares}}{10 \text{ (squares counted)}} \times \text{sample count}$$

Your results should be reported for a volume of water.

3. An excellent book on identifying algae can be obtained from the United States Department of Health, Education and Welfare. Title: An Illustrative Manual on the Identification, Significance, and Control of Algae in Water Supplies, by C. Mervin Palmer.

4. Questions

a. Why is algae growth enhanced by pollutants, sewage, and phosphates?

b. What danger can excess algae cause?

E. Problems - Labs Two and Three

1. Analyze water in a small stream as it flows away from a pollution source. Try to find a source of detergents and sewage. Take samples every 1,000 feet for at least two miles. Make charts to show types and amounts of bacteria, types and amounts of algae, and amounts of sediment.
2. Test various types of detergents' abilities to cause algae to grow. Use a mixed culture and only very small amounts of detergent. Count numbers of algae using algae count technique taught in Lab Three. Also check to see which types of algae are affected.
3. Learn to make up chemically defined media and try growing various bacteria on them. Record on a chart the growth of each type of bacteria on each type of medium.
4. Grow algae taken from pond water under various conditions in the lab. Try controlling the amount of light the algae receive by placing them

in a box whose light is controlled by a timer. Try changing temperature by placing the algae in incubators set a different temperatures. Check all of these for types of algae and number of algae grown over a period of time. Daily record charts are easiest to keep.

5. Make up a stock solution of nutrient broth and divide it into 100 ml. samples and sterilize. Using an innoculating loop, transfer one loop of E. coli stock to each bottle. Place in an incubator at 37° C. Take one bottle out every two hours and filter 10 ml. with a .45 µ filter. Place filter in sterile petri dish with coliform medium and take a colony count the following day. Calculate bacteria per liter of medium. Plot numbers of bacteria per liter against incubation time for each sample. Plot the log of the numbers of bacteria against incubation time.

F. Substitute Media Formulas[2]

Read label of each product for specific directions pertaining to it. Formulas are in grams per liter of distilled water.

1. Glucose broth - general growth
   Peptone, 10
   Glucose, 5
   Sodium chloride, 5
   pH 7.3

2. Eosin methylene blue (EMB)
   Peptone, 10
   Lactose, 10
   Dipotassium phosphate, 2
   Eosin Y, 0.4
   Methylene blue, 0.065
   pH 7.1

3. Nutrient broth
   Peptone, 5
   Beef extract, 3
   pH 7.0

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[2]*Difco Manual*, Difco Laboratories Inc., Detroit, Mich., is very useful for media preparation.

4. Yeast extract broth
   Peptone, 5
   Yeast extract, 5
   Beef extract, 3
   Sodium chloride, 5
   pH 7.0

5. Nutrient Agar
   Peptone, 5
   Beef extract, 3
   Agar, 15
   pH 7

6. Sabaard's Agar (molds)
   Peptone, 10
   Glucose, 40
   Agar, 15
   pH 7

G. Process for Sterilizing Media

1. Make certain to sterilize all of these media in an autoclave using 20 lb. pressure for 20 minutes. They should be in approximately 100 ml. portions in bottles with the caps on very loosely to allow for expansion. The broths can be used in the small petri dishes supplied by Millipore Corp. 2 ml. of broth is all that is necessary in these. Make certain sterile petri dishes are used and sterile technique of transfer is followed. Any good book on microbiology will explain this if you are not familiar with techniques.
2. To re-sterilize the small Millipore[R] petri dishes, they should be placed in straigh bleach for 10 minutes then removed with forceps. The filter and absorbent pad can be thrown out safely now. Then place the dish in 70% alcohol for ten minutes. Air dry quickly and put back together.[3]

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[3] <u>Millipore[R] Experiments</u>, p. 21.

VI. Materials: Class of 24 working with partners.

Millipore Catalog #	Item	Price
XX11 047 00	12 Sterifil[R] Aseptic Filtration Systems	$12.00 each
XKEM 001 07	12 Hand Vacuum Assemblies	4.50 each
XX62 000 06	12 Stainless Steel Forceps	2.75 each
HAWG 047 SO	3 boxes Sterile Filters	17.50 /box 100
HABG 047 SO	3 boxes Sterile Filters	22.00 /box 100
AAWG 047 SO	3 boxes Sterile Filters	17.50/box 1[illegible]
PD10 047 00	2 boxes Petri Dishes	8.00/box 1[illegible]
XX61 000 00	1 Vacuum Pump (not necessary)	120.00 each
	Total Count Media	
XKEM00114	Ampula	12.00/box 100
MB000000T	Powdered	6.30/ ¼ lb.
	Coliform Media	
XKEM00112	Ampula	12.00/box 100
MB000000E	Powdered	4.40/ ¼ lb.
	Yeast and Mold Media	
XKEM00113	Ampula	12.00/box 100
MB000000Y	Powdered	4.40/¼ lb.
---------	1 incubator for cultures	---------------

ENVIRONMENTAL STUDIES PROGRAM - IN-SERVICE TRAINING
Ecological and Environmental Testing

HYDROLOGIC CYCLE *

The broad, universal system of evaporation of water from the earth's surface, movement as vapor through the atmosphere and precipitation back to the surface is termed the Hydrologic Cycle.[1]

From the aforegoing description, it can be ascertained that there are many subdivisions in this cycle. That is, the hydrologic cycle is not a simple system, but rather a fairly complex system made up of much simpler subsystems which affect the equilibrium of the whole cycle. The cycle is complex insofar as precipitation (snow, rain, etc.), the path of water upon the earth, and the mode of loss of surface water back to the atmosphere are concerned.

There are several things which happen to precipitation in the form of rain, snow or ice. When precipitation in the form of rain stops, the water which lies on the vegetation or in the form of mist begins to evaporate and find its way into the atmosphere. That which falls on the soil will do one of two things: it will seep its way to a stream, river or lake and be carried out to the ocean or sea, or it will percolate downwards until it reaches the natural level of free ground water, the water table. The free ground water tends to flow horizontally in the subsoil until it reaches land which is at a lower altitude where it may emerge as a body of water or an artesian well; the process of evaporation takes over again and returns the water back to the atmosphere.

The water which falls upon the soil and percolates downwards, along with water above the water table which moves upwards by acpillary action, may find its way to the roots of plants and be taken up by them. Once in the plants, the water travels to the stems and leaves where the process of transpiration takes place.

1. Ecology of Inland Waters and Estuaries, Reid, George K., 1961.

* By Raymond Demers, West High School, Manchester, NH

The purpose of this chapter is to devise means of examining the various stages of the hydrologic cycle with a more critical eye, and thereby, arrive at more useful data about the availability of water in our environment.

Surface Runoff Experiment

The purpose of the surface runoff experiment is two-fold: (a) to determine the varying effects that different soils have on water retention versus runoff; (b) to determine at which slope angle optimum water retention is achieved for each soil sample.

Materials

1 Surface runoff box (see construction article)

1 Shovel (dirt, not snow)

Several liters of distilled water

Several #10 cans open at one end, and other end punched with small brad holes (used for simulating rain). Cans must be marked at 1 liter levels.

1 Meter stick

1 Broiling pan wider than 22"

Soil samples measuring 19 3/4" X 19 3/4" X 4"

1 Kitchen strainer

Procedure

1. Collect similar samples of soil measuring 19 3/4"X19 3/4"X4".

2. Place samples, one at a time, in runoff boxes.

3. Set runoff box inclination at 0.

4. Evenly distribute 1 liter of artificial rain, using a #10 punched can, over entire soil sample.

5. Collect runoff in broiling pan. (If no runoff, repeat procedure).

6. Filter water collected using strainer and determine what percentage of water was absorbed by soil.

7. Wait 10 minutes then repeat above procedures on same soil sample to determine the effect of increased soil moisture on water retention.

   NOTE: The experiment can be readily accelerated if several funoff boxes at different inclinations are available.

8. Repeat entire procedures using different soils and different inclinations.

9. Total surface runoff per cubic meter can be calculated by multiplying volume of runoff water obtained by 40.

10. Graph results of surface runoff versus inclination for different soil samples and compare results.

Construction--Runoff Box

2 21 1/4" X 4" X 3/4" Pine

2 19 3/4" X 4" X 3/4" Pine

1 1/4" X 21 1/4" X 21 1/4" Plywood

20 1" nails or brads

2 2" X 1/4" bolts with washers and wing nuts

2 20" X 1 1/2" X 3/4" elevation boards with a 1/4" slot down the center starting and ending 1" from each end

1 tube of Dow Corning silicone rubber caulking compound.

1 pt. ebonite ski surface finisher or lab counter paint.

1 protractor

1 1/16" wire 3 1/2" long

1 1/2" wood screw, flat head

1 1/8" X 2" bolt with 2 nuts and 2 washers

Clinometer Gauge Attachment

1. Drill 2 holes, 1/8", in protractor, one at 90^{o} and one at base center.

2. Drill a 1/8" hole on one of the side panels to the runoff box.

3. Push pointer bolt assembly through hole and tighten until the protractor is seeded but pointer needle moves freely.

4. Square protractor with side of box and then attach wood screw to make clinometer immobile.

Soil Evaporation and Transpiration Experiment

Purpose

To determine the amount of soil water loss by means of evaporation from day to day.

Materials

1 Ohaus or equivalent double pan balance.

1 Soil shovel

1 Drying oven

1 Meter stick

1 Balance mass set

Various soil samples (measuring 10cm. X 10cm. X 10cm.)

Procedure

1. 3 soil samples measuring 10cm X 10cm. X 10cm. individually are obtained. The vegetation from these samples is removed and discarded.

2. The samples are then weighed individually. The weights are then recorded.

3. The individual samples are then placed in a drying oven for several hours, or overnight, and then reweighed.

4. The difference in the weights of the samples before and after drying is a measure of the moisture content of the soil.

5. On the following day, 3 more samples of soil are obtained from the same area as the first three samples.

6. Steps 1 through 4 are repeated for the second set of samples. The difference in weights of moisture content of the two sets of soil samples indicates the amount of evaporation and transpiration which took place in the soil over a 24-hour time period.

Water Seepage and Water Quality

Purpose

To determine the effect of water seepage in soil on the chemistry of the water.

Materials

1 Surface runoff box

1 Shovel

Several soil samples for surface runoff box

1 #10 can graduated at 1 liter. (Can must be open at one end and perforated at other end by small nails).

1 22" wide broiler pan

Several liters of distilled water

Procedure

1. Set up surface runoff box.

2. Place a soil sample in the runoff box.

3. Saturate soil with distilled water using #10 can as rain simulator apparatus.

4. Collect seepage water and filter.

5. Run water chemistry tests on seepage water to determine concentrations of minerals in water. Use commercially available water chemistry test equipment such as HACH kits.

6. NOTE: To properly determine the extent to which minerals have been dissolved in water, the chemistry tests should be performed on the distilled water prior to the start of the experiment.

Homemade Weather Station

The following is a brief description of various types of meteorological equipment which can be made from materials available and can be readily transported to the field.

A. Psychrometer (Wet-Dry Bulb Thermometers)

The Psychrometer is important in determining the amount of relative humidity in the air at a certain temperature. The relative humidity is defined as the amount of water vapor in the air divided by the amount it could hold at a certain temperature and pressure.

Materials

2 Thermometers, °F, identical (alcohol or mercury)

1 6" length of alcohol lamp wick or muslin

1 Piece of string 4" long

1 Baby food jar, containing water.

Procedure

1. Attach wick or muslin to bulb of one thermometer by means of a string.

2. Dip wicked thermometer in water, make sure portion of wick remains in water.

3. The two thermometers should be situated close to each other and exposed to the elements. However, they should not be placed in direct sunlight, nor should they be placed under trees as this would give faulty readings.

4. Record temperatures of wet-bulb and dry-bulb thermometers.

5. Using table on next page determine relative humidity.

6. Usually, a sharp rise in moisture while the temperature remains fairly constant or a sharp drop in temperature while the moisture remains constant is a fairly good indication of on-coming rain.

RELATIVE HUMIDITY, PER CENT
(Barometric pressure, 30.00 inches)

Air Temp °F	Depression of Wet-bulb Thermometer													
	1	2	3	4	6	8	10	12	14	16	18	20	25	30
0	67	33	1											
5	73	46	20											
10	78	56	34	13										
15	82	64	46	29										
20	85	70	55	40	12									
25	87	74	62	49	25	1								
30	89	78	67	56	36	16								
35	91	81	72	63	45	27	10							
40	92	83	75	68	52	37	22	7						
45	93	86	78	71	57	44	31	18	6					
50	93	87	80	74	61	49	38	27	16	5				
55	94	88	82	76	65	54	43	33	23	14	5			
60	94	89	83	78	68	58	48	39	30	21	13	5		
65	95	90	85	80	70	61	52	44	35	27	20	12		
70	95	90	86	81	72	64	55	48	40	33	25	19	3	
75	96	91	86	82	74	66	58	51	44	37	30	24	9	
80	96	91	87	83	75	68	61	54	47	41	35	29	15	3
85	96	92	88	84	76	70	63	56	50	44	38	32	20	8
90	96	92	89	85	78	71	65	58	52	47	41	36	24	13
95	96	93	89	86	79	72	66	60	54	49	44	38	27	17
100	96	93	89	86	80	73	68	62	56	51	46	41	30	21

B. Anemometer

The Anemometer is a device for measuring wind speed. A homemade cup anemometer can be made which is fairly accurate. However, it suffers from a common fault of most of the anemometers, and that is it tends to give the mean speed of the wind. The reason for this is that the cups do not decelerate as fast as they accelerate. Also, it must be checked periodically to insure that the cups rotate freely. NOTE: The anemometer must be calibrated before it can be used, a description of this procedure will follow construction.

Materials

1 0-1mA meter

1 5K linear taper pot

1 Small electric motor, Pittman type

3 Pieces of braided insulated hookup wire, 36" total length

2 Old tennis balls with smooth outer surface

1 Roll black electrical tape

1 24" X 3/4" dowel

1 Strip of tin can stock 1" X 4"

2 1/2" wood screws

1 1/2" round head wood screw

2 24" X 1/4" wood dowels

1 Pkg. of Hobby Poxy or Devcon epoxy glue

Procedure

1. Split tennis balls into two identical halves. Cut a groove along the center back of each ball half, to accept a dowel.

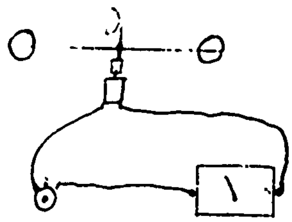
2. In the center of the two 24" X 1/4" dowels cut out a groove of large enough proportions to permit the fitting of the dowels in a cross fashion.

3. Cut a 1" length off of the 3/4" dowel. On one end of the dowel drill a hole of sufficient diameter and depth to accept the gear of the electric motor. On the other end of dowel drill a hole 1/16" dia. X 1/4" deep. Glue electric motor to dowel by means of epoxy and let harden.

4. Glue the tennis ball cups to the two 24" dowels in such a fashion that the cups all face the same direction and are perpendicular to the grooves cut in the dowels. When the epoxy has hardened glue the two dowels together at the center groove and allow to harden.

5. Drill a 1/16" dia. hole in the center of the rotor cross assembly. Using a wood screw and again some epoxy attach rotor to the electric motor and 1" dowel assembly. Let harden.

6. Next, solder a wire to each terminal of the electric motor. One wire from the motor is then connected to one side of the meter, the other is connected to the 5K pot. The third wire is connected to the other side of the 5K pot and the remaining terminal on the meter. The system setup is shown in the following figure.



7. By means of the tin can stock the electric motor is fastened to the 23" remaining of the 3/4" dowel. (HINT: epoxy may help in fastening motor to dowel.)

8. Using electrical tape, mask entire electric motor with the exception of the shaft. This is done to protect it from the elements.

9. CALIBRATION: On a calm day hold rotor outside of a car window. Instruct driver to move the car from 5 to 70 MPH in 5 MPH increments. With the help of an assistant mark off the face of the meter in 5 MPH increments. Some adjustment of the 5K pot may be necessary to keep readings on scale. Once the pot is adjusted it should be epoxied in place.

BEAUFORT NUMBER AND WIND EFFECTS ON LAND

Wind Speed in m.p.h.			Official Designation
Less than 1	0	Calm; smoke rises vertically	Light
1 -3	1	Direction of wind shown by smoke but not by wind vanes	
4 -7	2	Wind felt on face; leaves rustle; wind vanes move	
8 -12	3	Leaves and small twigs in motion; wind extends light flag	Gentle
13 -18	4	Wind raises dust and loose paper; small branches move	Moderate
19 -24	5	Small leaves in trees begin to sway; crested wavelets appear on inland waters	Fresh
25 -31	6	Large branches move; telegraph wires whistle; umbrellas become unwieldy	Strong
32 -38	7	Whole trees sway; walking into wind is difficult	
39 -46	8	Twigs break off trees; cars veer on road	Gale
47 -54	9	Slight structural damage occurs	
55 -63	10	Trees are uprooted; considerable structural damage is done	Whole Gale
64 -72	11	Widespread damage	
73 or more	12	Widespread damage	Hurricane

C. <u>Wind Vane</u>

The wind vane is an instrument for monitoring the direction of the wind. It can have many shapes, but the most conventional seems to be that of an arrow.

<u>Materials</u>

1 Galvanized sheet metal stock measuring 1/16" X 4" X 12"

1 Brass tube with an inside diameter of 1/8"

1 1" dowel 4' long, or a broomstick handle

1 1/8" X 5" length of music wire

1 Spool of solder and a soldering iron

1 Compass

Procedure

1. Cut out the desired shape of pointer from sheet metal stock. Make sure pointer balances forward of midpoint; if not, trim until it does.

2. At balance point solder brass tube to sheet metal stock pointer.

3. Hammer the 1/8" music wire into one end of dowel or broomstick.

4. Place pointer on music wire and note direction of wind by verification with a compass.

D. Barometer

The barometer is not a readily transportable instrument. Therefore barometric readings should be taken prior to any field trips. The following is a chart of barometric readings and indications. (Next page.)

It is by no means expected that through this brief discussion of Cartography and Weather that a thorough knowledge is gained. All that is hoped for, is that a better understanding is achieved. For those individuals who are further interested in Cartography and Weather Forecasting, the following list of books is offered. (See Bibliography.)

BAROMETRIC INDICATIONS

Wind Direction	Barometer at 30.00"	Kind of weather to be Expected
SW to NW	30.10 to 30.20 steady	Fair with little temp. change for one or two days
SW to NW	30.10 to 30.20 rising fast	Fair followed by rain within two days
SW to NW	30.20 or above steady	Continued fair with little temp. change
SW to NW	30.20 or above falling slowly	Slowly rising temp.; fair for two days
S to SE	30.10 to 30.20 falling slowly	Rain within 24 hours
S to SE	30.10 to 30.20 falling fast	Wind rising in force: rain in 12 to 24 hours
SE to NE	30.10 to 30.20 falling slowly	Rain in 12 to 18 hours
SE to NE	30.10 to 30.20 falling fast	Rising wind; rain within 12 hours
E to NE	30.10 or above falling slowly	In summer, light winds, rain not immediately likely; in winter rain in 24 hours
E to NE	30.10 or above falling fast	In summer rain probable within 24 hours; in winter, rain or snow and windy
SE to NE	30.00 or below falling slowly	Steady rain for one or two days
SE to NE	30.00 or below falling fast	Rain and high wind, clearing within 36 hours
S to SW	30.00 or below rising slowly	Clearing within a few hours, fair for several days
S to E	29.80 or below falling fast	Severe storm imminent; clearing within 24 hours; colder in winter
E to N	29.80 or below falling fast	Severe northeast gale, heavy rain; in winter, heavy snow and cold wave.
Going to W	29.80 or below rising fast	clearing and colder

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ENVIRONMENTAL STUDIES PROGRAM
ST. ANSELM'S COLLEGE - MANCHESTER PUBLIC SCHOOLS

A GUIDE TO DEVELOPING AND BUILDING EQUIPMENT

FOR STUDYING THE AQUATIC ENVIRONMENT*

The main purpose of this information is to serve as a guide and inspiration toward the design and construction of equipment needed in order to study aquatic environments.

One major reason that programs designed to study the environment are not considered is because of inadequate budget in order to purchase materials needed to begin such a study. This need not be the case, as much of the major equipment required can be constructed either by the teacher or the student (or both together) at little cost. Materials may be found around the lab, school shop, or purchased at the local hardware store. All that is required is the need for a particular piece of equipment, a little research into its design and use, a little imagination and a walk through a hardware store and for a few dollars you can construct a piece of equipment that might cost eighty dollars or more from some supply company.

In fact, even though your school can afford the necessary equipment the construction of equipment serves as a very definite educational tool. A greater understanding of the functional design and its limitations of the particular piece of equipment is fostered and creativity is encouraged.

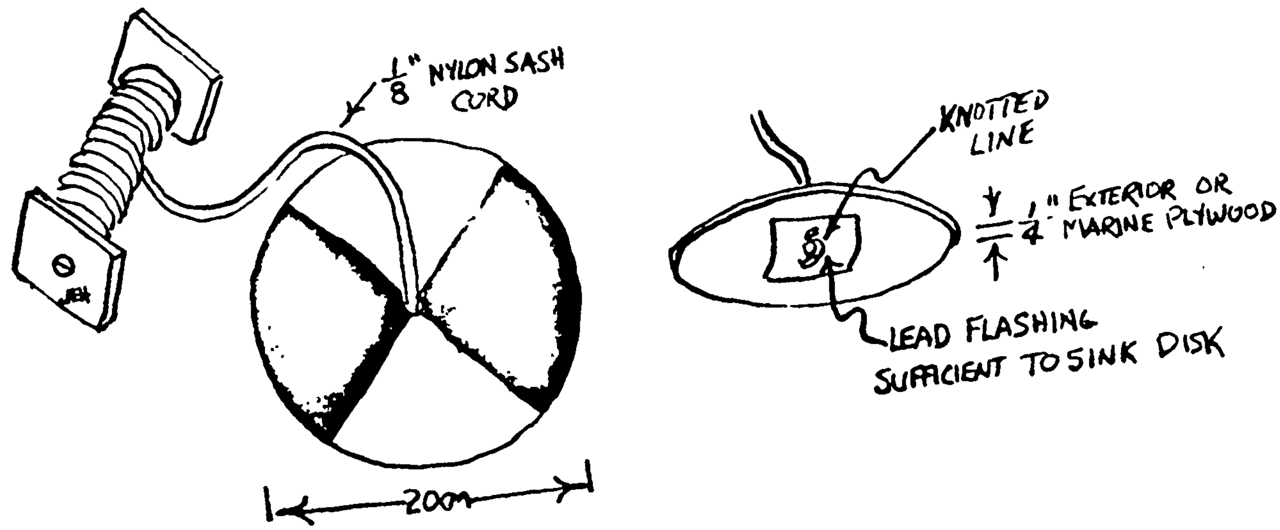
The equipment presented in this unit should serve as examples mainly to illustrate the kinds of things that can be done, although sufficient information is given if the reader wishes to construct any of these items. An extremely good and complete source of information concerning technical methods involved in limnology, the kinds of equipment that have been devised, and how they are used is a text by Paul S. Welch, Limnological Methods published in 1948 by McGraw-Hill.

In general the format for this presentation will consist of: (1) a suggestion of the need for a particular apparatus;

*By John E. Hutchins, Hanover High School, Hanover, NH
Draft: March 1, 1973

(2) the rational behind the design; (3) the design mainly in illustrative form (with sufficient detail if the apparatus is to be copies); (4) some suggestions on its use; and (5) any limitations or inadequacies of the device.

Very often it is necessary to get information on the penetration of light into water. Obviously some sort of photometric device would be best and such a device can be either purchased or constructed, but even if constructed the cost would be great. A very simple and adequate piece of equipment when used properly can give useful information. The Secchi disk, as it is called, depends on a measure of the limits of visibility. It is simply a disk painted in four black and white quadrants which is lowered into the water until it disappears from view and the depth at which this occurs is recorded. It is then raised until it can be seen again and this distance is recorded and an average of the two readings is calculated. The bottom of the 20 cm in diameter disk is painted black so that it will not reflect light.



SECCHI DISK

The Secchi disk is obviously not an actual measure of light penetration but is useful for comparing a body of water at different times or to compare different bodies of water. Since the results will vary between observers and between light conditions and water surface conditions the observations should be made as standard as possible (for example, use a water telescope or the shaded side of the boat to cut down on surface reflections) and the recorded observations should carry information under which the tests were made.

Samples of water need to be collected below the surface in order that various chemical tests may be made, such as, the amount of dissolved oxygen at various levels. A Kemmerer water sampler may be purchased but several inexpensive substitutes can be made. The simplest type is the cork stoppered lead weighted soda bottle sampler.

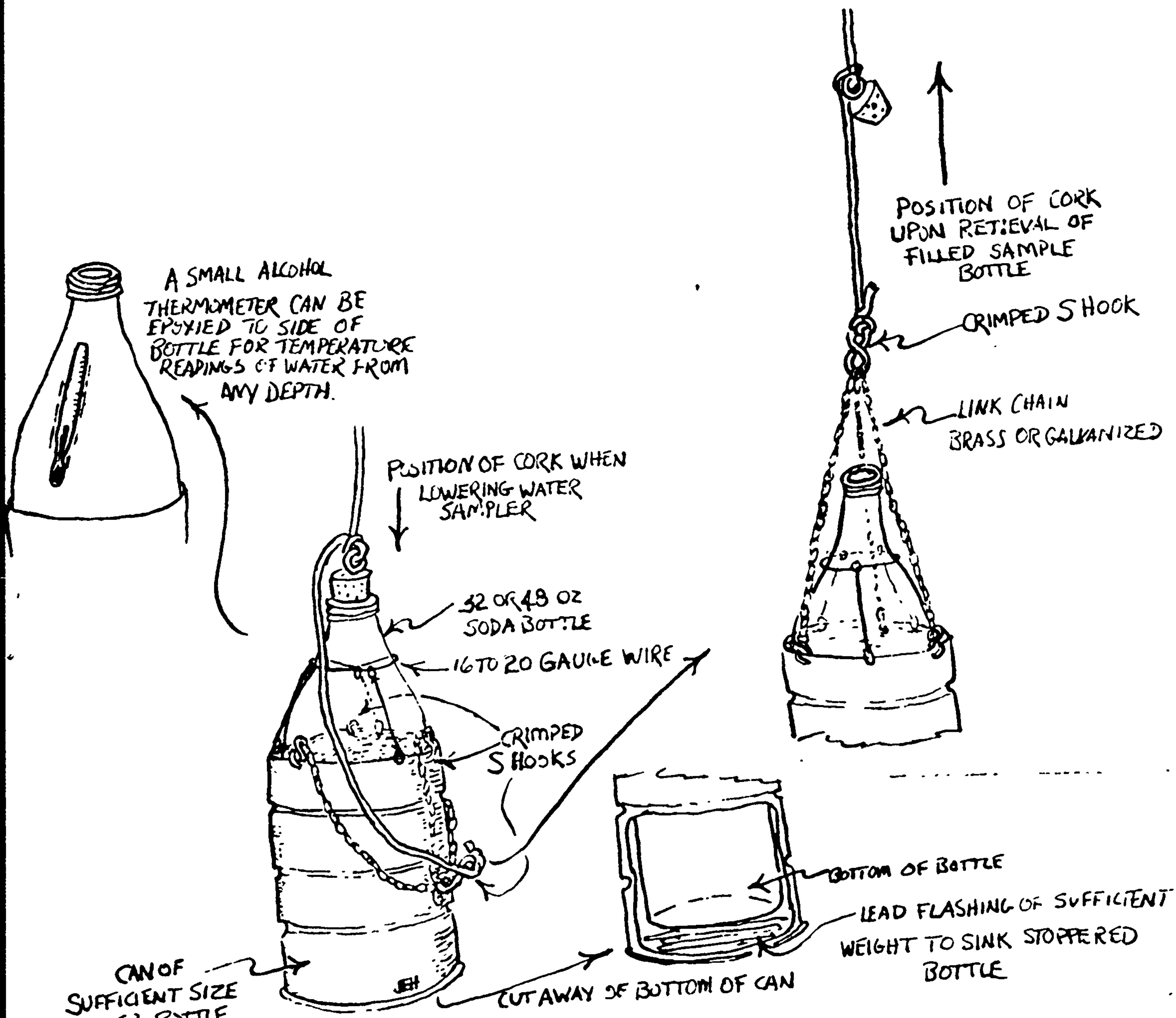
A line is fastened to a cork (and the sampler itself) which is placed in a large (32 or 48 ounce) soda bottle sufficiently tight enough to support the weight of the sampler and some lead weight which is used to sink the bottle. When the bottle is at a desired depth a jerk on the line will remove the stopper and the bottle will fill with water. (See next two pages for illustrations of the soda bottle samplers).

Apparently, as some studies have shown, as the bottle is retrieved once it is filled there is little mixing of the water collected at one depth with that which it passes through. The severest limitations concern the length of time to fill the bottle, the size of the sample collected, and the depth to which the sampler is effective.

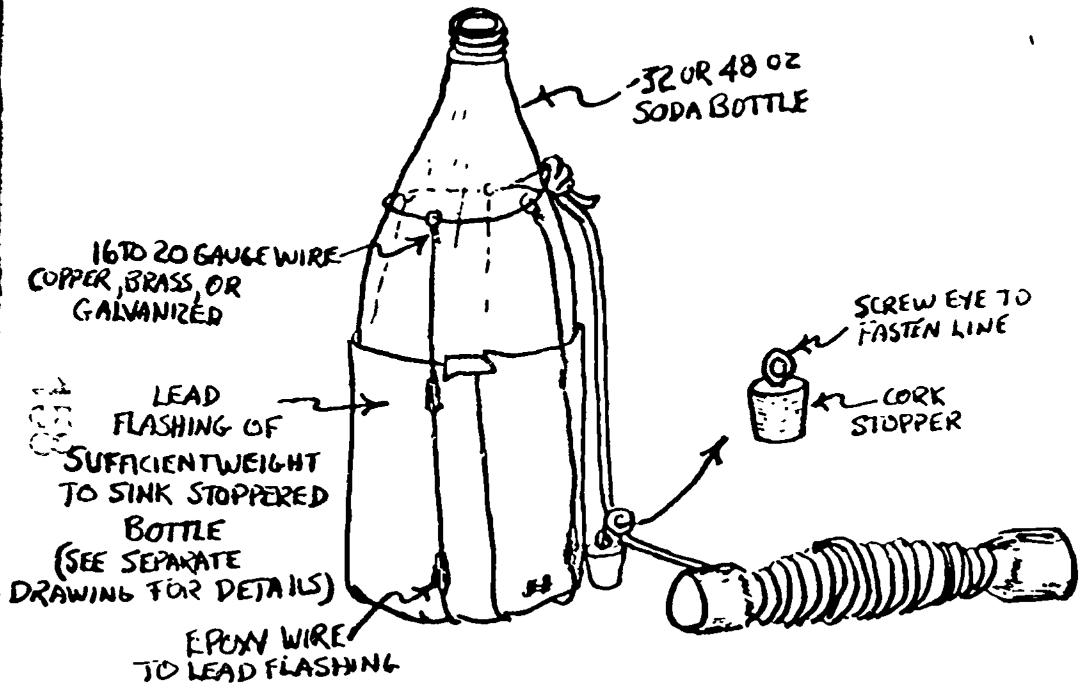
It is necessary either to time how long it takes the bottle to fill, then allow a little more time than this when collecting a sample or to watch for bubbles arriving at the surface as an indication as to when the sampler is filled.

Due to water pressure on the stopper the sampler cannot be used at very great depths as it becomes impossible to pull the stopper out. If samples are to be taken in depths greater than teen feet some other sort of sampler should be used.

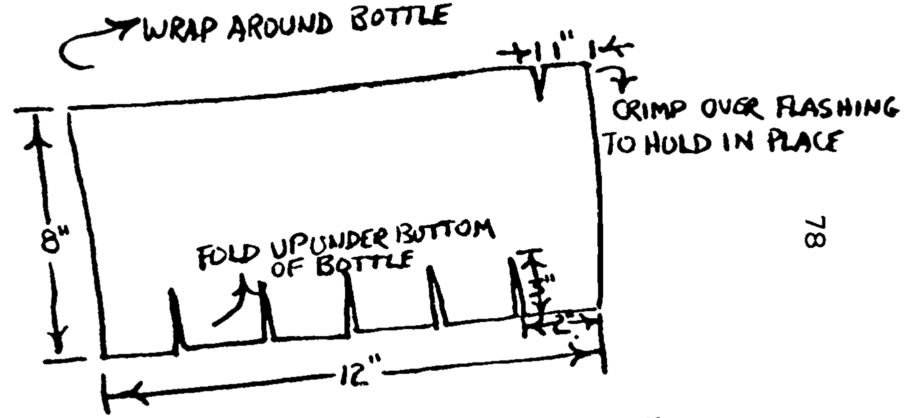
A water sampler similar to the Kemmerer can be constructed to overcome the problems of depth, size of sample, and time to collect the sample. Built of materials found in any hardware



SIMPLE WATER SAMPLER



SIMPLE WATER SAMPLER



APPROXIMATE SIZE OF LEAD FLASHING TO SINK 32 OZ STOPPERED BOTTLE store these samplers are nearly as effective as a commercially constructed Kemmerer type. Building one is not as simple as the soda bottle type, but in the end the effort is worth it. Two types have been designed, one a typical vertical sampler, the other a horizontal one which would allow for a sample right on the bottom of the body of water being sampled.

Both samplers are made of basically the same materials: toilet tank ball valves; eyebolts; latex tubing; assorted bolts, nuts, and washers; small link chain; hose clamps; and two inch polyvinylchloride (PVC) drain pipe which is easily drilled, sawed, or carved.

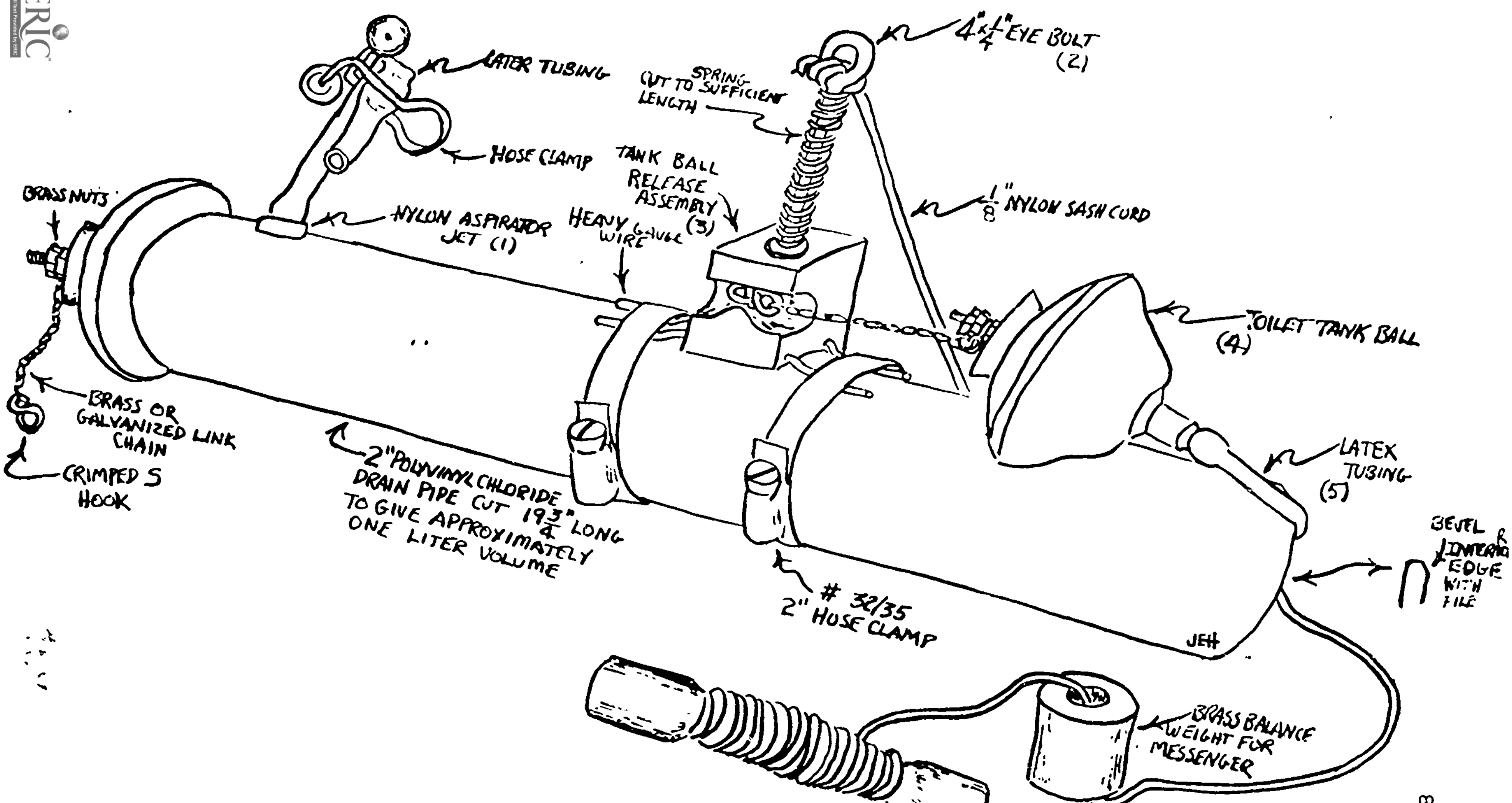
The basic idea is that the assembly is lowered by line to the depth desired to be sampled, a weighted messenger is dropped which strikes a release mechanism on the sampler thus releasing the toilet tank balls which trap the water being collected in the drain pipe. The sampler is then retrieved and the water can then be released as needed by a clamped latex tube in the sampler wall.

The illustration presented here are for both types of samplers. Given first in complete detail is the horizontal sampler. Important dimensions are given, but some are not and will have to be determined when adjusting tension and the like on the sampler. (See next 3 pages for illustration of the horizontal water sampler, and detailed illustrations).

Detailed illustrations of particular aspects of the sampler are as follows:

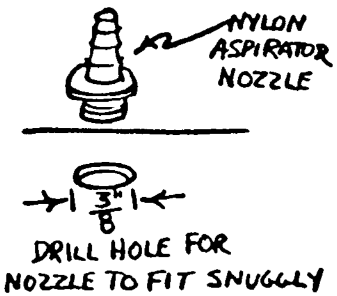
#1 One of the difficulties with using polyvinylchloride is that it is almost impossible to use adhesives except when bonding PVC to PVC or to copper. This is why hose clamps are used. There are many ways that the spiggot for removing the sample may be attached. In this case a hole slightly smaller than the nylon aspirator nozzle is made sc that the nozzle is then forced into the hole. Then latex tubing can be fitted over the nozzle.

#2 On the prototype model a hole was drilled up into the end of the eyebolt, then the screw hook epoxied into the hole, but this is not recommended as it is difficult to drill straight up the bolt. The adjustment nut makes it possible to adjust the amount the hook extends up into the release assembly block. The spring should be cut so that sufficient tension is produced to hold the hook up into the release assembly block.

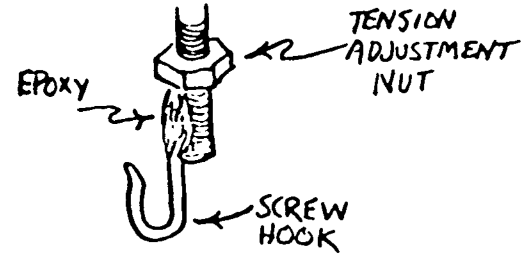


HORIZONTAL WATER SAMPLER

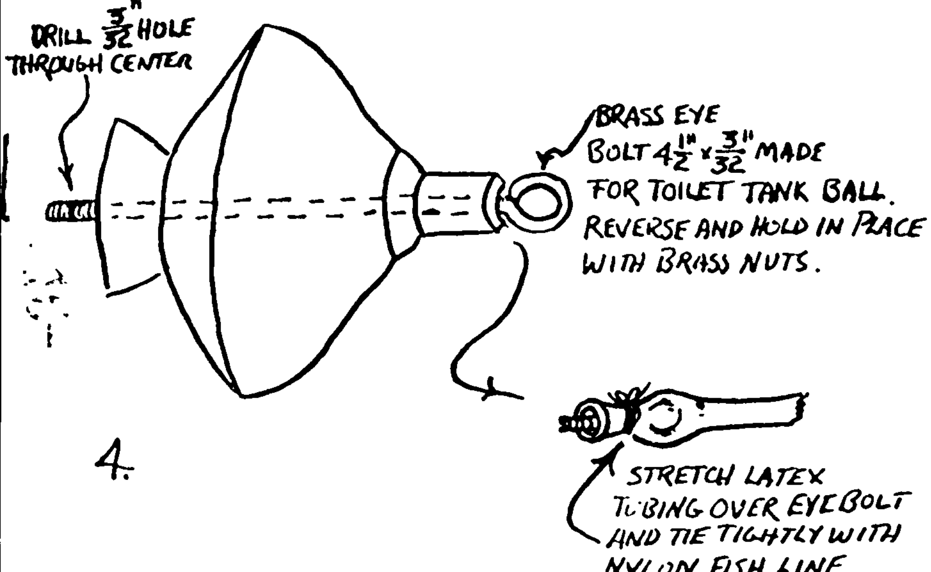
1.

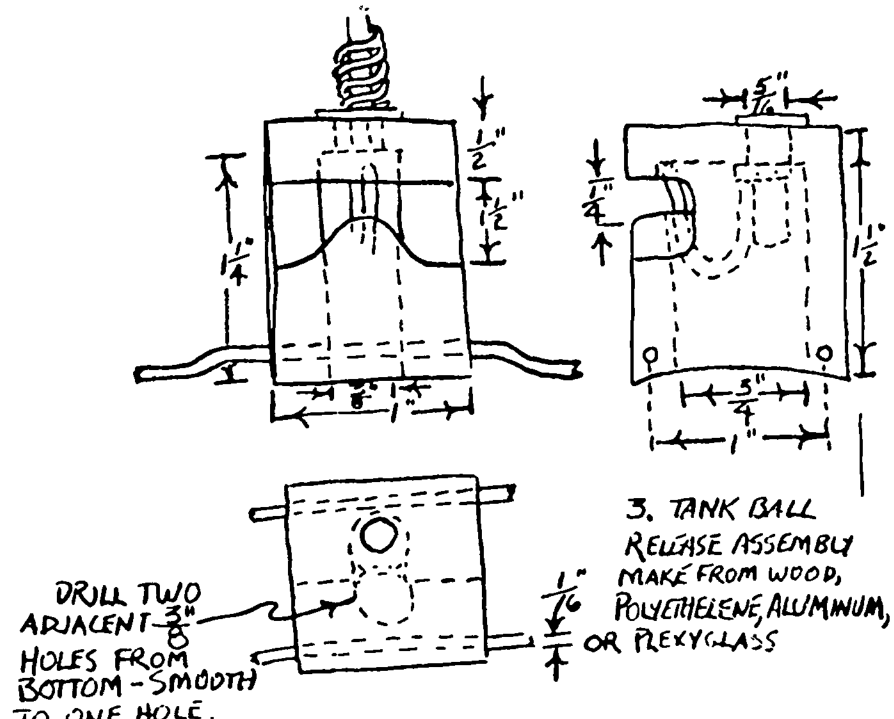


2.

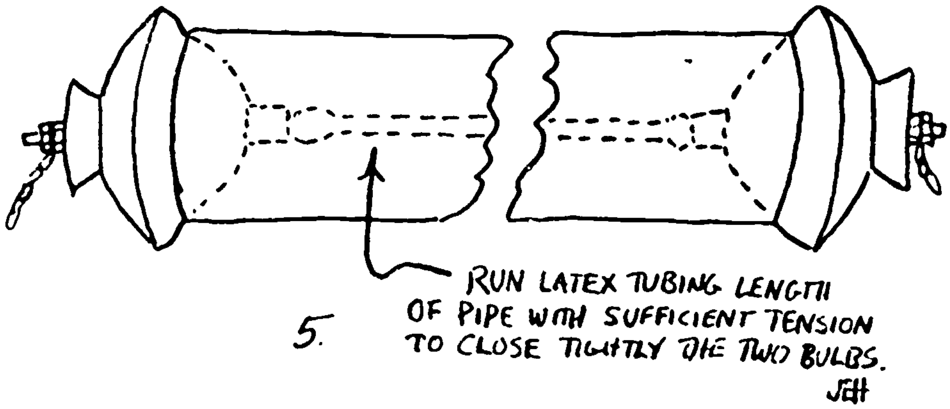


4.

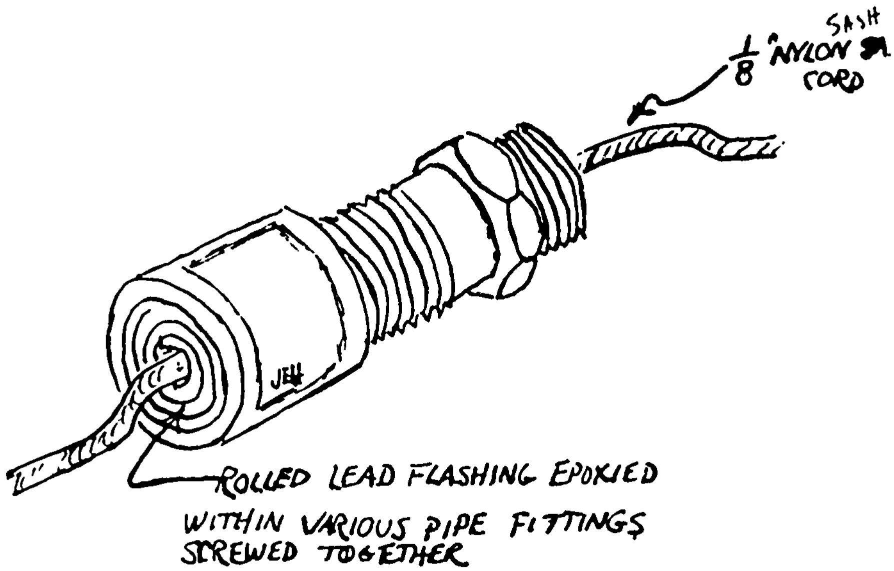




3. TANK BALL RELEASE ASSEMBLY MAKE FROM WOOD, POLYETHELENE, ALUMINUM, OR PLEXYGLASS



5.



6. MESSENGER

#3 It is not important as to what material is used for the release assembly block but the material should be durable, rust proof, and easy to machine, carve, or file. A piece of polyethylene packing material one inch thick was used on the prototype. It is important that the hook extend up into the block so that when set the S hooks cannot slip off until the messenger, when it hits the eyebolt, pushes the hook low enough so that both S hooks are released.

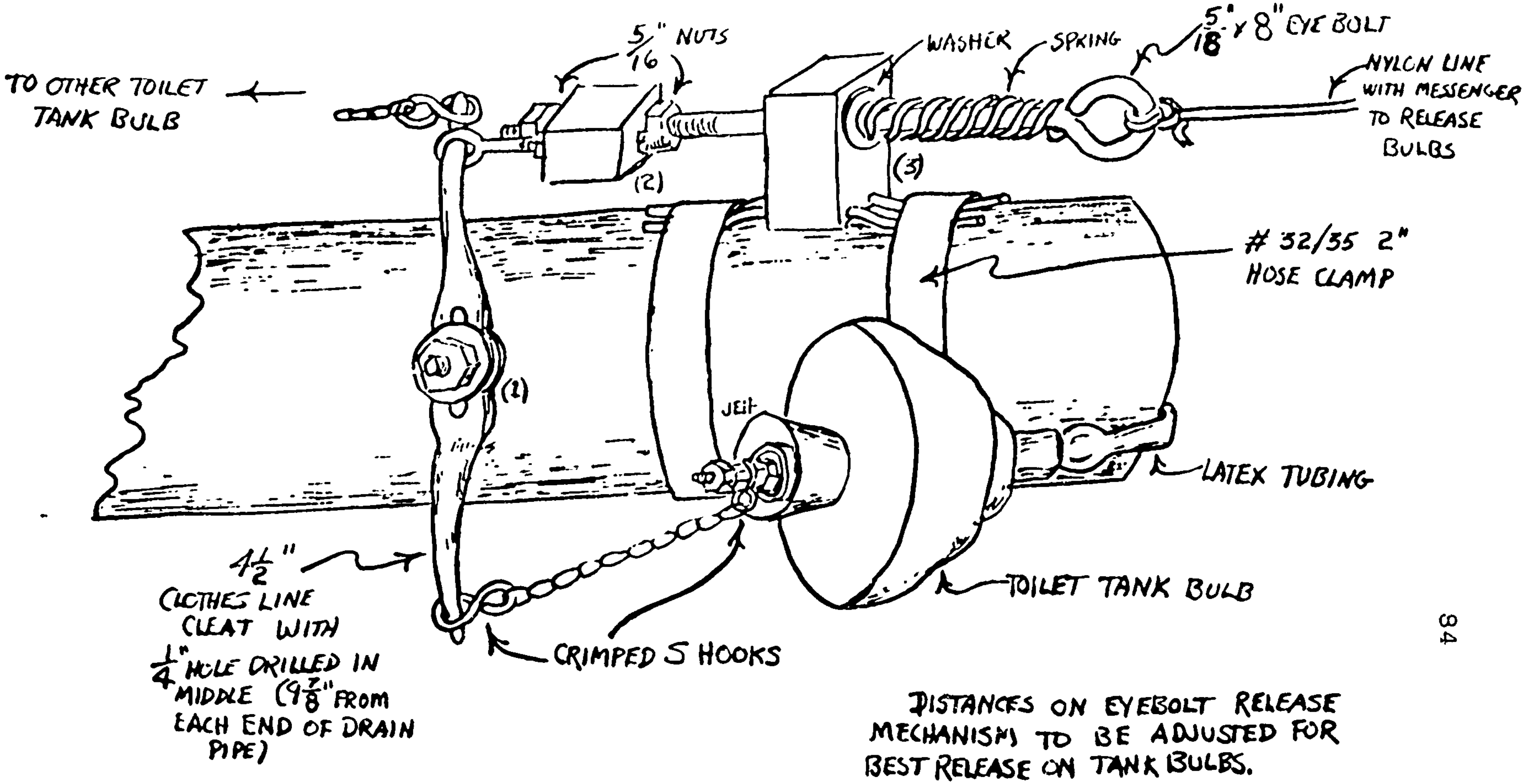
#4 The brass eyebolt is made for the toilet tank ball, but must be purchased separately. Nuts do not come with this eyebolt, but some brass nuts can be purchased which fit. Drill the hole through the brass fitting in the center of the ball and through the rubber under the fitting until the interior of the toilet tank ball is reached. The brass eyebolt is then inserted in the reverse position it is meant to be and held in place with a brass nut. Then one end of the link chain is placed over the bolt and secured with two nuts, one to lock the other in place.

$5 Latex tubing should be of sufficient length to close tightly both tank balls so no leakage occurs but loose enough so that both bulbs can be attached to the release assembly.

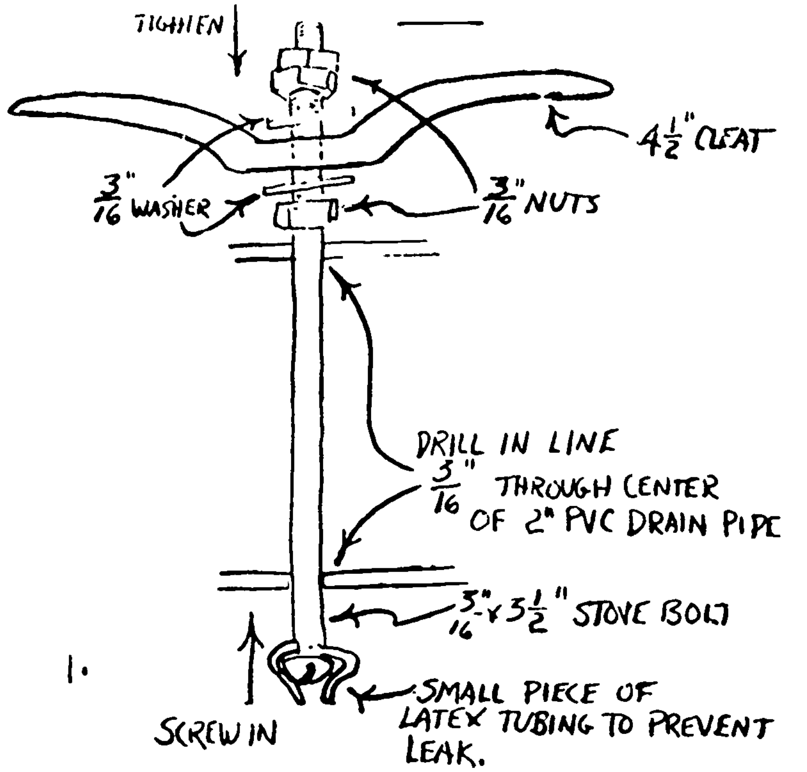
#6 The brass messenger (normally costs around fifteen dollars) can be made from a large brass balance weight from which the knob is unscrewed and a hole drilled through the center, or by screwing some pipe fittings together and epoxying a rolled piece of lead flashing in the center to give it sufficient weight.

The vertical water sampler is basically the same as the horizontal sampler. Therefore, details are given only for the release mechanism which differs in this sampler. (See next three pages for illustration of the vertical sater sampler and detailed illustrations).

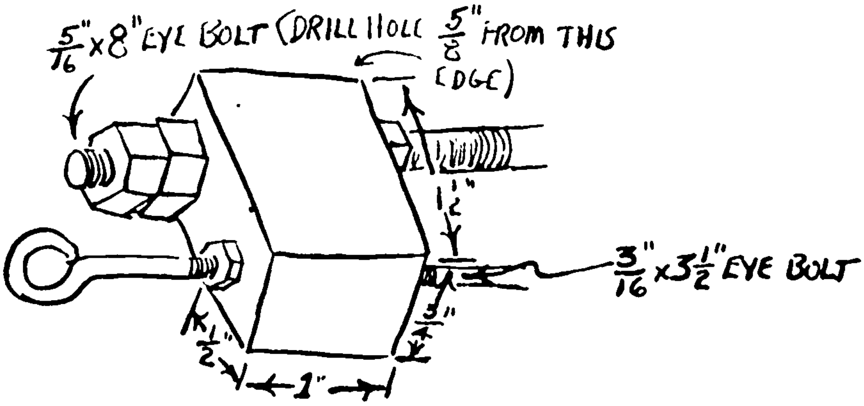
#1 Hole should be drilled exactly in the middle of the drain pipe and through the center of the circumference. Make the hole slightly smaller than the size of the stovebolt so that when inserted it is possible to cut threads by screwing the bolt through the hole. This should help prevent any leaks. The head of the bolt can be covered with a small piece of latex tubing to help prevent a leak at this point. Tighten the first nut so the bolt cannot turn but tighten the last so that the cleat can rotate freely.



VERTICAL WATER SAMPLER
(COMPLETE DETAILS AS IN HORIZONTAL SAMPLER)


TIGHTEN
4 1/2" CLEAT
3/16" WASHER
3/16" NUTS
DRILL IN LINE
3/16" THROUGH CENTER
OF 2" PVC DRAIN PIPE
3/16" x 3 1/2" STOVE BOLT
SCREW IN
SMALL PIECE OF
LATEX TUBING TO PREVENT
LEAK.

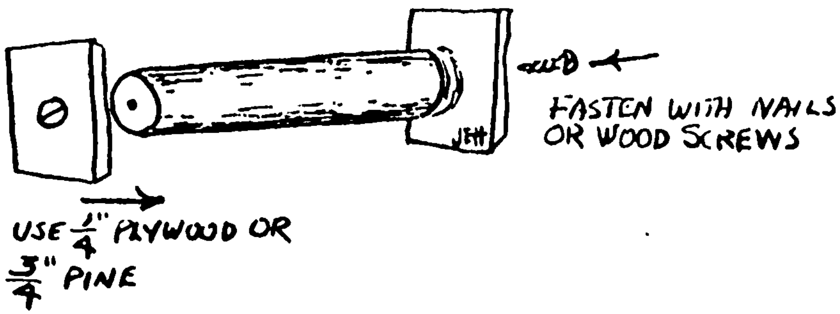
1.

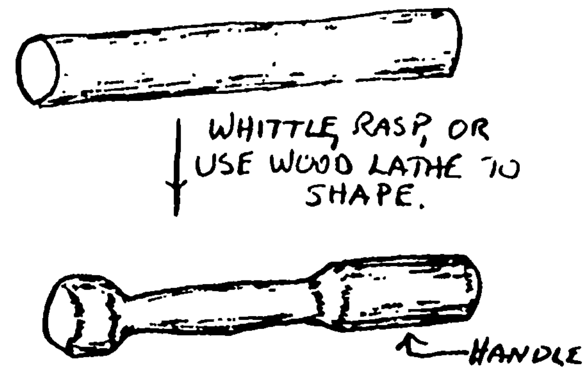

5/16" x 8" EYE BOLT (DRILL HOLE 5/8" FROM THIS
EDGE)
1/2"
3/16" x 3 1/2" EYE BOLT
1/2"
3/4"
1"

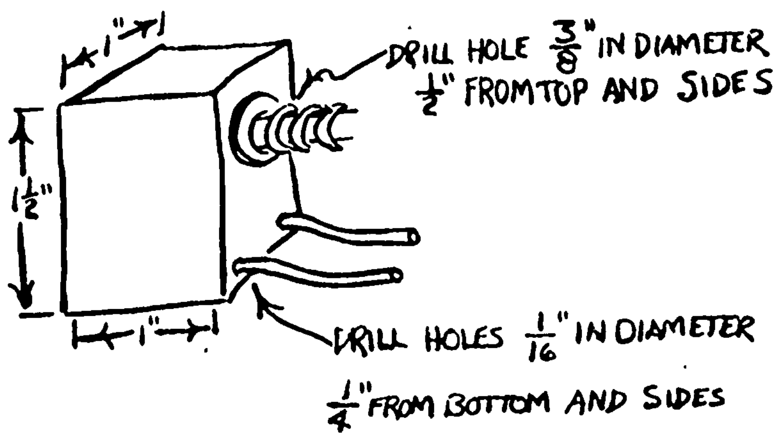
2.

SPOOLS TO WIND LINE ON.

USE $1\frac{1}{4}$" CLOSET POLE







3.

#2 The smaller eyebolt is secured from both sides with nuts as is the larger bolt. The length of the assembly can be adjusted by using these nuts. This block and the one given in illustration three may be made of the same material as the release mechanism of the horizontal sampler.

#3 The spring must be cut of sufficient length to give proper tension on the cleat so that the bulbs are not prematurely released, but will release when the messenger is dropped.

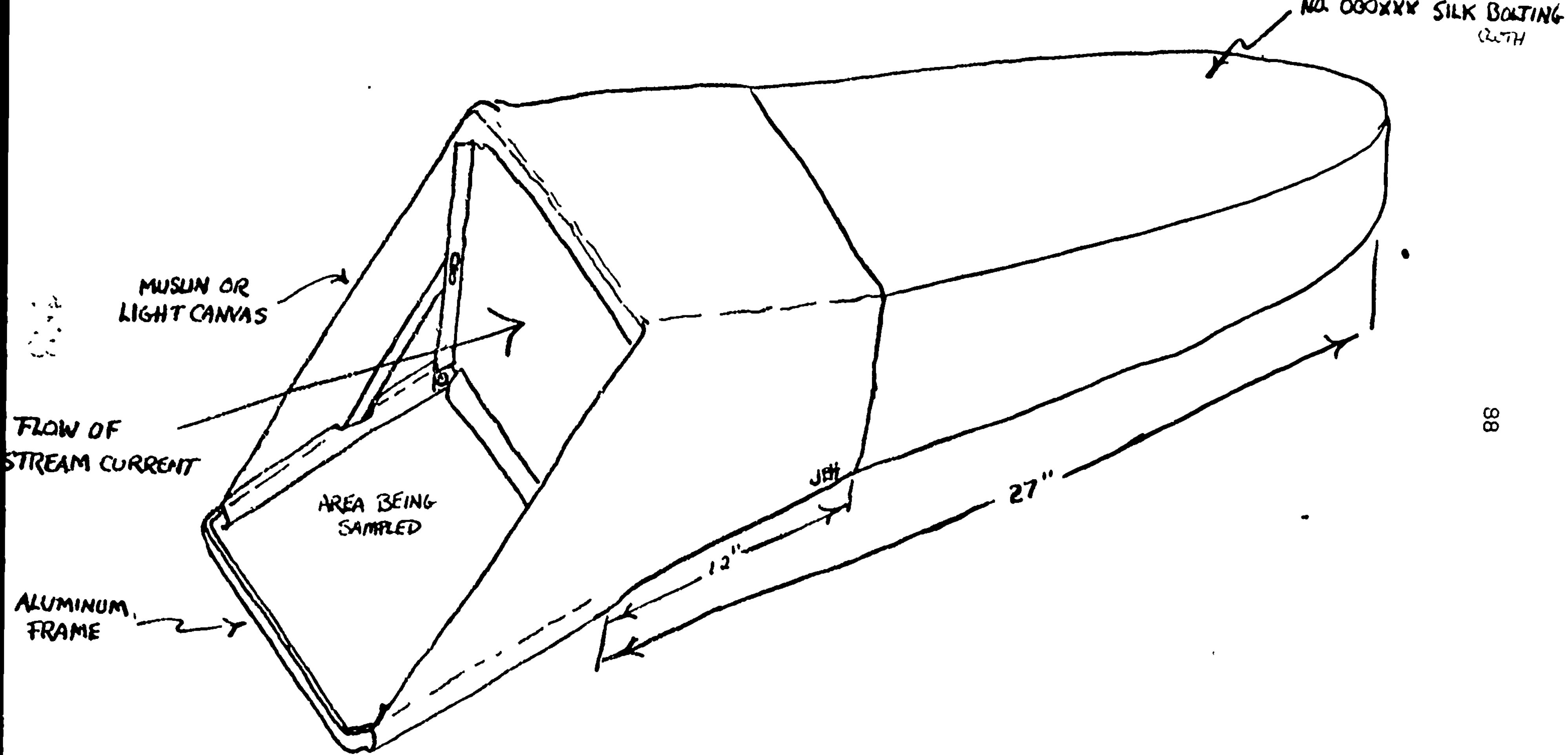
#4 Spools to wind line on.

The only difficulties in using either sampler are concerned with the fact that even when all tensions are adequately adjusted, occasionally one of the tank balls does not close properly, but this occurs in about one in five tries. The horizontal sampler should be allowed to remain at the depth to be tested for a few moments to insure that the water being trapped is indeed from that depth.

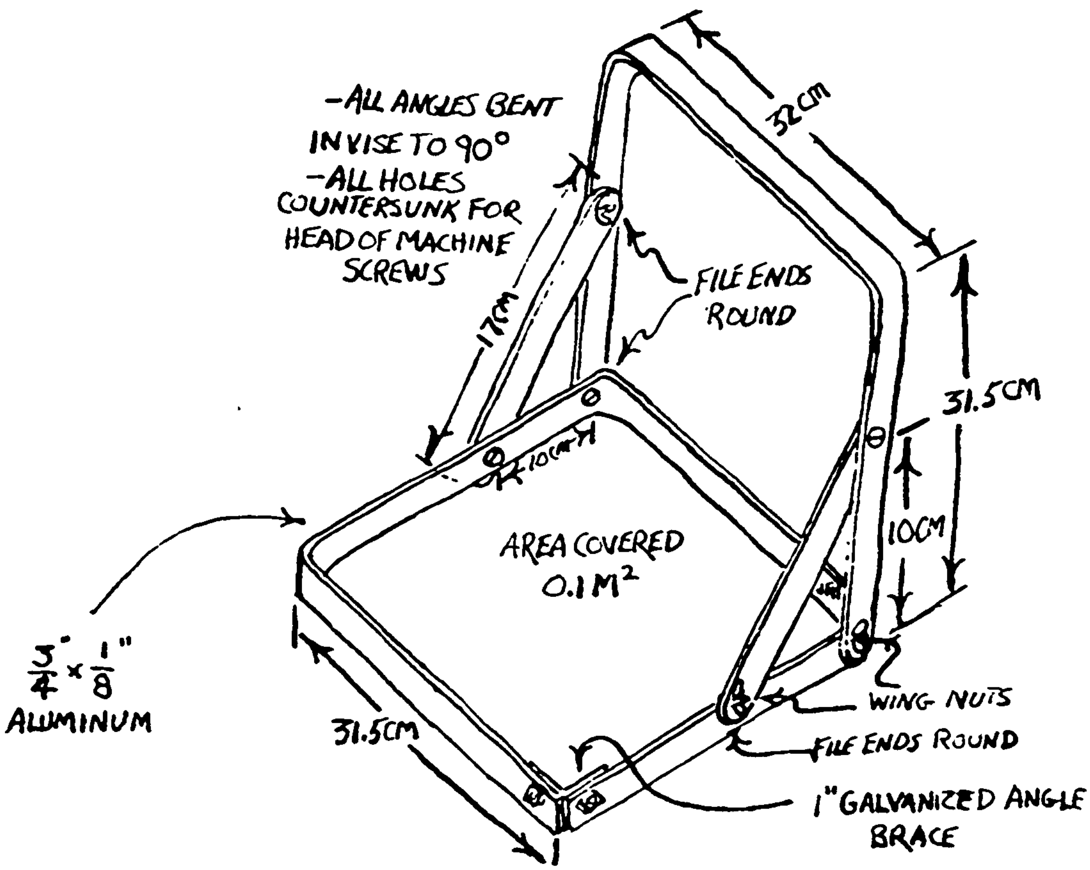
When removing a sample with the latex tubing it is necessary to support the lowest bult in the palm of one hand while the pipe rests against the arm. The clamp will have to be operated with the same hand as is the one supporting the lower tank ball, as the other hand must tip the upper tank ball to allow air in to replace the water removed.

In order to collect specimens from the bottom of a shallow stream a Surber stream bottom sampler is usually affective. A good collapsable brass one with case can be purchased but it is possible to make a similar one out of aluminum. All that is essential is a good seamstress. The basic frame is made from a bar of one-eighth inch by three-quarter inch by six feet Alcoa aluminum bar which can be easily bent in a vise and drilled with a quarter inch drill. (See following pages).

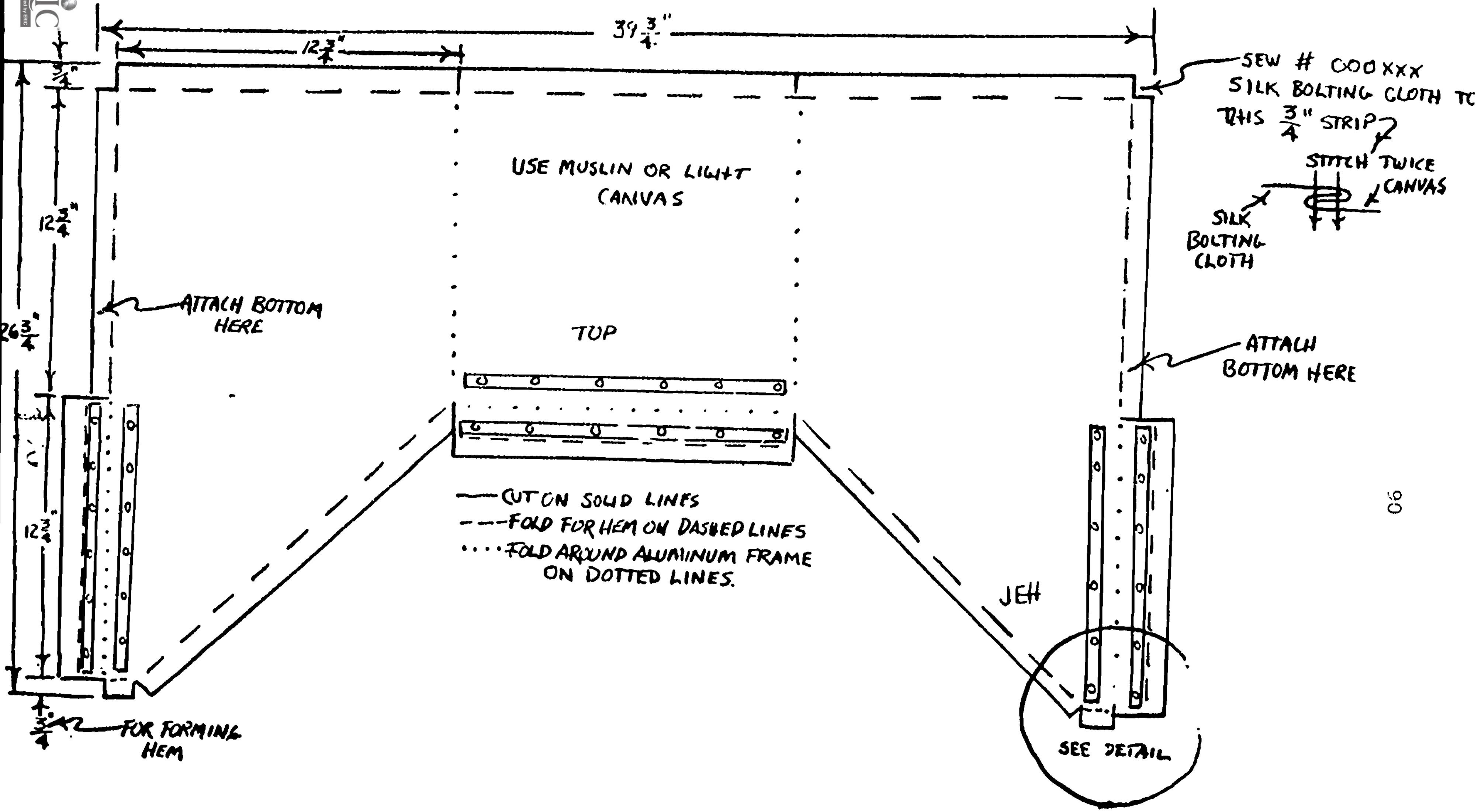
The net is made with gripper tape which makes it possible to remove the net for cleaning. Canvas may be bought at an artist supply store and the netting will probably have to be purchased from a supply house. (See following pages).

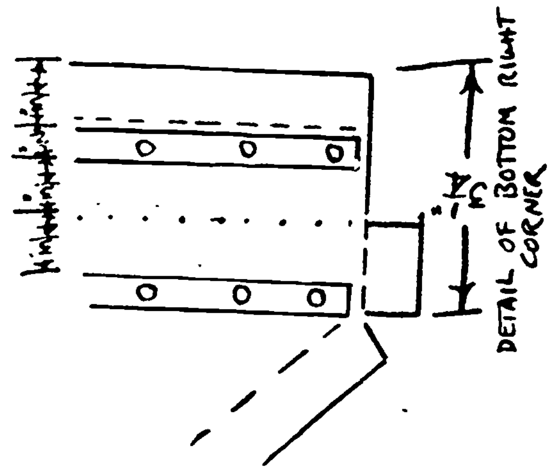


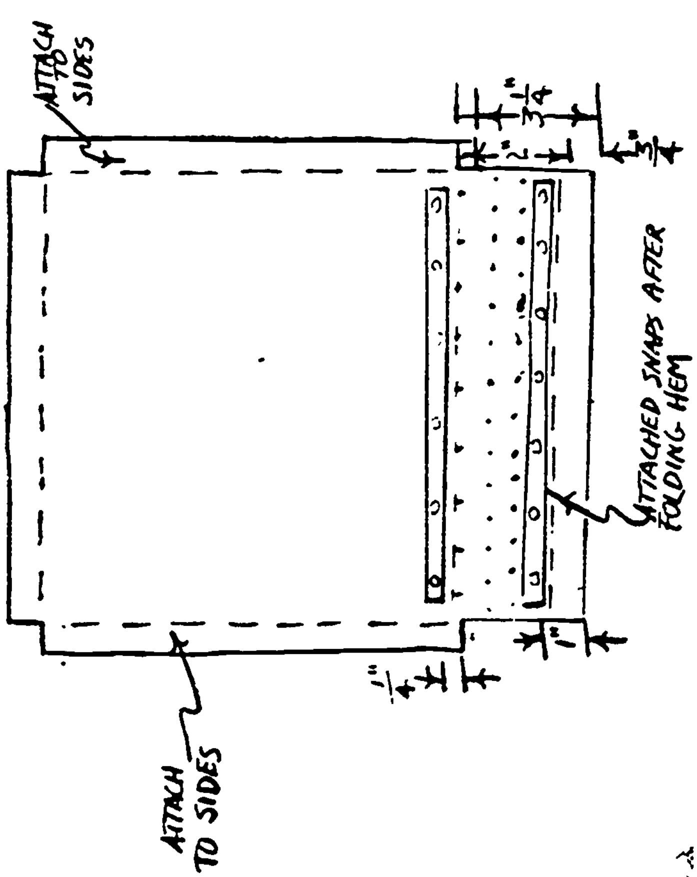
SURBER STREAM BOTTOM SAMPLER

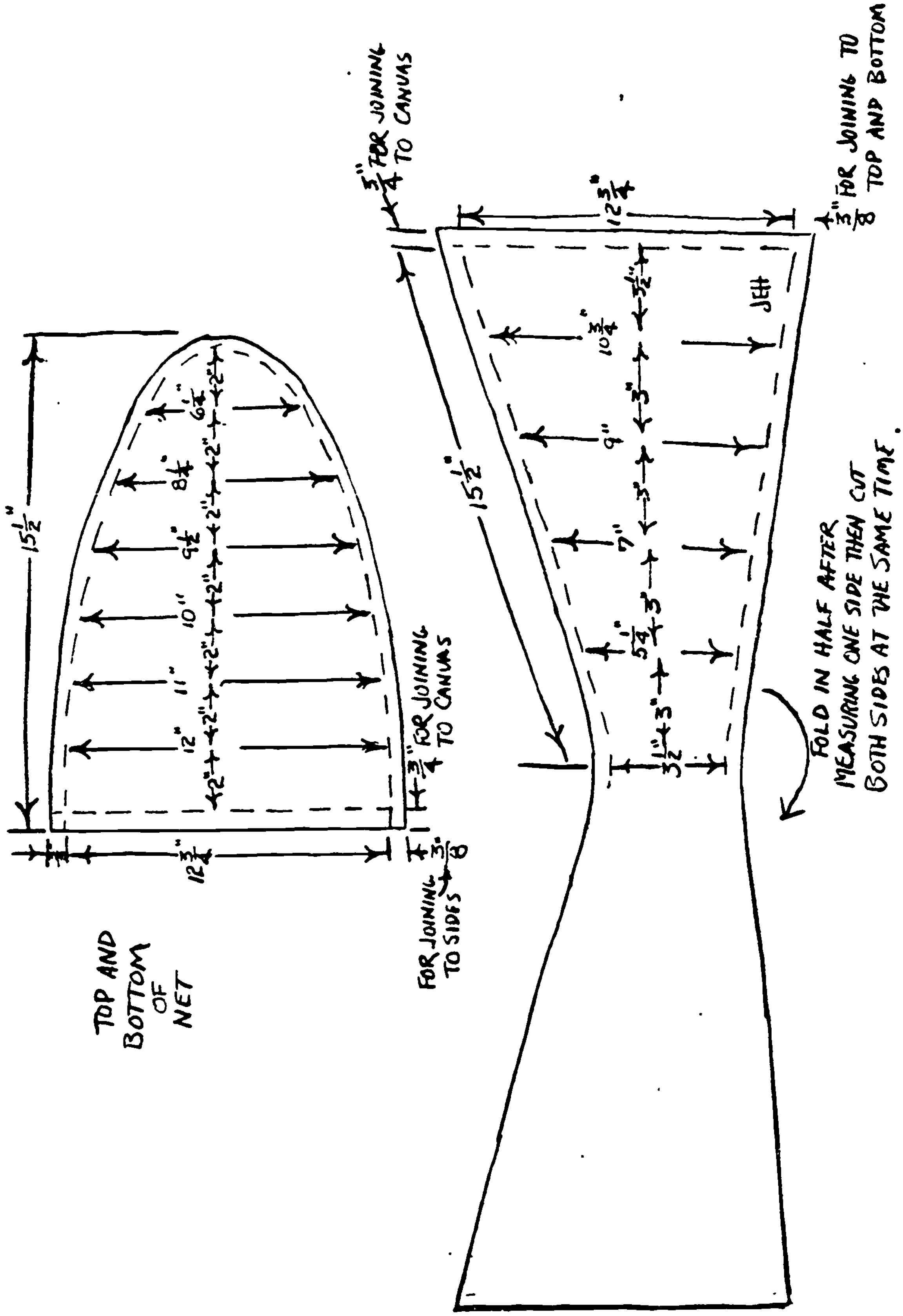


SUPPORTING FRAME FOR SURBER SAMPLER


39 3/4"
12 3/4"
SEW # 000XXX SILK BOLTING CLOTH TO THIS 3/4" STRIP
STITCH TWICE
CANVAS
SILK BOLTING CLOTH
USE MUSLIN OR LIGHT CANVAS
TOP
ATTACH BOTTOM HERE
ATTACH BOTTOM HERE
3/4"
12 3/4"
26 3/4"
12 3/4
3/4
FOR FORMING HEM
CUT ON SOLID LINES
FOLD FOR HEM ON DASHED LINES
FOLD AROUND ALUMINUM FRAME ON DOTTED LINES.
JEH
SEE DETAIL


DETAIL OF BOTTOM RIGHT CORNER


ATTACH TO SIDES
ATTACHED SNAPS AFTER FOLDING HEM
ATTACH TO SIDES



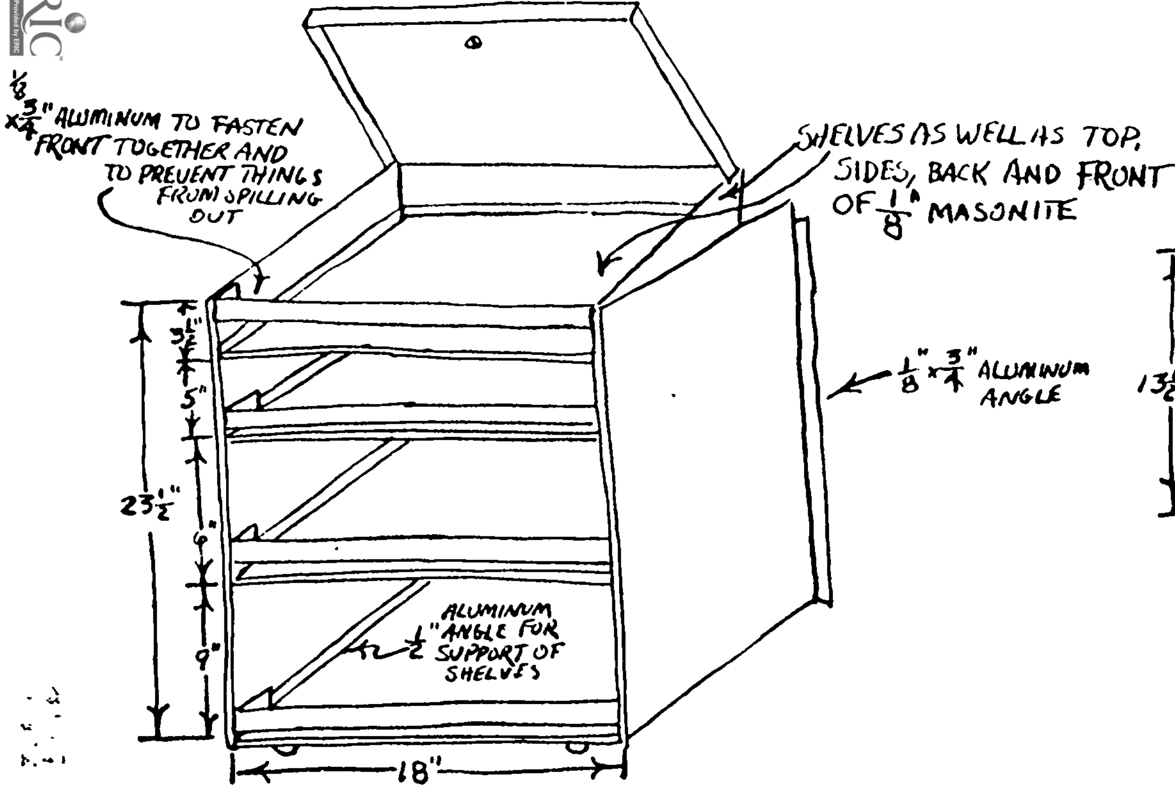
TOP AND BOTTOM OF NET
15 1/2"
12 3/4"
3/4" FOR JOINING TO CANVAS
3/8" FOR JOINING TO SIDES
12"
11"
10"
9 1/2"
8 1/4"
6 1/4"
2"
3/4" FOR JOINING TO CANVAS
3/8" FOR JOINING TO TOP AND BOTTOM
10 3/4"
9"
7"
5 1/4"
3 1/2"
3"
5 1/2"
FOLD IN HALF AFTER MEASURING ONE SIDE THEN CUT BOTH SIDES AT THE SAME TIME.

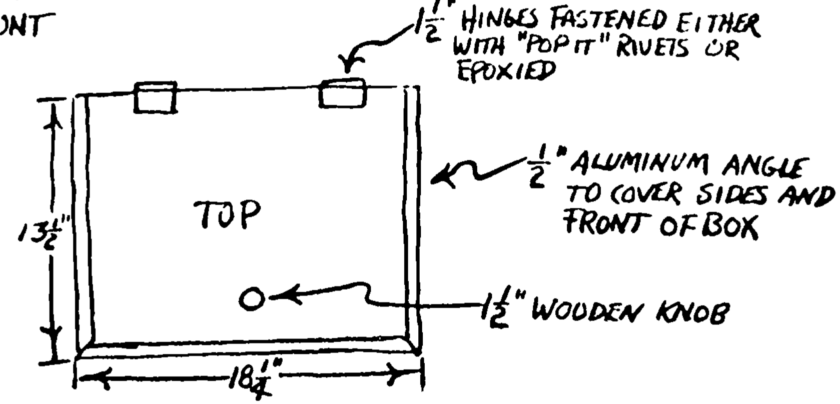
Three quarters of an inch is left around the edge to double stitch a hem. Stitch the hem on the flaps before sewing on the gripper strip. When sewing the netting pieces together overlap them by three quarters of an inch and double stitch with single fold bias tape.

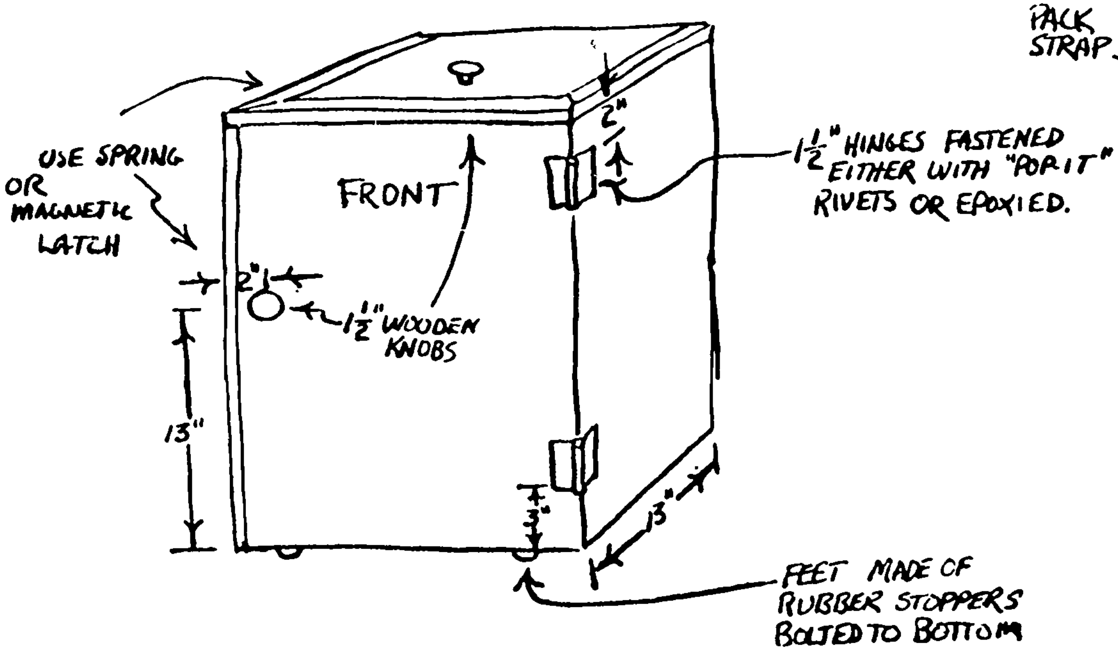
Normally, Surber samplers cover a square foot, but in keeping with the use of the metric system in science this one is designed to cover one-tenth of a square meter. The net is made to be used in shallow moving bodies of water. It is placed on the bottom with the open mouth facing upstream so that the water flows into the net. As the net is held in place by hand or knee, rocks should be used from outside the net and placed around the outside perimeter so that organisms cannot escape under the net. Then, while the net is held in place rocks are picked over, held in front of the net and either rubbed by hand or a small stiff bristle brush to release organisms into the net. Gravel and sand may be sifted through the fingers as well, until the full area is covered. When finished the net should be picked up by pulling forward and out. Material in the net may be washed and collected at the bottom of the net by splashing the exterior sides of the net with stream water. The contents can either be saved in a bottle kept under ice for examination in the lab or at the site by dumping on some sort of white sorting tray.

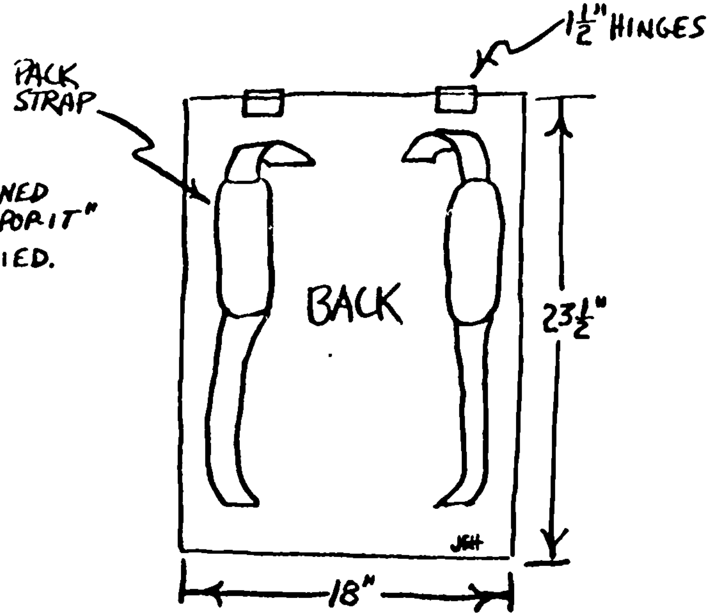
Obviously, the net is good only for certain conditions as mentioned earlier, but one other problem occurs. When heavy sand is encountered. It is necessary to examine for organisms amongst some sand which may be separated out by using different sized sieves.

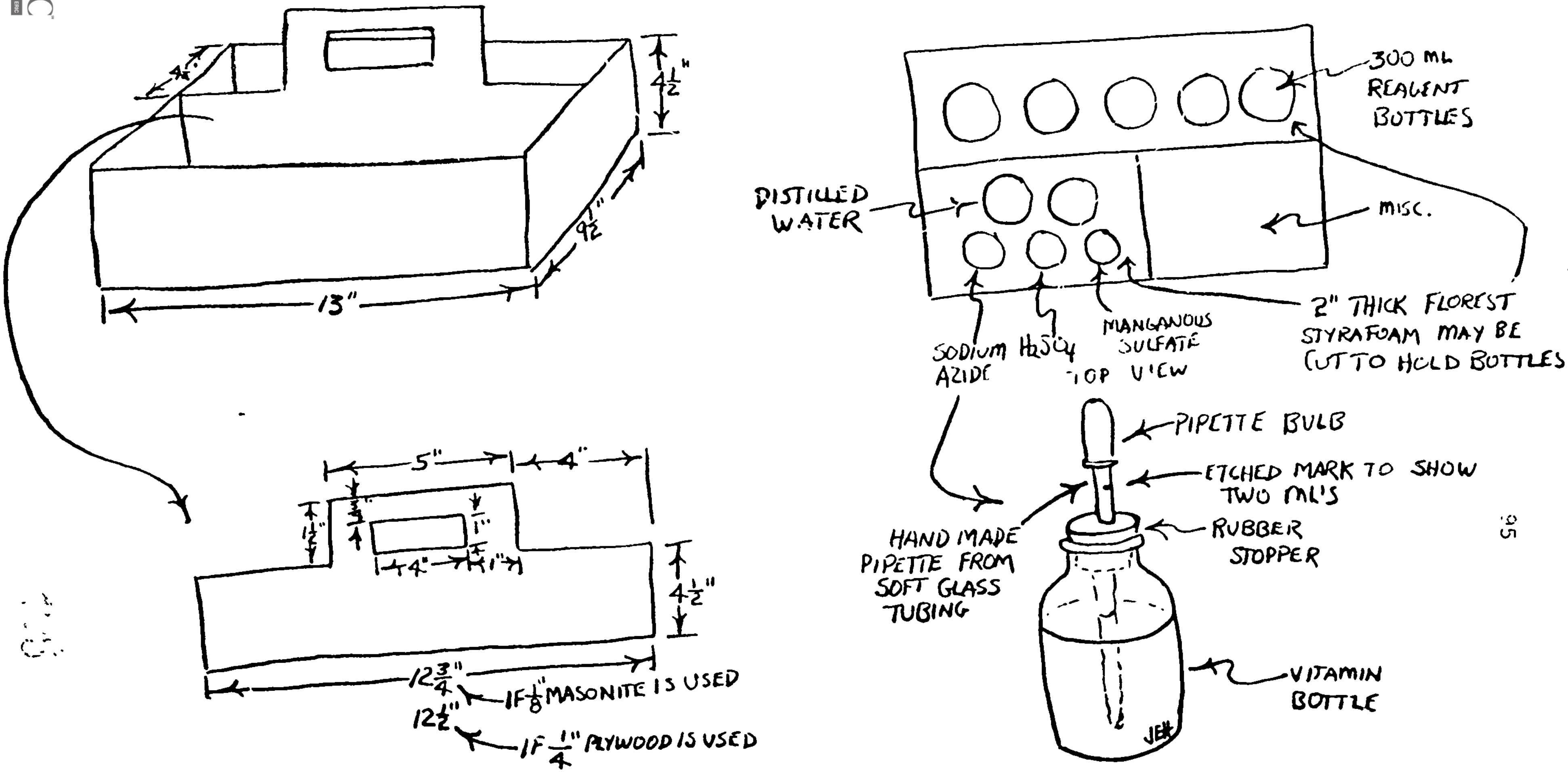
One important need when studying aquatic environments is some sort of system to carry all the various equipment and sampling bottles to the site and back to the laboratory. One way to facilitate this problem is to build some sort of portable carry-all. A rectangular box of one-eighth inch masonite is both strong enough and light enough to be carried as a pack, and when used with plastic sample bottles it is even possible to carry large quantities of samples without considerable difficulty. The unit described here was successfully carried loaded with samples from the back of a station wagon and up one flight of stairs to the lab by an average size junior girl.


1/8 x 3/4" ALUMINUM TO FASTEN FRONT TOGETHER AND TO PREVENT THINGS FROM SPILLING OUT
SHELVES AS WELL AS TOP, SIDES, BACK AND FRONT OF 1/8" MASONITE
1/8" x 3/4" ALUMINUM ANGLE
1/2" ALUMINUM ANGLE FOR SUPPORT OF SHELVES
3 1/2"
5"
6"
9"
23 1/2"
18"


1 1/2" HINGES FASTENED EITHER WITH "POP IT" RIVETS OR EPOXIED
1/2" ALUMINUM ANGLE TO COVER SIDES AND FRONT OF BOX
TOP
1 1/2" WOODEN KNOB
13 1/2"
18 1/4"


USE SPRING OR MAGNETIC LATCH
FRONT
2"
2"
1 1/2" WOODEN KNOBS
1 1/2" HINGES FASTENED EITHER WITH "POP IT" RIVETS OR EPOXIED.
13"
13"
3"
FEET MADE OF RUBBER STOPPERS BOLTED TO BOTTOM


PACK STRAP
1 1/2" HINGES
BACK
JGH
23 1/2"
18"



DISSOLVED OXYGEN TRAY

The frame can be made of either one by one-and-one-half inch wood or one-half inch Alcoa angle aluminum and attached with "Pop-it" rivets. The aluminum is superior because it is lighter in weight. Pack straps may be attached by bolting the straps through the back of the pack.

Dividers of masonite may be added to separate shelves to prevent mixing of the bottles. On the bottom shelf 500 ml plastic amber bottles may be used for collecting water samples while 300 ml white plastic bottles are just right for collecting samples for measuring dissolved oxygen. These bottles are not suitable for studying BOD or IOD as oxygen is capable of diffusing through the plastic. It is also possible to keep distilled water, insect repellent, and a plastic refrigerator jar to store waste paper.

Polycarbonate, wide mouth 300 ml jars for collecting samples to make bacteria counts along with kimwipes and a small plankton net may be placed on the second from the botton shelf.

On the third shelf from the bottom, small widemouth square bottles for collecting specimens may be stored, while in the top shelf, thermometers, clipboard, stop watch, collapsed Surber sampler, etc. may be kept.

A separate carrying box for holding bottles and reagents for making dissolved oxygen tests by the Winkler method may be used on the bottom shelf. This box may also be made of one-eighth inch masonite and aluminum or one-quarter inch plywood glued together. (See next two pages for illustration of pack unit and diagram of dissolved oxygen tray).

The major limitation with the back pack is that when loaded it is very difficult to put on and get off the ground without help, but when used with a station wagon it is quite handy.

As was suggested in the beginning of this unit, these are only a few suggestions or examples of the type of things that can be done at little cost and without a great deal of difficulty. In a like manner, many additional items can be designed and made if they are needed. Many nets, such as dip nets and plankton nets, can be constructed using one-half inch Alcoa Aluminum rod, closet pole, and netting. The aluminum rod is easily bent to any shape in a vise and can be drilled to fasten to the closet pole for handles. A Wisconsin trap for collecting vegetation-inhabiting animals can be made in a similar manner as the Surber sampler with the one-eighth by three-quarters of an inch aluminum, canvas, and appropriate netting

Perhaps it is possible to make a Jackson dredge from a one gallon food can cut in half and aluminum bar fashioned to form the handles to close the two can halves around a sample of mud; or, is it possible to construct an economical Eckman Dredge for collecting samples of mud at great depths? Maybe you need to collect more accurately samples of water for dissolved oxygen tests, then you may want to construct a modified Hale's water sampler. All you require is a need, a look at the basic design of the type of apparatus you would like, and a little imagination and it is quite probable that an inexpensive substitute can be made.

VI LOAN PROGRAM

ENVIRONMENTAL STUDIES PROGRAM
ST. ANSELM'S COLLEGE/MANCHESTER PUBLIC SCHOOLS

On this date ______________ I, ______________________________
(signature)
received on loan from West High School/St. Anselm's Environmental Studies Program, the following equipment. I assume full responsibility for this equipment until returned to West High School.

________ PLANT PRESSES (FIELD)

________ LAB PRESSES

________ VASCULUMS

________ D. O. BOTTLE

________ SECCHI DISC'S

________ BACK PACKS

________ PLANKTON NETS

________ MILLIPORE FIELD PUMP & FILTERS, MEDIA

____

____

Name ______________________________

Home Address ______________________________

City ______________ State ______________

Zip ______________ Home Telephone ______________

School ______________ School Telephone ______________

ST. ANSELM'S COLLEGE
USOE GRANT #OE-G-O-73-5422

ENVIRONMENTAL EDUCATION

HOMEMADE EQUIPMENT DESCRIPTIONS

St. Anselm's College
in cooperation with
Manchester Public Schools
Manchester, New Hampshire 03102

SECCHI DISK

The Secchi disk is a simple device used to measure the limit of visibility or the approximate compensation level. The compensation level is the depth to which photosynthesis occurs.

Construction

The Secchi disk is a circular plate of 20 cm. diameter. It can be made out of wood (Marine plywood) or metal of at least 18 gauge thickness. The upper surface of the disk is divided into alternatively black and white quandrants. The under surface is painted black. The center of the disk is drilled and a weight and bolt eye are attached. To the bolt eye is attached a line which has been accurately calibrated in meters.

Use

The disk is lowered in the water until it disappears. This depth is noted. The disk is then raised and a depth is noted when the disk reappears. The average of these two readings is the limit of visibility.

Precautions

The readings taken with the disk should be standardized. The conditions which make this possible are the following: clear sky, sun directly overhead, readings taken on protected side of boat, the use of a water telescope.

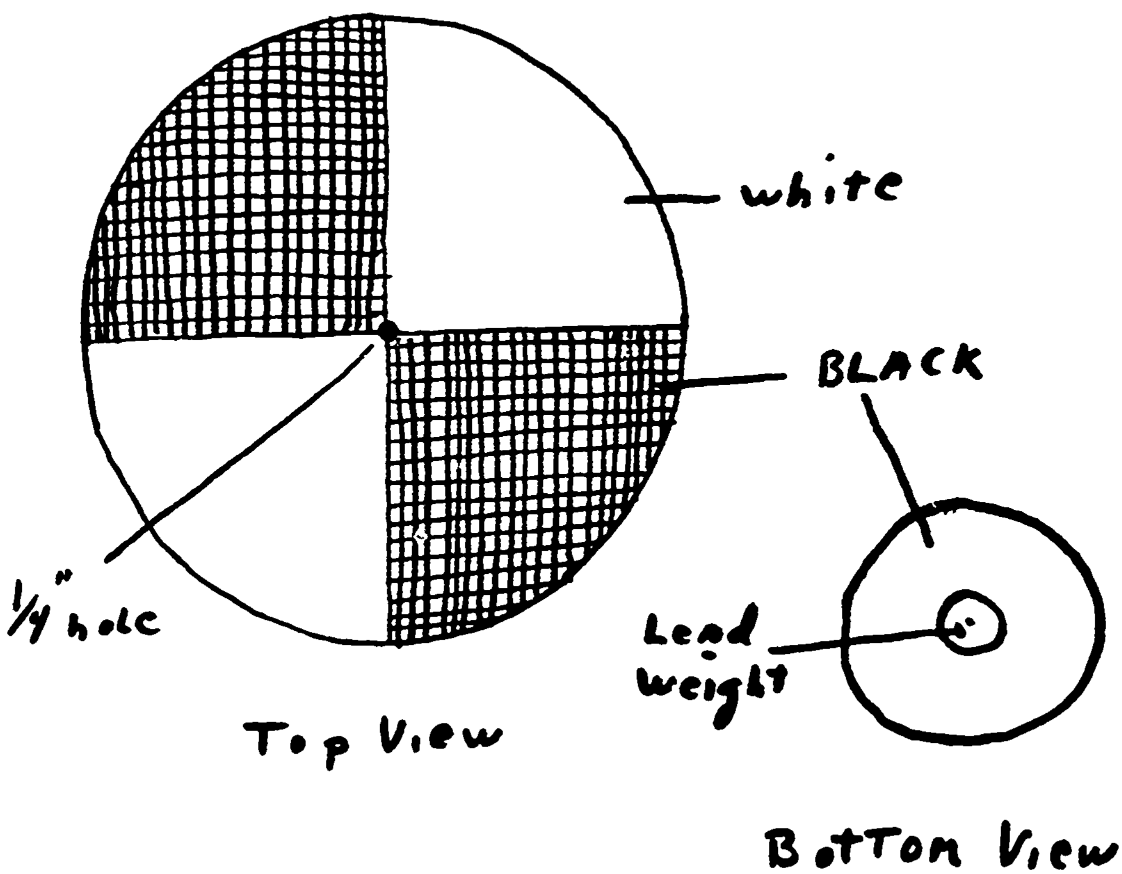
In addition to the previous conditions it must be noted that the disk must not be allowed to become scarred or dulled. If this should happen the readings would become inaccurate; therefore, constant checking and painting is advisable.

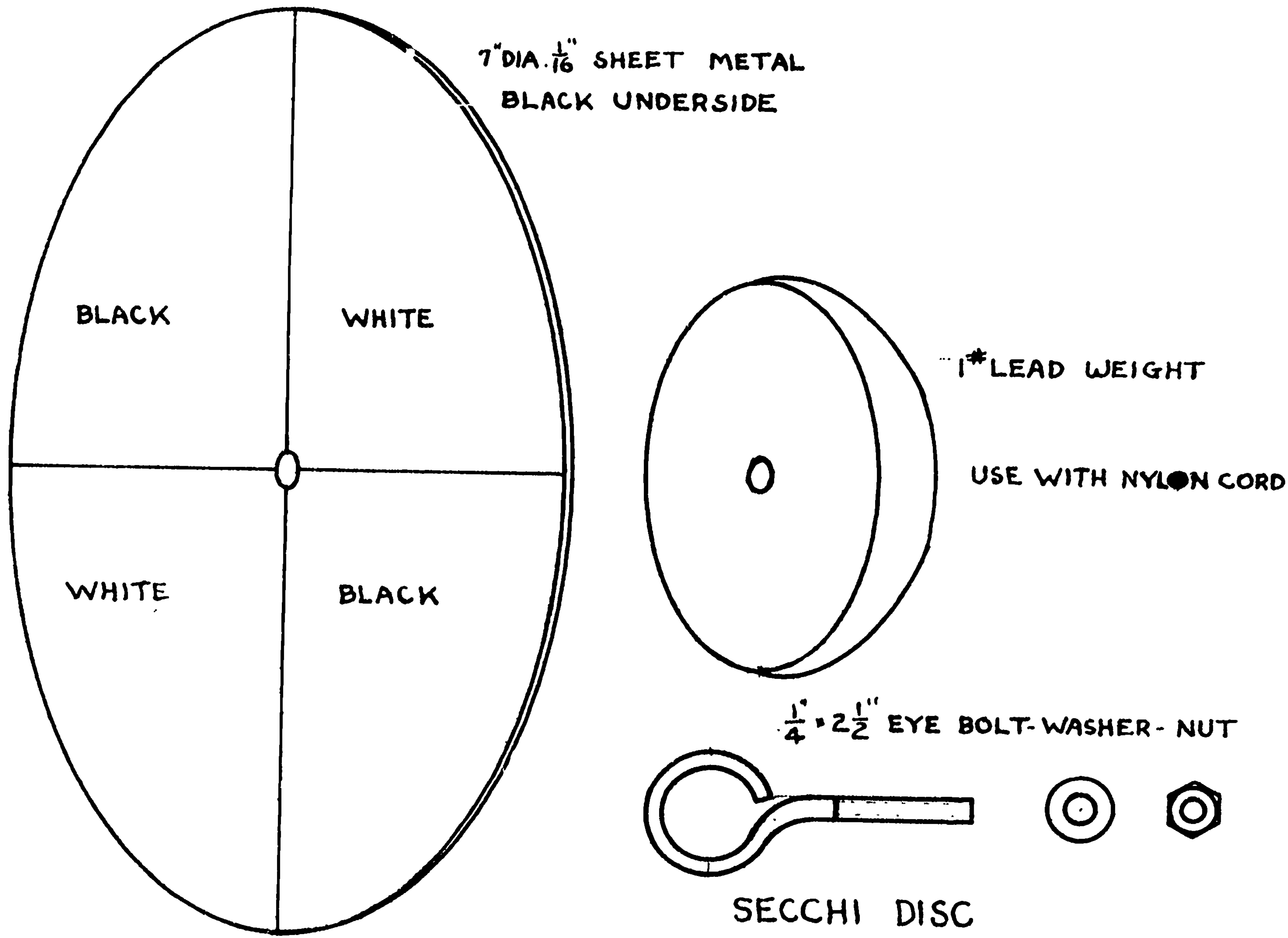
Instructions

1 disk 20 cm diameter made of 1/4", 3/8" exterior or marine grade plywood, or 24 gauge galvanized sheet metal. NOTE: If plywood is used it must be finished with shellac before coloring.

1 screw eye

Paint bottom black to minimize reflection. Divide the top in fourths. Using semi-gloss enamel paint opposing fourths black, others white. Weigh botton with lead. Attach 40' 1/8" nylon cord or equivalent which has been properly marked.


white
BLACK
1/4" hole
Lead weight
Top View
Botton View



7" DIA. 1/16" SHEET METAL
BLACK UNDERSIDE
BLACK
WHITE
WHITE
BLACK
1# LEAD WEIGHT
USE WITH NYLON CORD
1/4" × 2 1/2" EYE BOLT-WASHER-NUT

SECCHI DISC

BIOLOGICAL OXYGEN DEMAND (B.O.D.)

The Biological Oxygen Demand is a measurement of the amount of relative metabolism occuring in a body of water. This test is done so that there can be some indication as to the net productivity of a body of water.

The B.O.D. sampler consists of a 2 X 4 which is 3 feet long. To this board at both ends is attached a cord to which a bottle is fastened. The bottle on one of the ends should be made of clear glass whereas the bottle at the other end could be made of any colored glass and then either painted black or covered with aluminum foil or both. The length of the two cords is variable in order that the compensation level of the body of water may be determined as well as the net productivity. The compensation level is that point in a body of water in which the plants are just able to balance food production and utilization.

To keep the apparatus stationary a third line is attached to the center of the 2 X 4. This line should be of sufficient length to reach bottom. Secure one end of the line to the center of the 2 X 4 and secure a large stone or brick to the other end.

An alternate B.O.D. apparatus is found by attaching a cord to a sealed plastic bleach container (1 gal. size). At regular intervals along the line two glass bottles are attached, one bottle of which is darkened, the other being clear. The description of both of these systems is shown in the accompanying drawings.

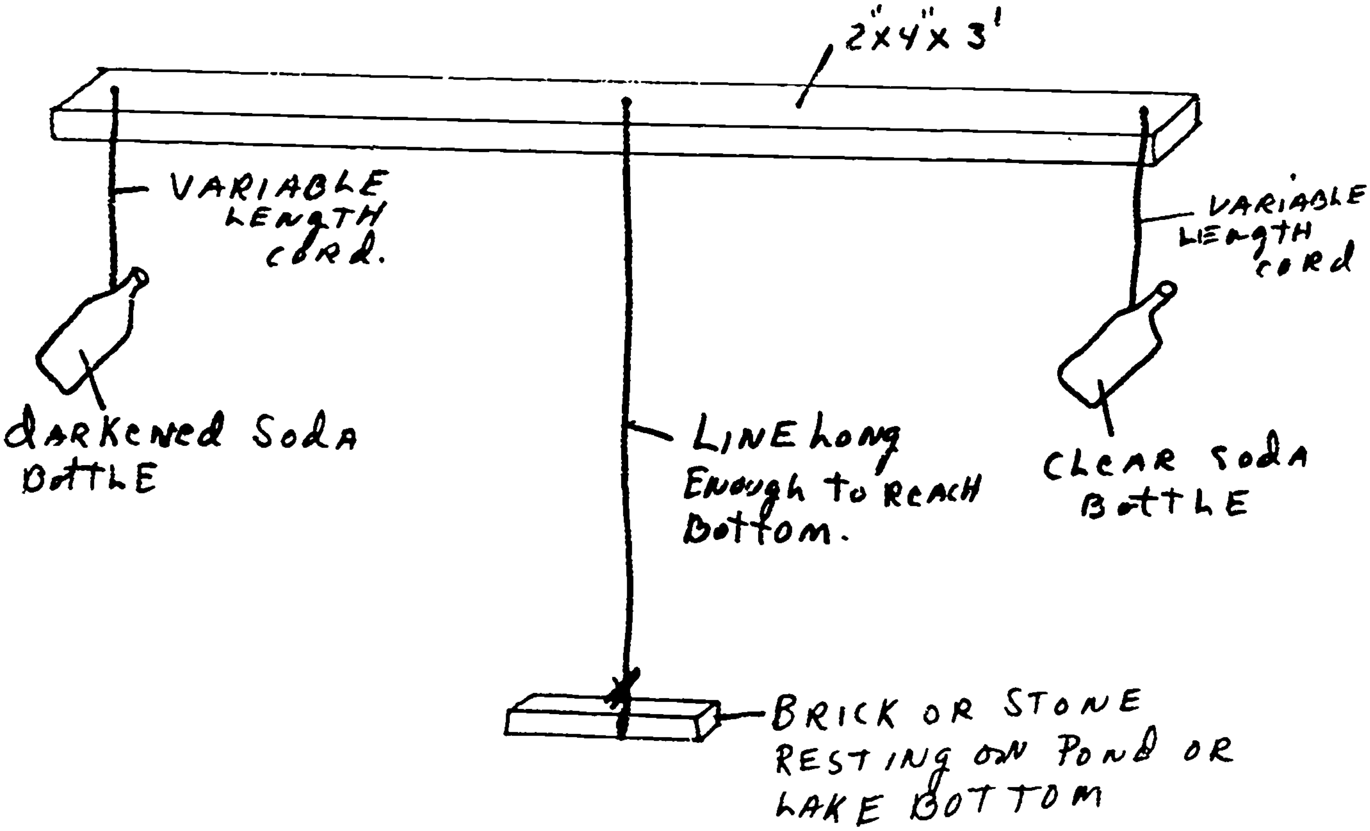
Precautions

A Dissolved Oxygen (D.O.) determination should be made at the depth the B.O.D. bottles are set at the time of setting. This determination will serve as a baseline in B.O.D. computations.

The B.O.D. sampler should be left in the water for a period of 24 hours, in order that an accurate reading may be obtained. Also, the dissolved oxygen of each container should be determined as soon as possible after removing from the water.

The standard method used for D.O. determination is the Winkler. A more practical method can be found by the use of such kits as are sold by Hach or LaMotte.

B.O.D.
SAMPLING
APPARATUS



DISSOLVED OXYGEN

This test is performed in order that an indication of the amount of oxygen being produced by a body of water and therefore, what is available to the aquatic plants and animals. It is usually good practice to do a B.O.D. on the water at the same time as this will also give an indication of the net productivity of the gas for the body of water and not just the gross productivity.

Sampler

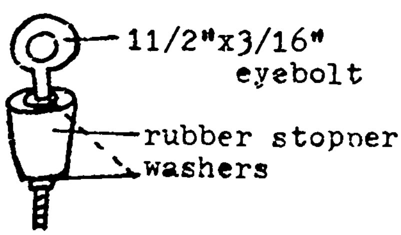
The following is a description of a sampler which was devised to beat the high cost of commercial units yet provide repeatability in sample collection.

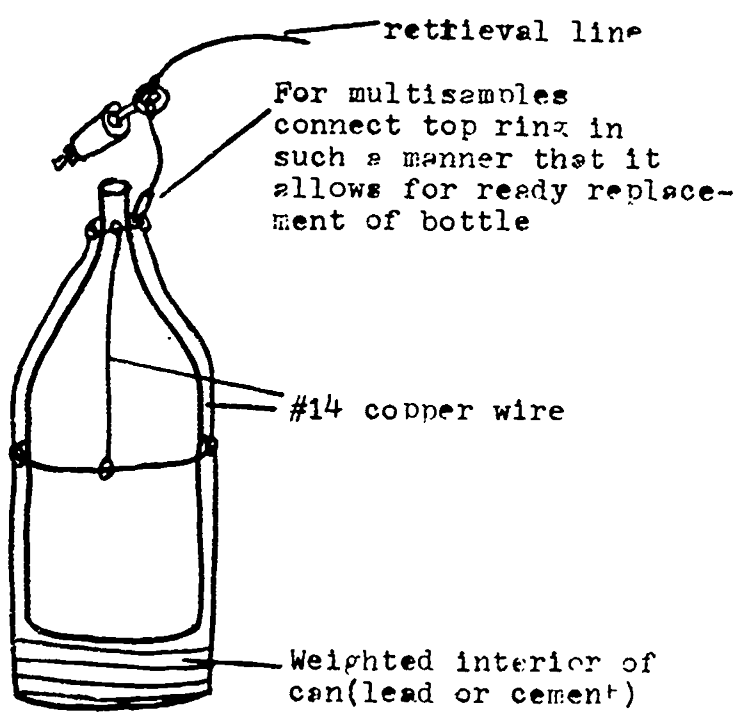
Materials

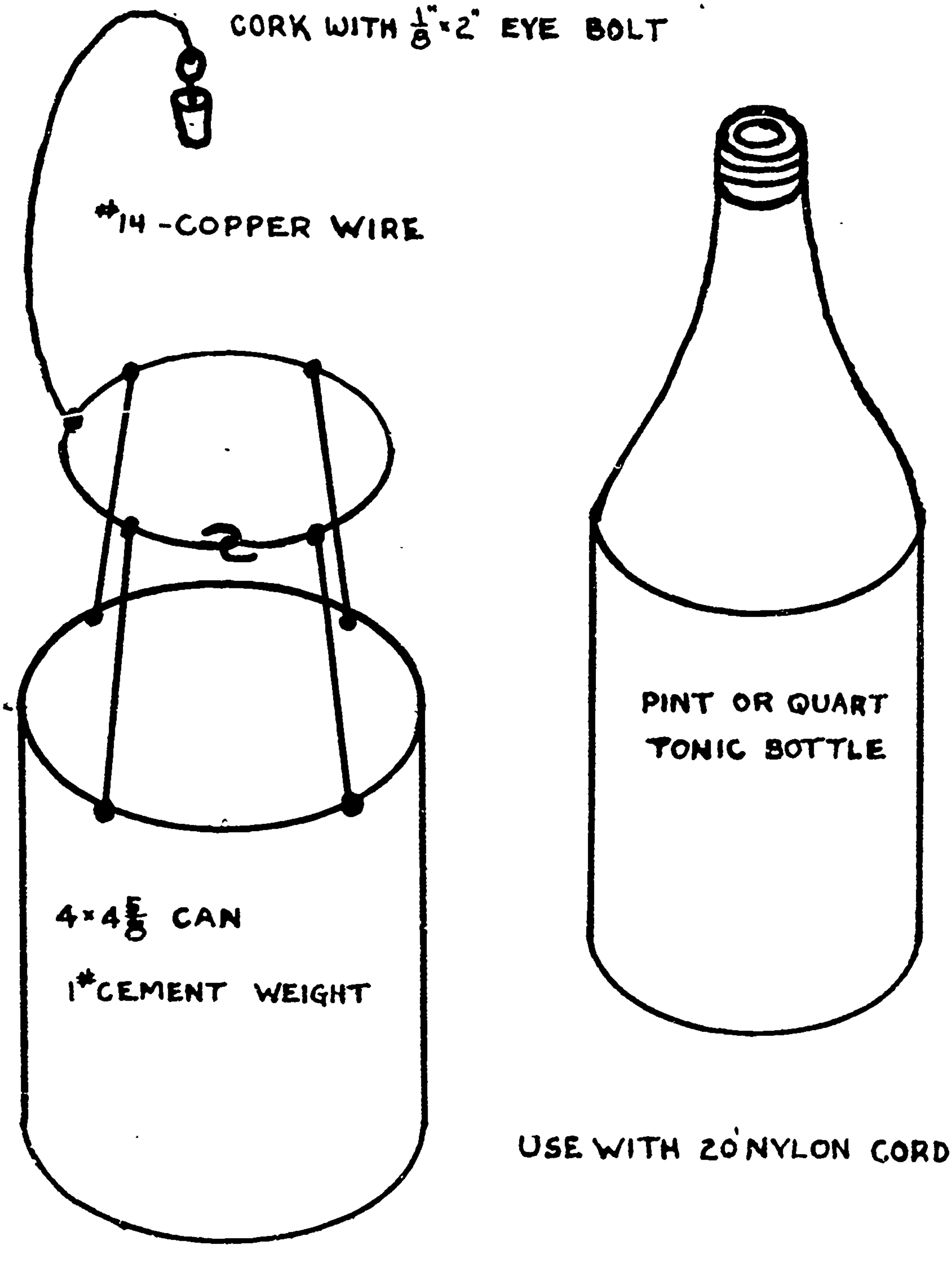
Quart bottle; one hole rubber stopper to fit top of bottle; tim can to loosely fit quart bottle; lead flashing or ready mixed cement, retrieval line marked in meters; several lengths of #14 copper wire; eyebolt (1 1/2" X 3/16"); 2 washers to fit eyebolt.

Construction

See diagram below.

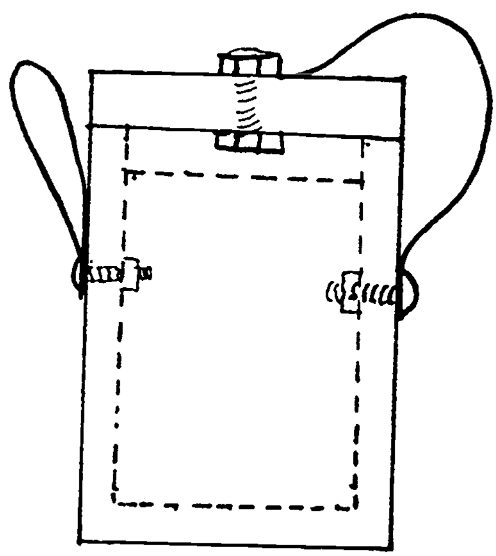





CORK WITH 1/8" × 2" EYE BOLT
#14 - COPPER WIRE
PINT OR QUART
TONIC BOTTLE
4 × 4 5/8 CAN
1# CEMENT WEIGHT
USE WITH 20' NYLON CORD

SOIL, SAMPLE HOLDER

It is advantageous when making analyses of invertebrate forms and larval forms to return a sample of soil to the laboratory as nearly in tact as possible. In general, however, these samples suffer for dessication. In an effort to eliminate the drying up of these samples a holder has been devised using whole blood containers. These containers are made of styrofoam which is excellent insulating material and has the advantage of being watertight. They have been used by students for carrying about soil samples, sometimes for as long as 8 hours with no appreciable change in soil texture nor more than a 5°C change in temperature, as long as the cover was placed upon it securely. The description of the container is as follows, the drawing of which is self explanatory.



BOTTOM SAMPLERS

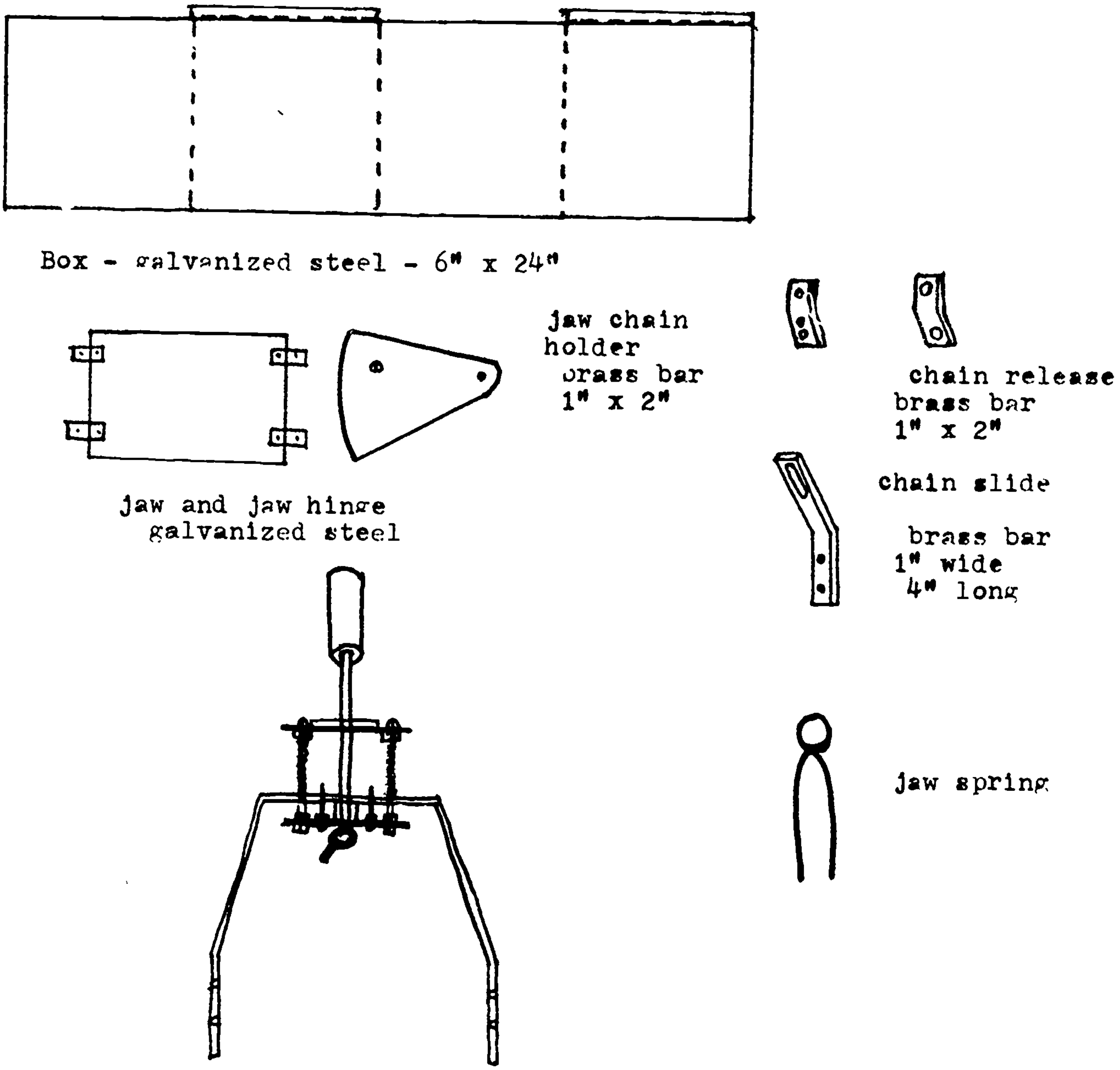
Since the requirements for bottom sampling are varied, there are various types of samplers available to perform different tasks. In general, however, we are concerned with three (3) classes: A. Eckman Dredge; B. Peterson Dredge; C. Vertical Core Sampler.

A. The Eckman Dredge is a sampler which is used for soft bottom sampling. The dredge box is available in one of two sizes either 6" X 6" or 9" X 9". On commercially produced units the dredge is usually made of brass. The dredge can be home-built, however, using galvanized steel at a considerable savings. Drawing #1 describes the construction of such a unit.

B. The Peterson Dredge is a sampler which is used on hard bottoms such as clay, gravel and sand. It consists of an iron cylinder which is capped at both ends and hinged longitudinally. Drawing #2 describes the construction of a home-built version.

C. The vertical core sampler is useful in determining bottom stratification. It is extremely effective in soft bottomed bodies of water, but weights have to be attached to it when it is used where hard bottoms are in evidence. The sampler gives uniform samples unless the bottom is unusually soft in which case some difficulty might be had in obtaining suitable samples. A description of the construction of such a sampler is provided for in drawing #3.

Drawing #1 ECKMAN DREDGE



Release mechanism fabricated so that messenger lowers springs, thereby lowering chain pins and releasing chains.

NOTE: Small brass chain should be used to hold jaws open.

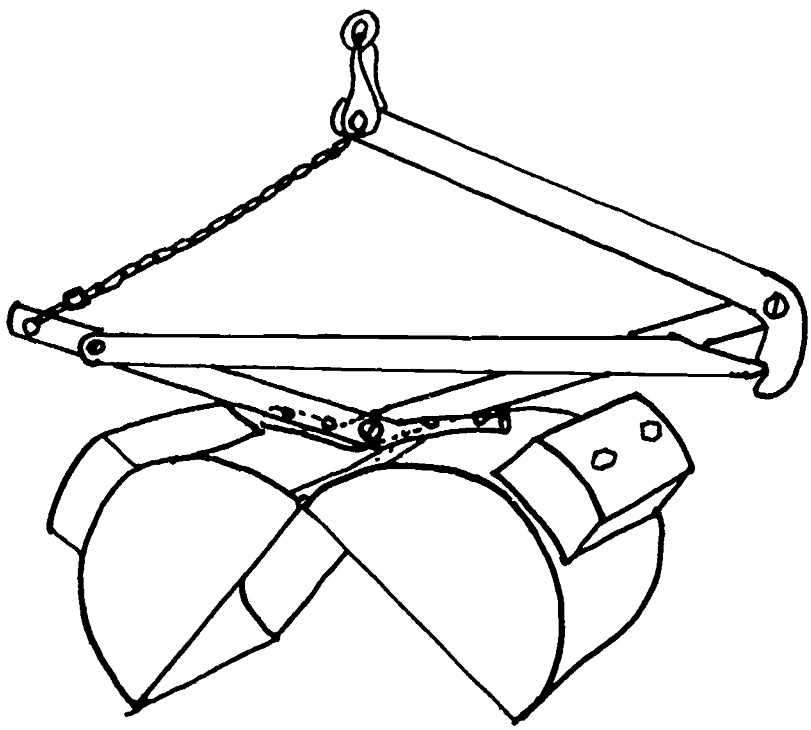
For a drawing of the completed dredge, refer to Limnological Methods by Welch.

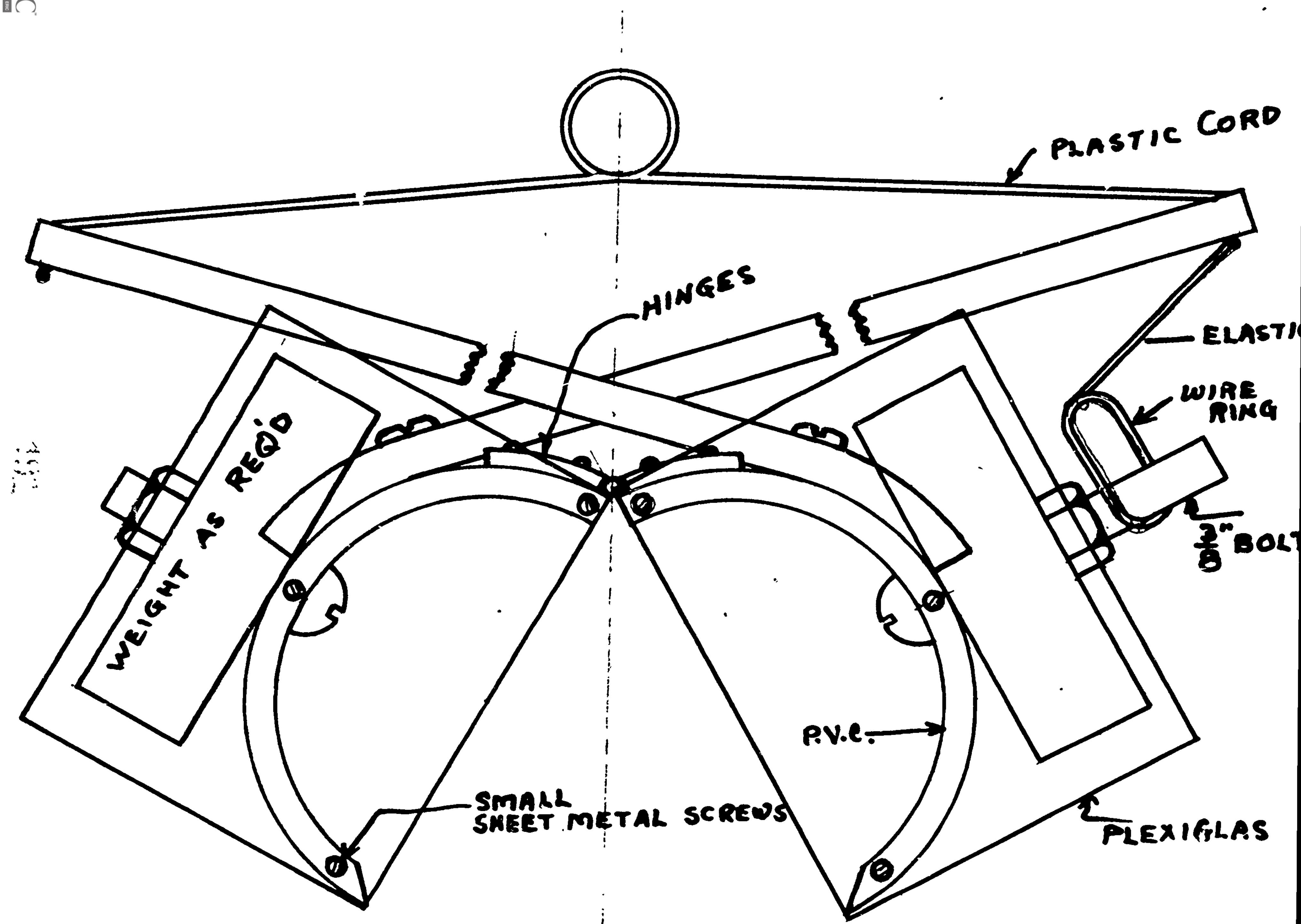
Drawing #2 PETERSON DREDGE

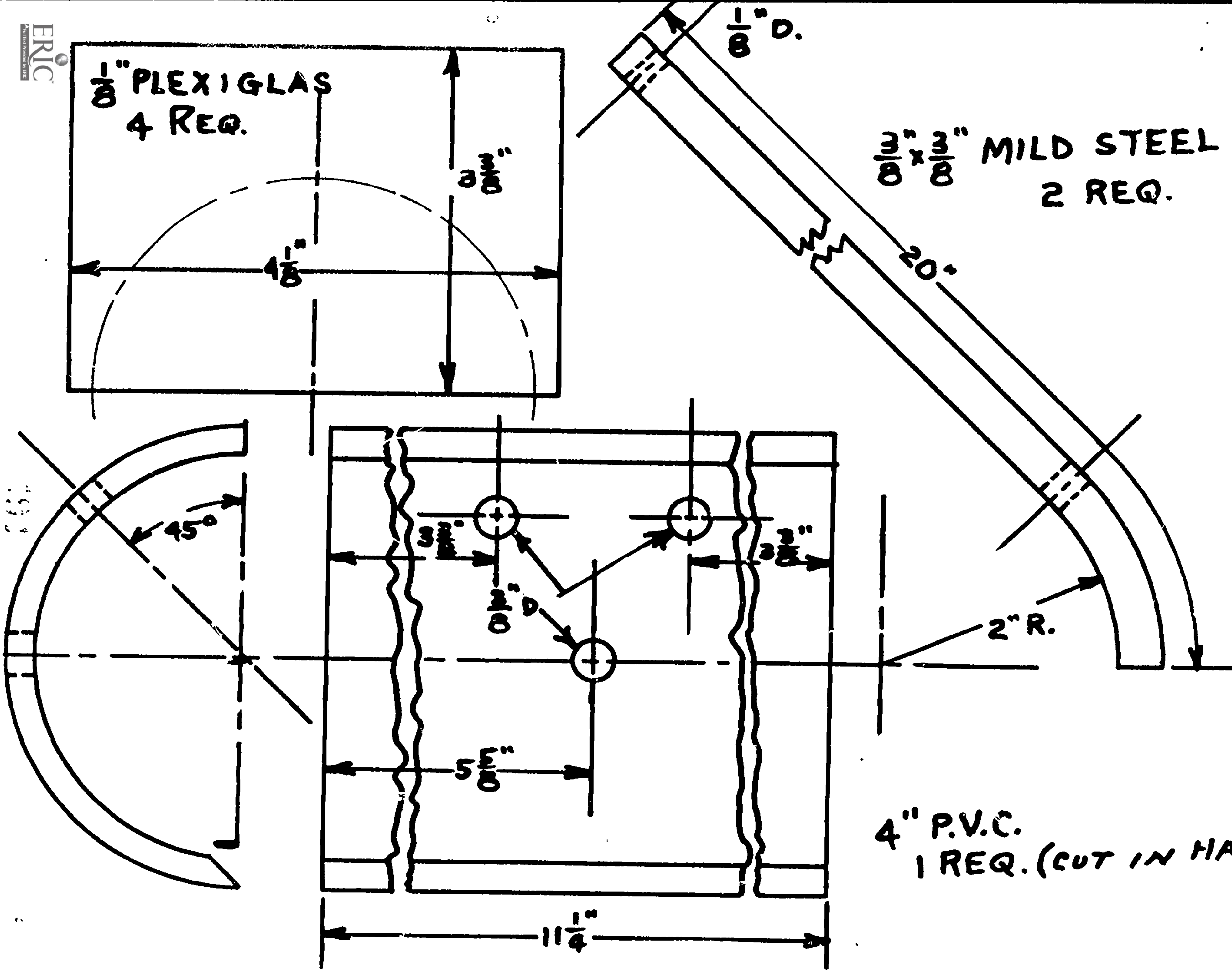
This dredge can be fabricated using 4" PVC pipe which has been capped at both ends and split longitudinally. The hinge is made of brass as are the bolts for attaching the same. The weights are made of lead in a form. They should be available in pairs of varying weights. They are attached to the PVC pipe by carriage bolts. The unhinged portion of the dredge should be filed to a point from the outside inwards.

The tripping mechanism of the dredge is made of 1/2" O.D. aluminum pipe which has been flattened in portions to allow for the attachment of hinging bolts.

The length of the 4" PVC pipe used can vary depending upon the requirements for sample size which are established.




PLASTIC CORD
HINGES
ELASTI
WIRE RING
3/8" BOLT
WEIGHT AS REQ'D
P.V.C.
SMALL SHEET METAL SCREWS
PLEXIGLAS



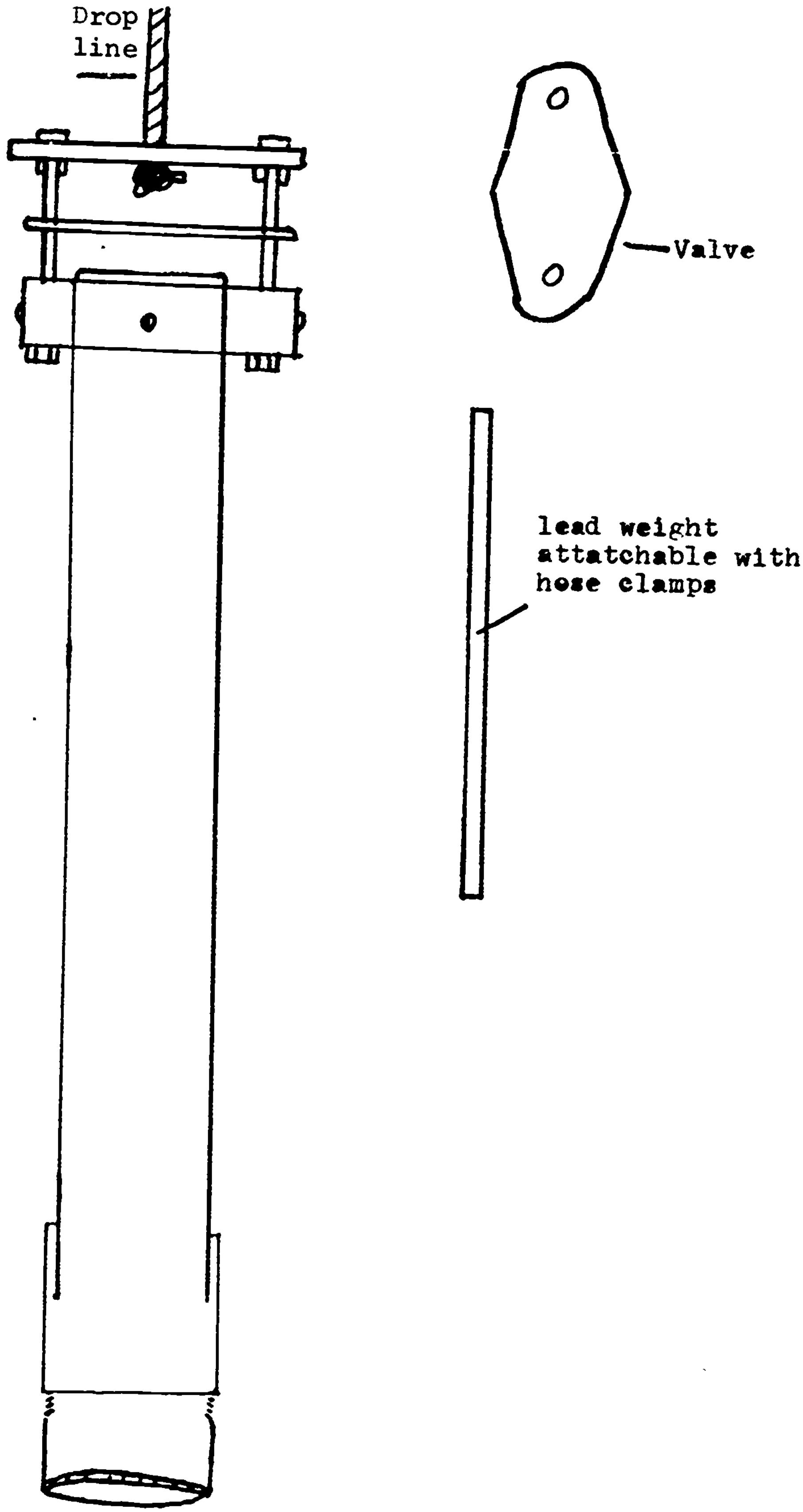
1/8" PLEXIGLAS
4 REQ.
3 3/8"
4 1/8"
1/8" D.
3/8" x 3/8" MILD STEEL
2 REQ.
20"
2" R.
45°
3 3/8"
3/8" D
3 3/8"
5 5/8"
11 1/4"
4" P.V.C.
1 REQ. (CUT IN HALF

Drawing #3 VERTICAL CORE SAMPLER

The core sampler is made of 1 1/2" PVC pipe which is 6' long. Two foot long lead weights are made attachable to sides for better penetration of bottoms. A 3" dia. piece of 3/4" pine with a 1 1/2" diameter hole drilled through is attached 1/4" from top of sampler by beans of 1/8" X 1" brass bolts. The valve runs on two 4" lag bolts. When sampler is on its way down valve remains open but closes from water pressure when sampler is on its way up.

The lower portion of sampler is fitted with a portion of 1 1/2" pipe which has been bevelled from out to in.

Samples are removed by means of a 1 1/2" dia. rubber piston which has been attached to a 1/4" wooden dowel.



EXPERIMENT

NANNOPLANKTON (MICROPLANKTON NETS)

Determine the level in a pond to which photosynthesis occurs, the compensation level. This is done using a secchi disk. After this level has been determined take samples of water from various depths up to that level and run them through a silk net. Empty contents of each level into a suitable container. Next, take samples from the area below the compensation level, the aphotic zone, and run them through the nannoplankton net. The samples of water can be taken at various depths using a D.O. collection bottle.

After samples of nannoplankton have been collected, a Dissolved Oxygen as well as a CO_2 determination, should be done at each level. If a remote sensing thermometer is available a thermocline should also be included in data recorded. The collection of the specimens and identification should be followed by classroom discussions.

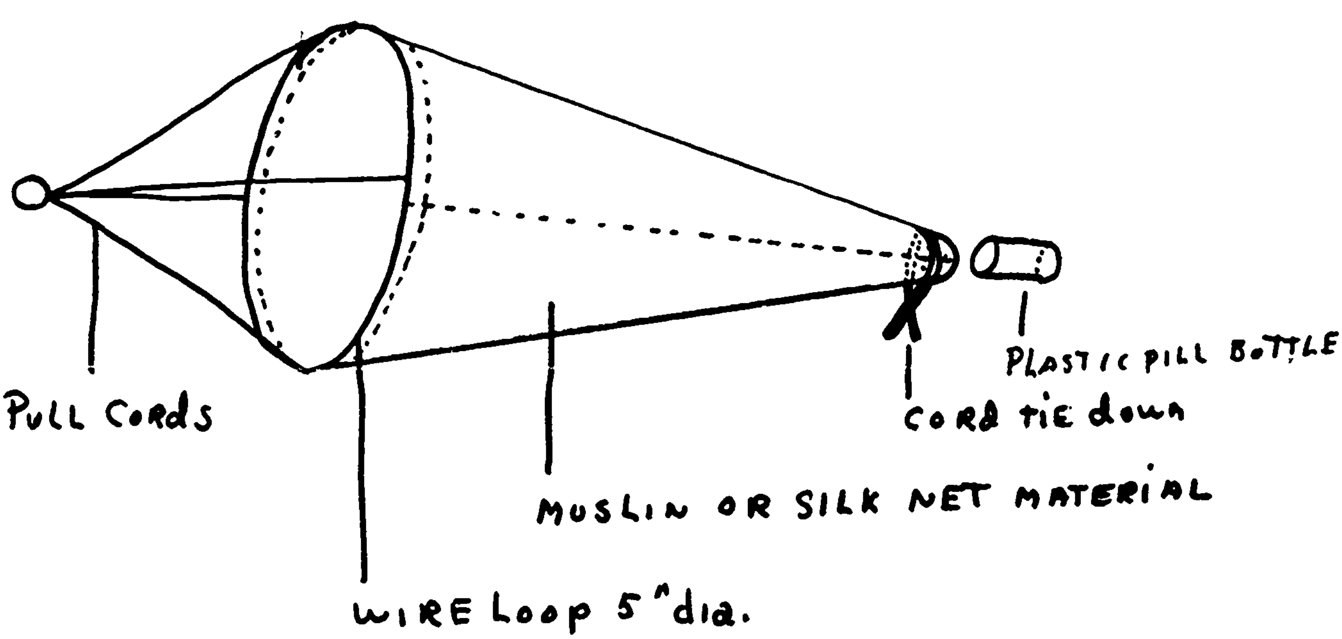
PLANKTON NETS: MACRO AND NANNO

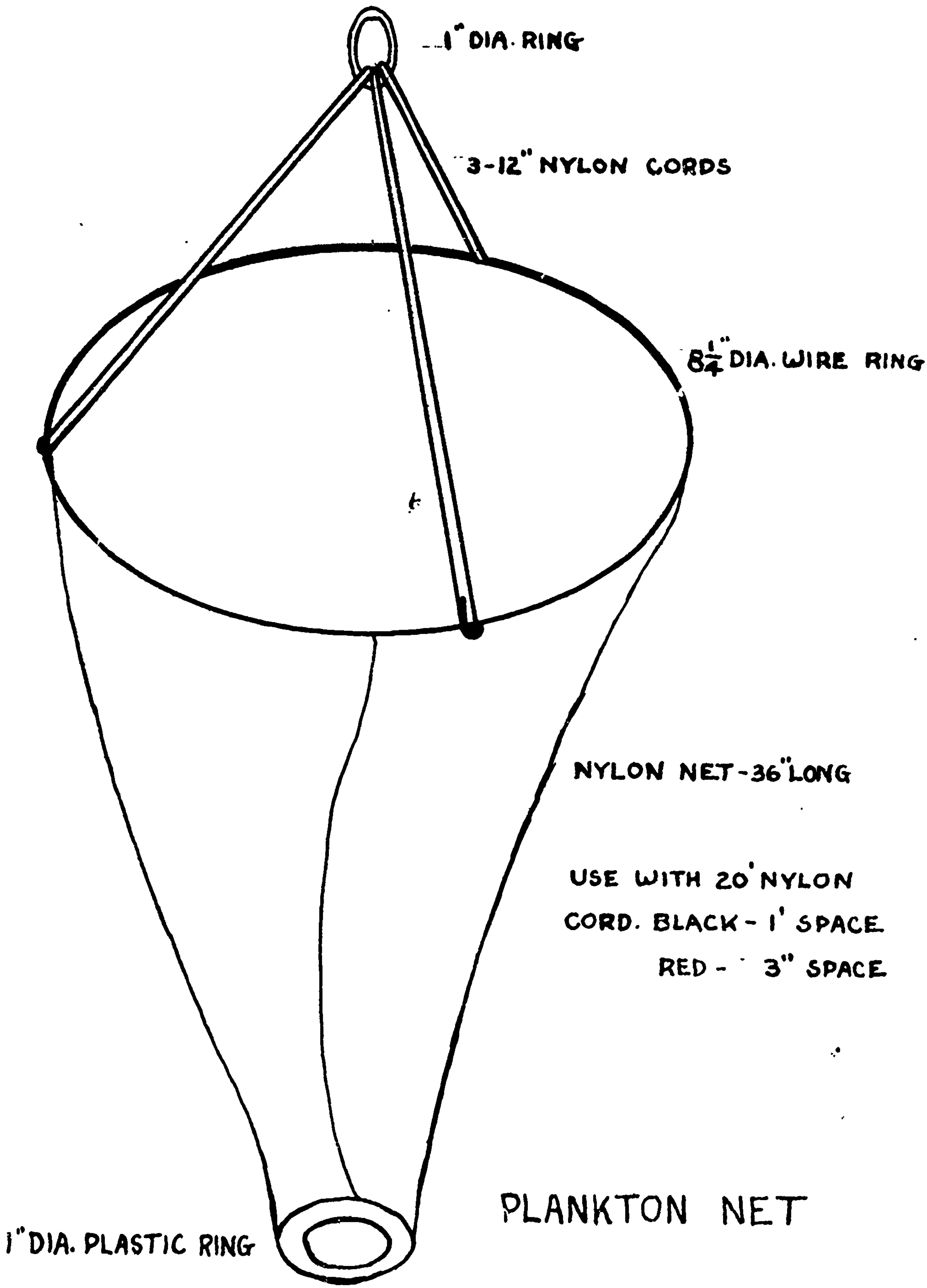
The two types of nets are essentially the same and vary only in the net material used. In the case of the macroplankton net the material is muslin and for the nannoplankton the material is silk.

The materials needed for either net are:

4 pieces of nylon cord, each two feet long
1 wire coat hanger
1 pill bottle (plastic)
1 sheet of muslin or silk with the approximate dimensions of 20" X 16"

At one end of the net the material is sewn around a 5" diameter loop made of the coat hanger. At the other end of the net the material is sewn so as to fashion a loop that can be tightened around a plastic pill bottle. The material of the net is then sewn so as to form a conical structure. After the net has been formed the pull cords are attached by sewing.





PLANKTON NET

EXPERIMENT

A STUDY OF METAMORPHIC FORMS

After studying a unit on the morphology of insects, students are taken to a brook to observe first hand and undisturbed, the forms present. If students observe any forms for which they are familiar with in any other state of development, they are to record it in the following manner. Example: "Dobson Fly"- Helgramite.

Rocks are now placed across the brook in order that it may be dammed. Four stream nets are placed into position in order that they may float full length downstream. Several students upstream start to sweep up the bottom using birch branch brooms. The sweeping progresses in the direction of the nets. After sweeping is completed, other students replace rocks to their original positions in order that the area may be left in an undisturbed state as possible.

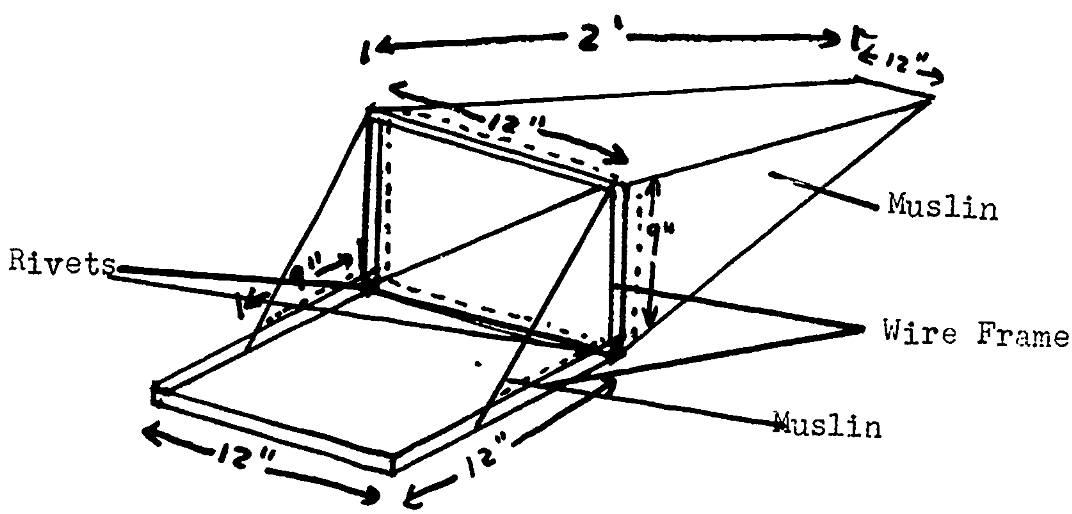
Specimens are now classified. This may be done out in the field or in the laboratory. Using this technique, students are better able to understand and appreciate the various metamorphic forms which they have studied from textbooks. This also helps to bring into focus the various food chains which are inherently in evidence in the brook.

STREAM BOTTOM SAMPLER

The stream bottom sampler described here is invaluable when making a study of the metamorphic forms of insects found in a stream. It consists of two wire frames, one measuring 9" X 12" and the other measuring 12" X 12", which are pop-riveted together.

The body of the net is made of muslin cloth. Because the frame is riveted in only two spots it folds for easy transportation and storage.

The dimensions of the squared funnel are given in the drawing.



HALL'S TOMATO CAN MODIFICATION OF THE DENDY INVERTING SAMPLER

This device is recommended for bottom sampling within the litteral zone and those areas where there is a larger buildup of detribus and muck. It is excellent for obtaining large quantities of ditrivours and bottom saprophages.

Working in the litteral zone there is less washout and water loss, due to the shallowness of the water in this area. It is also useful in the hands of a scuba diver with a short handle for recovery of desmids and diatoms in the deeper waters. For working within the litteral zone a handle of 15 to 20 feet is recommended as one can exert pressure working off the stern of a boat, forcing the can deep into the substrate. A shorter handle is better employed by the scuba diver working deeper waters. About a 4 to 5 foot handle is recommended for this type of bottom recovery of substrate.

In doing a classification of the top ten inches of the floor of the pond, this device is excellent, as it conserves and keeps the specimens unharmed. Often the larger type dredges, because of size and crudeness of operation, mix this layer of organisms with those animals from deeper layers, not giving a general overview of organisms, nor giving any true degree as to level of location. The smaller worms from the first foot of substrate are easily collected by the Hall Modification of the Dendy Inverted Sampler.

This sampler may be used over a Nannoplankton net if one is interested in the microscopic forms, by a series of washings over the net, then by removing the bottle from your net and going to the microscope for continuing your bio-assay. For the larger specimens, simply wash your substrate over a large pan until all soil is washed into the pan and the specimens are collected on the screen of the sampler to be classified, preserved, or returned to the pond.

Construction

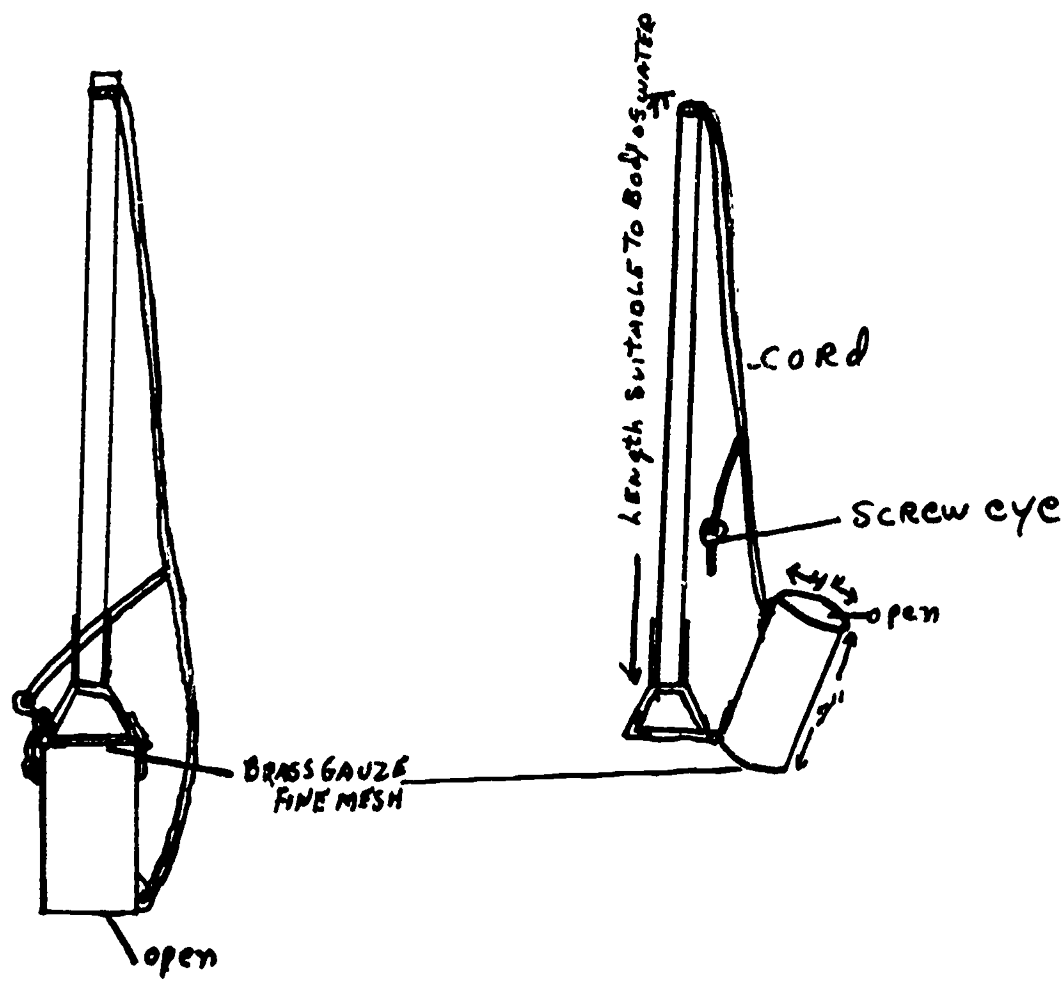
Remove both ends from a large size 7" X 4" tomato can, affix a fine mesh brass or copper screen to one end of the can (see illustration). Screening may be salvaged from old funnels and oil pumps on certain motors. Use an old hockey stick or any handle such as a broom, rake, garden hoe, or other type handle of this size, shaving six inches off each of the lower sides (lengthwise) so a flat surface is available to receive the support and pressure braces. These braces may be belted together or welded. (If brass, braised or belted). These are then affixed to the can by the following method: on one side of the pole bolt a 2" brass hinge to the pressure brace as in the diagram, then belt it to the top of the can (part with screen), as shown in the sketch. On the bottom of the can on the same side, solder or weld a small metal structure with an opening to which a rope can be fastened. On the other side of the can at the top (across from the hinge) fix a lock similar to the one depicted in the diagram. Secure the rope to the top of the pole and affix a small rope to this line at the juncture of the support braces. A second half of your lock assembly is attached to the end of this smaller rope. You may employ any number of friction hasps that will release on a tug of the rope at the surface.

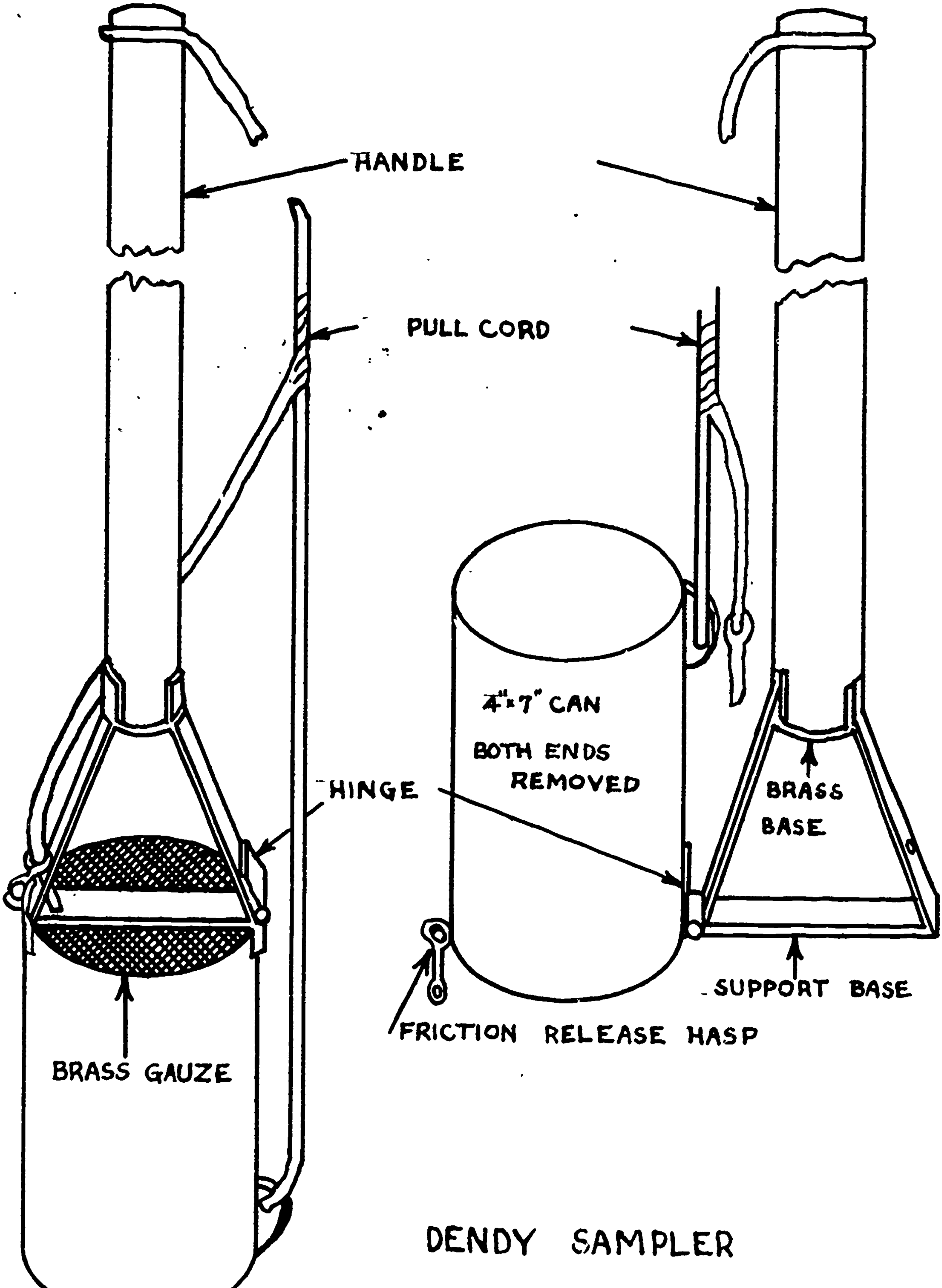
DENDY INVERTING SAMPLER

Bottom samples which contain fine gravel, small sticks, etc. are not homogeneous, and may be sampled with the Dendy sampler.

This is a simple device to duplicate. It consists of a pole to which is attached a hinged can. This can measures 4" in diameter and 7" in length. The can is open at both ends. The end of the can closest to the hinge, however, has a fine brass mesh screening fastened to it.

The device works in the following manner: by the use of the handle the sampler is lowered to the bottom of a body of water. Once on the botton, the cord is pulled releasing the screw eye holding the device closed. More tension on the cord causes the can to revolve around the hinge, thereby taking up a botton sample. Tension on the cord is applied until the sampler is completely retrieved.





DENDY SAMPLER

EXPERIMENT

A STUDY OF AN AQUATIC FOOD CHAIN

This experiment uses two types of nets: the muslin macroplankton net, and the silk nannoplankton net. It is designed to acquaint the students with the scope of the aquatic food chain in an ecosystem.

Students, after being introduced to morphology amont insects, are taken to a pond or a lake that has a sizeable litteral zone. Here, the macroplankton nets are set up with rocks surrounding them. The students brush the bottom of the body of water on a path toward the nets.

Next, taking the nannoplankton nets, they are set up behind a boat and pulled behind for several passes through the body of water. The nets are then emptied and their contents are examined with the use of a microscope either in the field or back in the laboratory. A discussion period following the lab is most helpful in tying in all of the observations noted by the students.

NOTE: Students should come properly dressed for such a lab. No barefootedness should be allowed because of the inherent possibility of injury. Also, the students on the boat should all be good swimmers.

THE VASCULUM

If one is to press plants effectively and neatly it cannot be stressed enough that specimens must be in as excellent a condition as possible. This has been made possible in the last 50 years by the use of a vasculum.

The vasculum has traditionally been a rectangular metal box, 1 1/2' in length and 5" wide X 6" high. The materials from which the vasculum has been made has changed in the last few years from galvanized sheet metal to plastic sheething. All, however, have been essentially waterproof.

In order to keep the plants fresh until returning from the field, a wet sponge or damp peat can be placed in the bottom of the container. This will assure the good condition of the plants for a day or two, provided they are kept away from excessive heat.

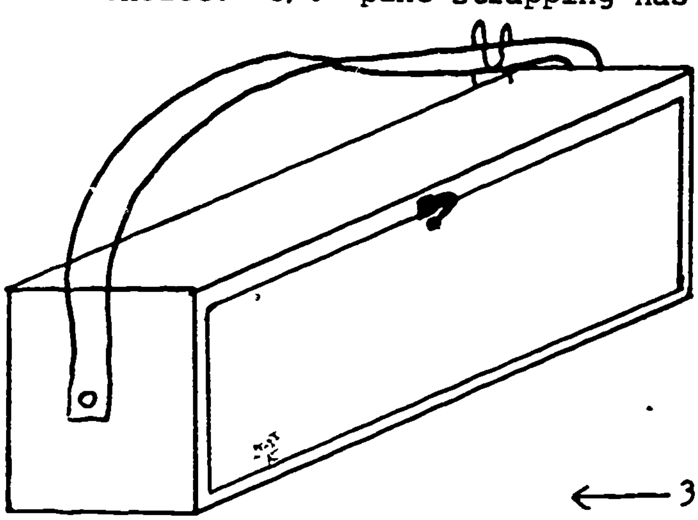
The vasculums which we have designed are of wood frame, which have been shellacked with marine spar varnish. To this frame we have attached a cover of plastic sheething. This assures a light and very durable vasculum.

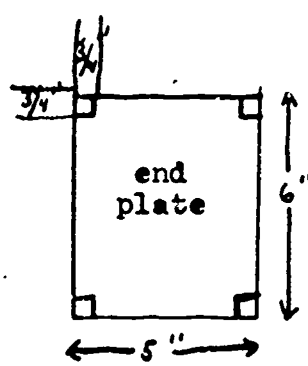
Woody plants placed in the vasculum should be pruned well, thereby assuring ample space for other plants and also providing less work back in the laboratory.

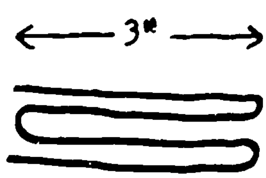
Follow the laboratory excercise accompanying the plant press project for further directions.

We have found that a vasculum measuring 5" X 6" X 18" to be of functional size.

Materials may vary depending upon availability; however, a wood frame covered with plastic has proved to be an excellent choice. 3/4" pine strapping has been used for the frame.







brass rod strap buckle

EXPERIMENT

USE OF VASCULUM AND FIELD PRESS

1. Plan trip in advance by carefully selecting an area to be studied. Identify plants in area which you have selected for student study. Mark them with ribbons or tags.

2. Alert class of upcoming field trip and notify them as to what type of clothing and equipment should be brought.

3. Get presses, pruners, and vasculum out a day ahead of trip. Have a practice lab in which the students are able to work with the materials. Make sure they understand how to use the vasculum, presses, and identification keys.

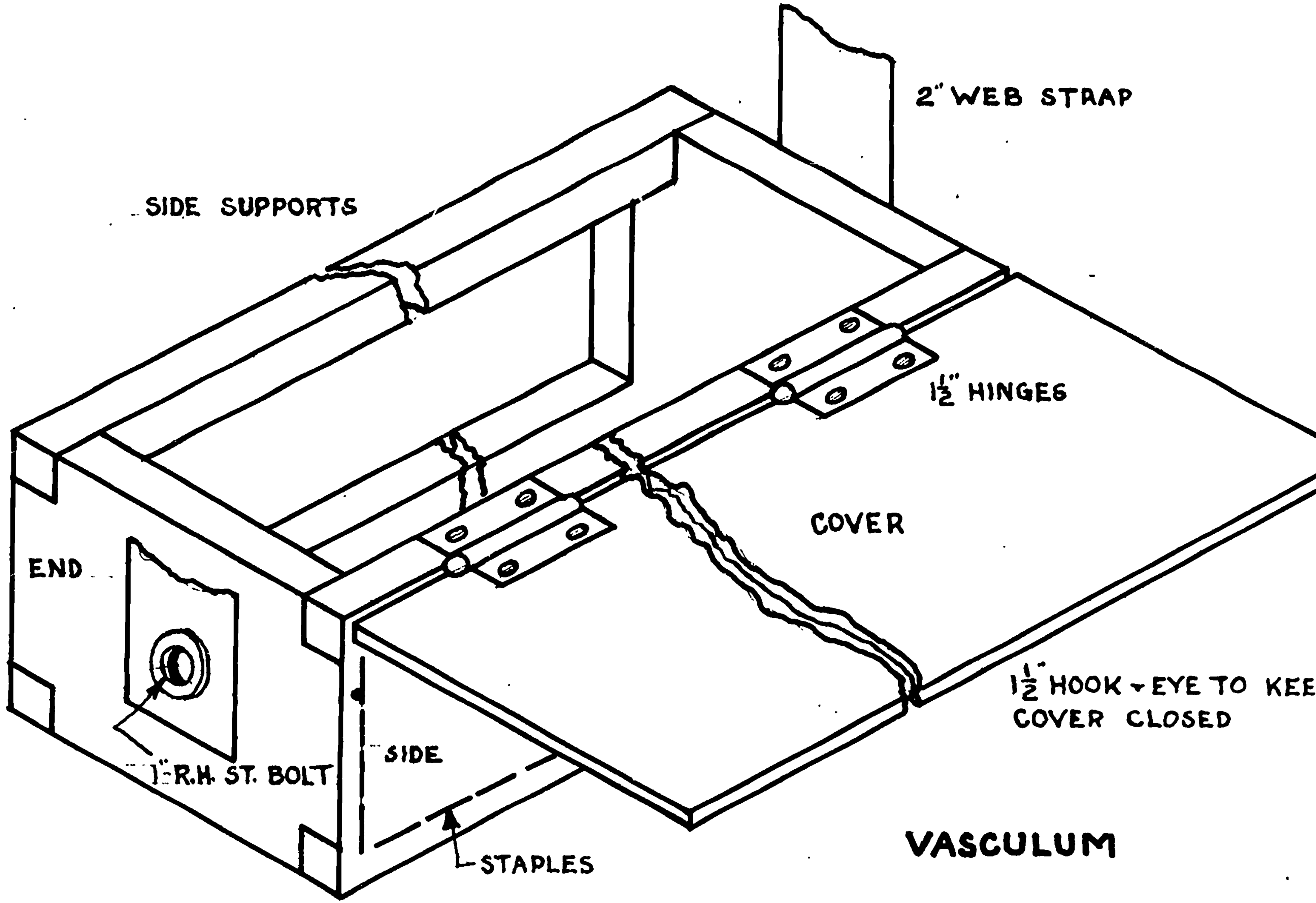
4. Show students a vasculum in which has been placed plant specimens from the previous day. Also, show students plants which have been left out overnight on a laboratory table. Have them note the wilting, drying out, and deterioration of the plants.

5. Select a stem and split it with a pocket knife, emphasizing to students the proper technique to avoid injury to self. Smooth cut side for proper placement in press. Remove any knots and explain why to the students. Make each section of stem approximately 5" long. Take the other half of this section and split it once more so that the bark and some of the wood is gone leaving a flat section with the heartwood exposed. (Explain that some trees are easily recognized by the heartwood, i.e., nut trees all have a coiled spring-like center). Prepare the root by splitting it in half to show the center wood. Take a thin slice from this area and also a section from the outer portion of the root. Snip off the long tapering portion of the root with the root hairs attached, and wash gently to keep root hairs in tact. Select the leaf, buds, nuts, seeds, or whatever else you plan to include in identification of your chosen specimen, and prepare them for the plant press.

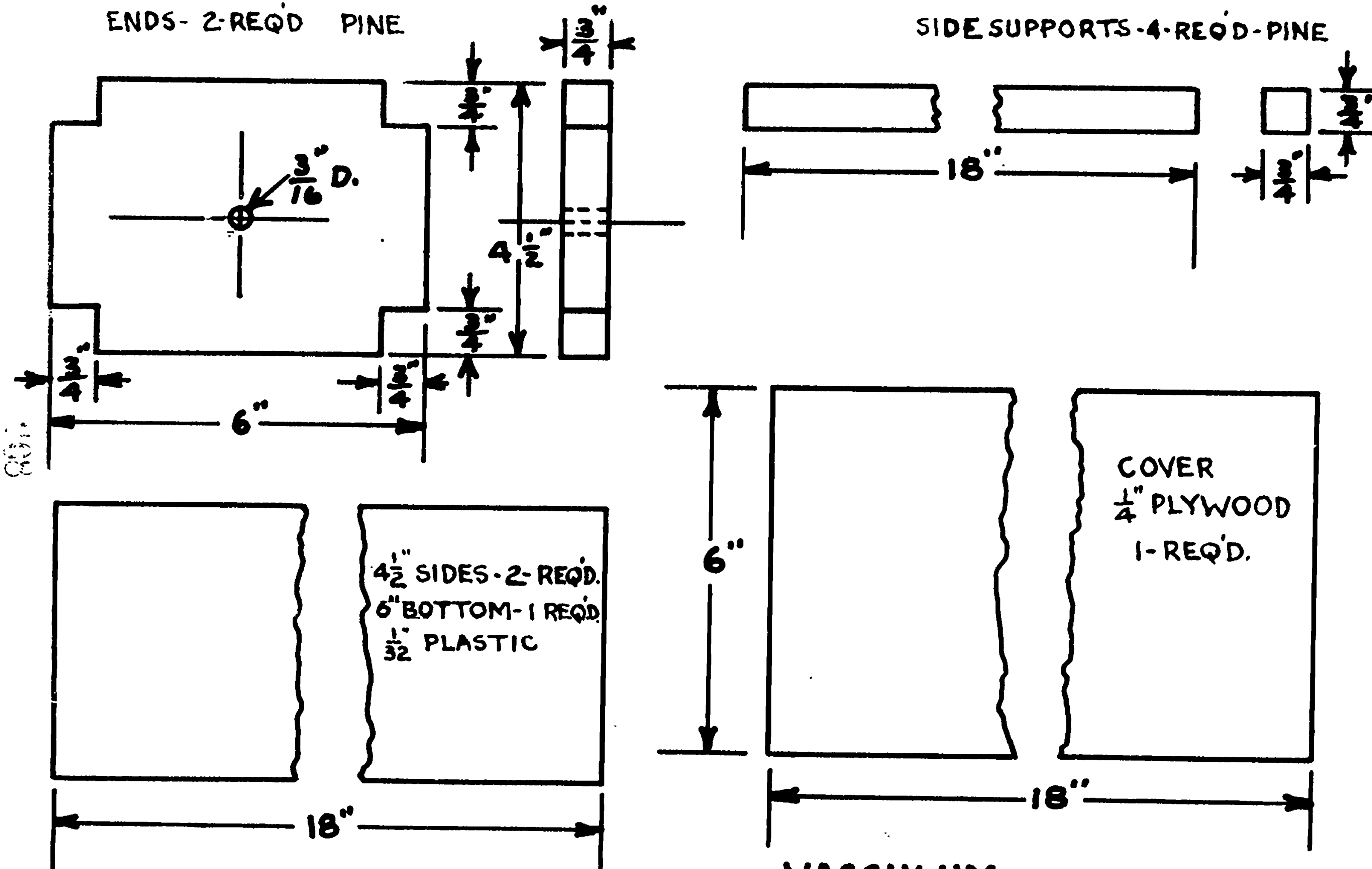
6. Lay the bottom of the press down in a well cleared area. On this, place a ventilated cardboard and then one complete sheet of newspaper folded in half. Open folded paper to receive plants. Lay section flat and even--be sure not to crowd sections. After they are spread out in their proper places, close newspaper and place a piece of blotter paper over it,

followed with another portion of ventilated cardboard. Place the top of the press in position and line up the straps equidistant from the ends of the press. With a steady, even, pressure, tighten straps until they are as tight as can be obtained. Rapid drying under moderate pressure is the secret to plant preservation. Finally, on blank sheets of paper, write the name of the plant, both Genus and species names, plus the common name. Next, put the area collected in and habitat down on paper. The date should also be written on the sheet.

7. Place the press over a radiator with moderate heat. The dryer sheets should be checked daily, and damp sheets of blotting paper removed. The protective newspapers should not be changed until the plants are thoroughly dried. The time required varies with the season and the succulence of the plants. However, four or five days is usually sufficient.

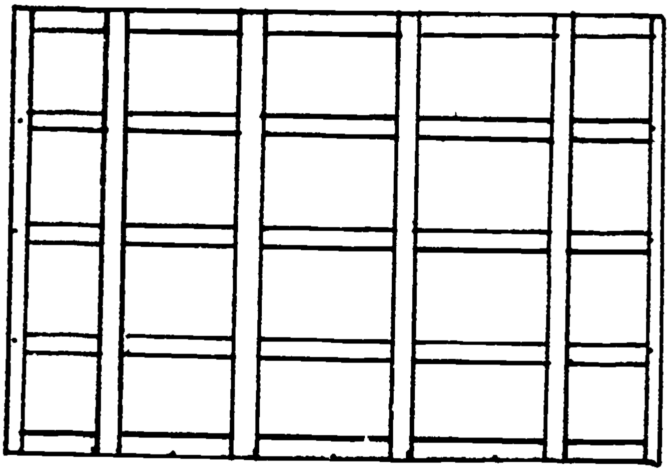

2" WEB STRAP
SIDE SUPPORTS
1½" HINGES
COVER
END
1" R.H. ST. BOLT
SIDE
STAPLES
1½" HOOK + EYE TO KEE
COVER CLOSED

VASCULUM


ENDS- 2-REQ'D PINE
3" /16 D.
3/4"
4 1/2"
6"
SIDE SUPPORTS-4-REQ'D-PINE
18"
4 1/2" SIDES-2-REQ'D.
6" BOTTOM-1 REQ'D.
1/32" PLASTIC
COVER
1/4" PLYWOOD
1-REQ'D.

VASCULUM

FIELD PLANT PRESS



The field plant press is the most common and most widely used press by botanists, because of its lightness and construction. It is comprised of five basic components: (1) a top and a base (latticelike) usually made of hardwood slats and riveted; (2) a series of ventilated cardboard; (3) a series of blotters; (4) a number of newspaper pages; and (5) a pair of straps similar to the ones used by mailmen, but of at least 60" in length.

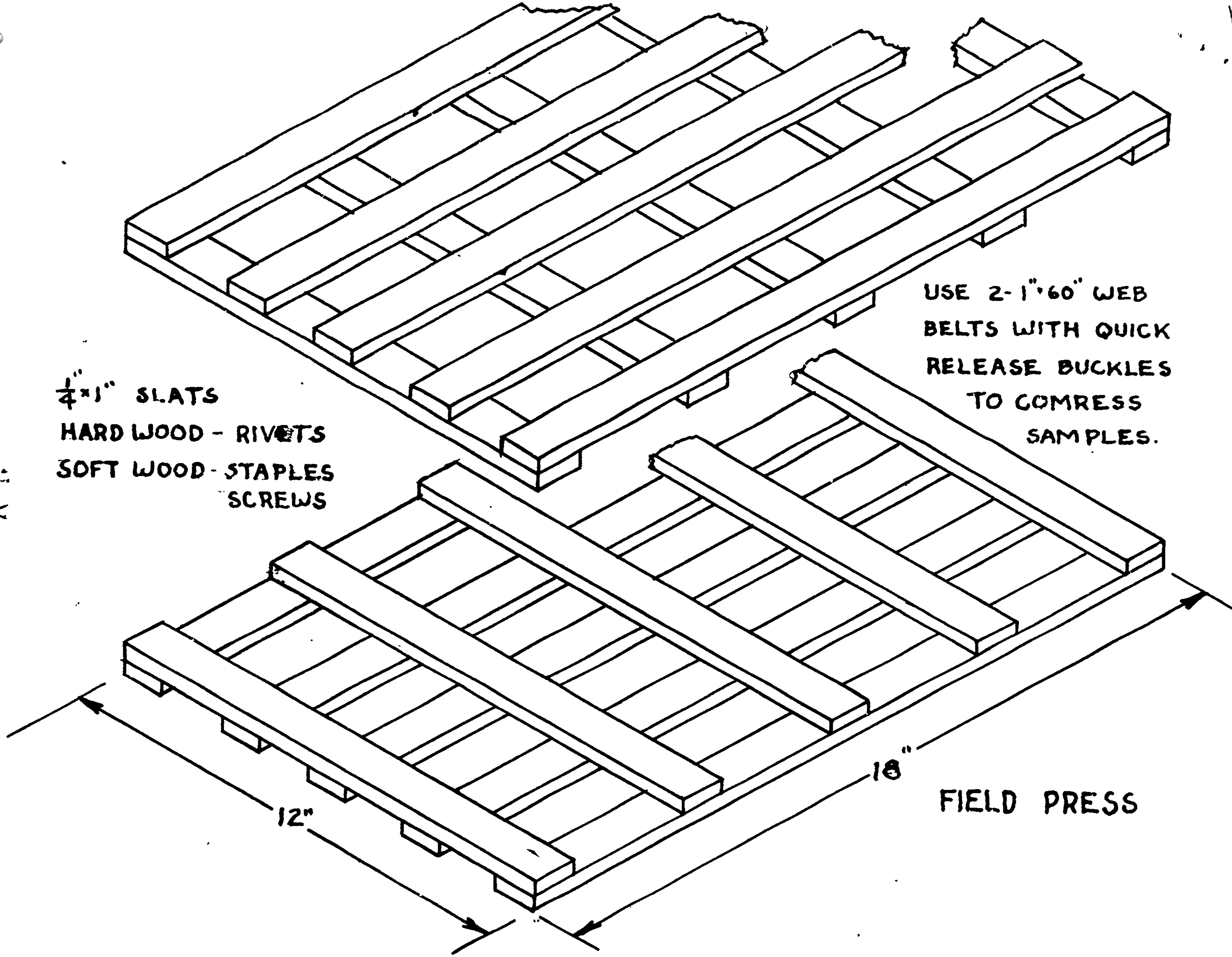
Construction

Cut wood into strips 1/4" thick X 1" wide.

Cut 12 pieces to 12" length.

Cut 10 pieces to 18" length.

Assemble as shown above, using pop rivets or small brass wood screws where slats meet. NOTE: Two panels will have to be made for one press.


USE 2-1"·60" WEB BELTS WITH QUICK RELEASE BUCKLES TO COMRESS SAMPLES.
$\frac{1}{4}$"×1" SLATS
HARD WOOD - RIVETS
SOFT WOOD - STAPLES SCREWS
18"
12"
FIELD PRESS

LABORATORY PLANT PRESS

The laboratory plant press is different from the field press, in that it is larger and heavier. Another difference is the absence of straps. In the place of straps, it has two large threaded rods passing through the base on either side and in a similar manner through the top. Large thumb screws (spare tire type) are fastened to the threaded rods and the pressure is tightened once it is full. Periodically, every three or four hours, the press is tightened for perfect pressure. This press is large enough to accommodate two field presses.

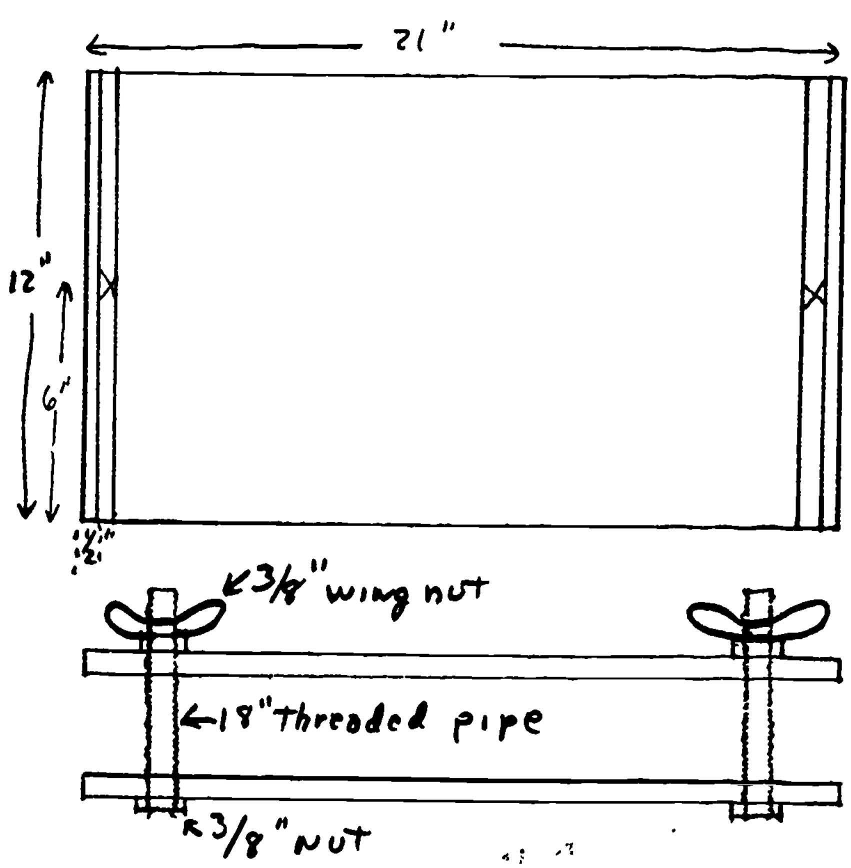
Materials

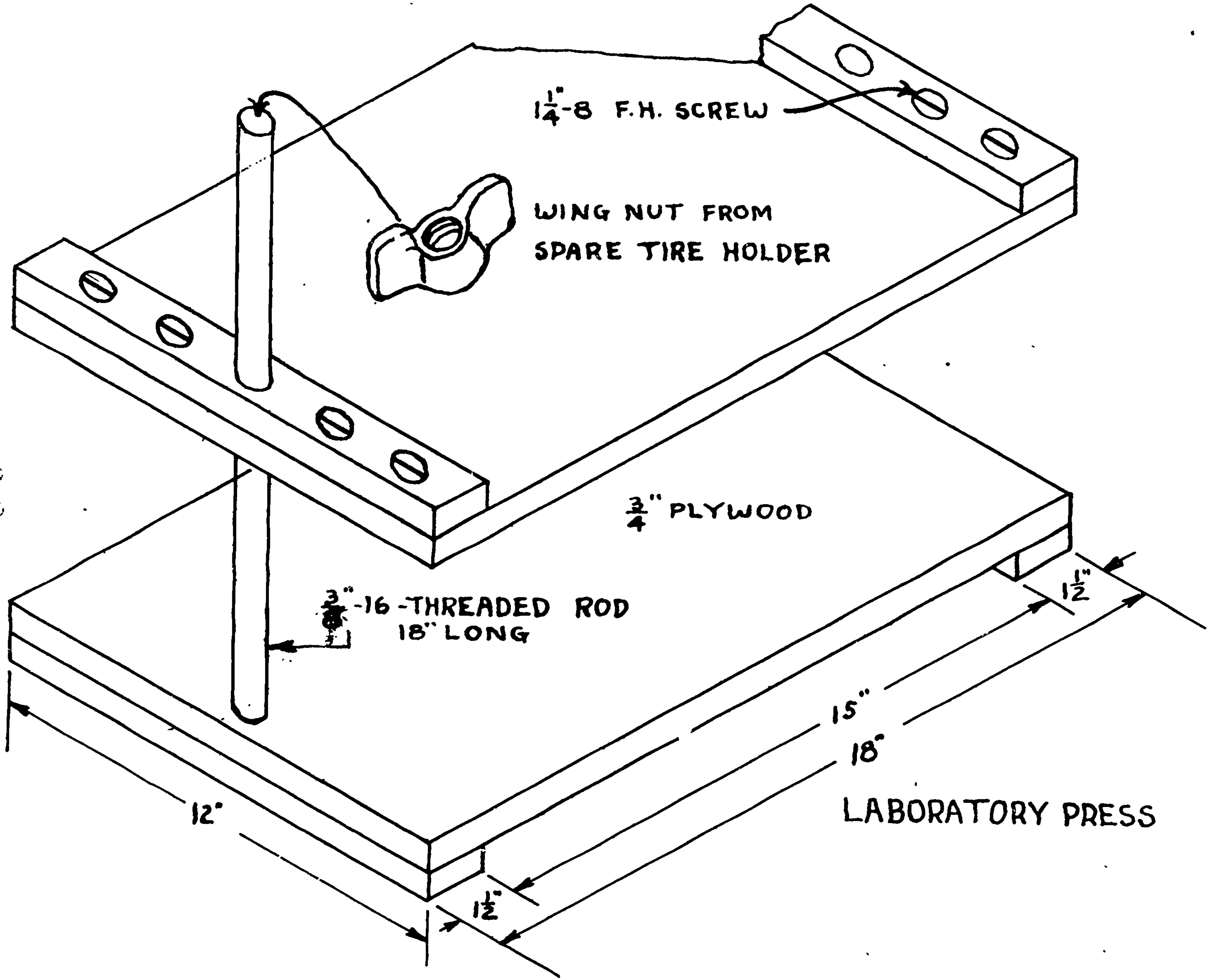
2 pieces of 1/2" or 3/4" plywood (exterior grade), size 12" X 21".

2 pieces of plywood 3/4" X 1" X 12".

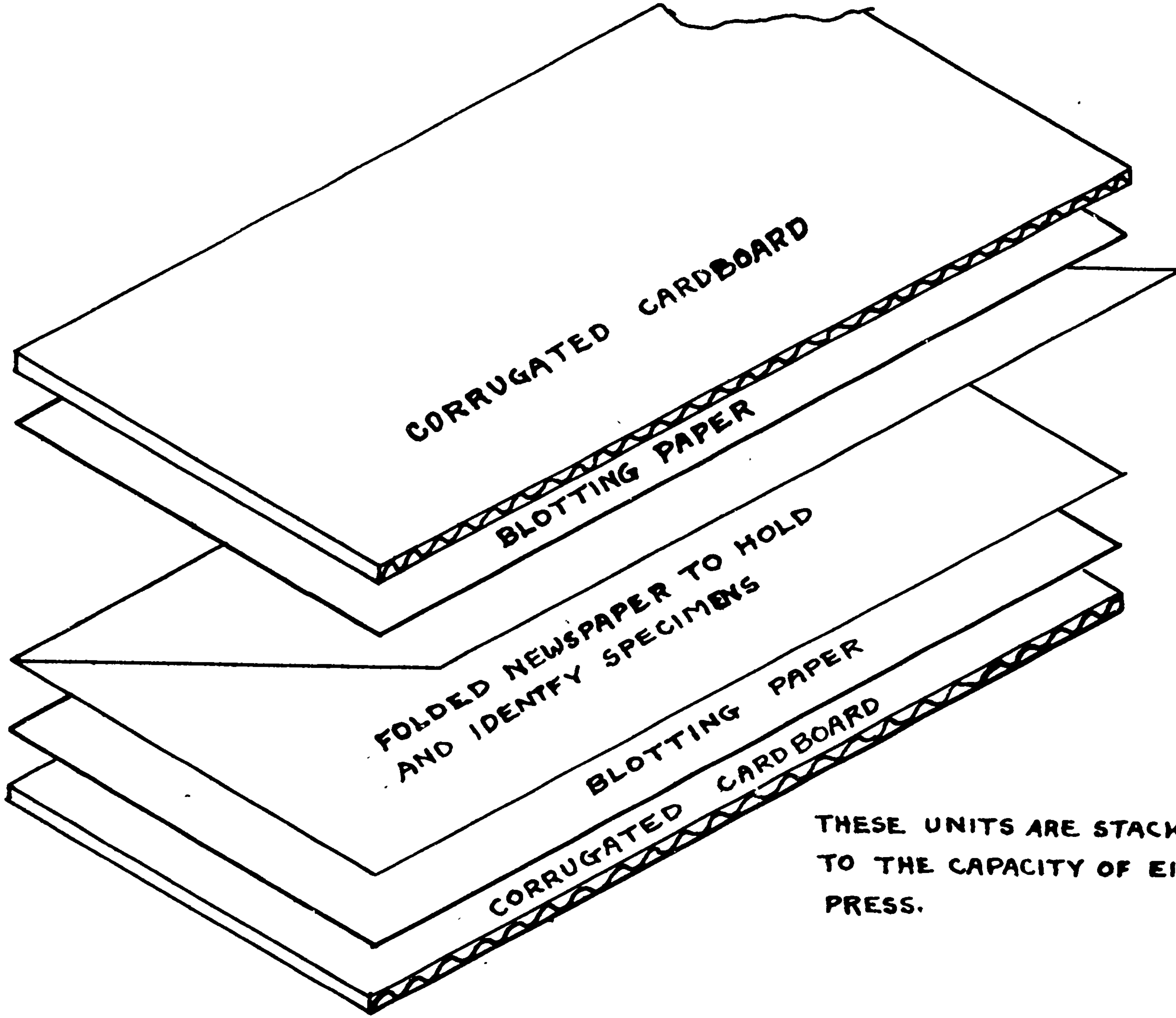
Construction

Screw the 1" strips to each 12" X 21" piece as shown. Drill a 3/8" hole at points marked by an "x". Take two 18" pieces of 3/8" threaded pipe and place a 3/8" nut on one end of each. Set the nut into the 1" slat so that the press will sit flat. Place the other half of press over the top of the pipes and screw on two 3/8" wingnuts. Varnish all sides.





LABORATORY PRESS



THESE UNITS ARE STACKED TO THE CAPACITY OF EITHER PRESS.

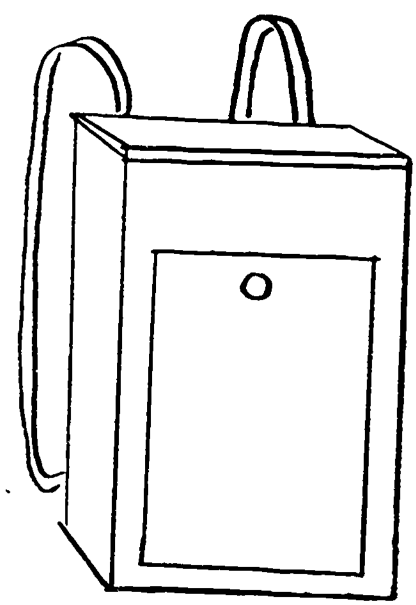
BACK PACK

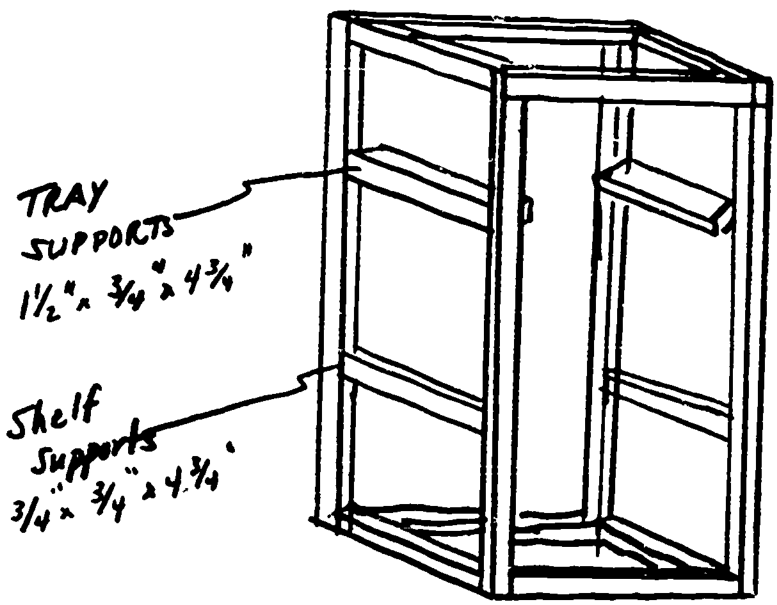
Of extreme importance in environmental studies is a method of transporting the wide variety of test equipment into and back from the field. A pack 24" long, 17 1/2" wide, 6 1/4" deep, serves as an ideal carryall. Covered with 1/8" tempered masonite, it is strong enough, yet light enough. With one shelf and a lift-out drawer, samples are easily transported to the lab for study.

Construction

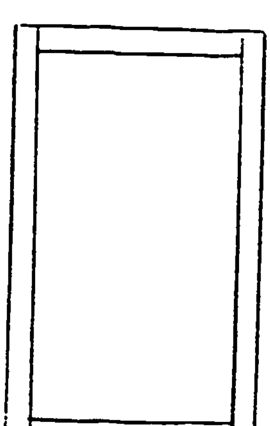
Make 1 1/2" X 3/4" pine frame as shown. Nail and glue all joints. Make cover frame as shown. Cover bottom, sides, back, and top frame with 1/8" tempered masonite.

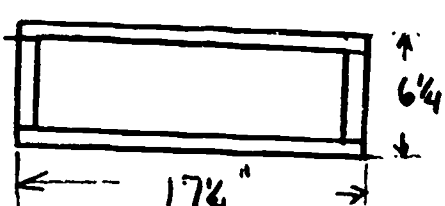
Make frame for door. Cover frame with masonite. Attach cover to frame with 1 1/2" hinges. Attach door to frame with 1 1/2" hinges. (hinge can be at bottom or side, per individual preference). Attach 1" gatehook and eye to latch top and front. Make tray from 1/2" pine. Glue and nail all joints. (Cost: approximately $5.75).



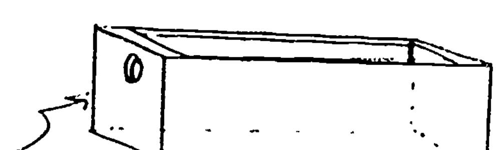


DOOR FRAME →





LIFT OUT TRAY



ST. ANSELM'S COLLEGE
USOE GRANT 1972-1973

NARRATION SLIDE TRAY #1

West High School Ecological Presentation Unit

1. This beautiful scene emphasizes the white water lily or Nymphaea odorata. Once they were plentiful in New Hampshire, but now, with so much pollution along with the wipe-out of small ponds by road construction and filling in for industrial progression, they are becoming scarce. The biggest enemy, however, is pollution and man-made pollution leads all other forms.

To the right of the lily, we see the insect eating Sundew or Drosera Ovale. This is a plant of great beauty. When one comes upon it in the early morning hours, with its shiny dew reflecting the morning sunshine, and your path is filled with them, the whole world seems clean and pure. The unsuspecting insect approaches it intent upon a refreshing drink of its sparkling liquid. As he steps into the sticky liquid and thrashes about trying to extract himself he only gets in deeper. He is as helpless as the dinosaurs were in the Labrie Tar Pits. Slowly he will be digested by the enzymes of this beautiful plant.

In the left foreground, we see the higher bushes. This is a stand of leather-leaf or Chamaedaphne calyculata which we find flowering in May, its white blossoms adding color to our early spring.

DO YOU LIKE THE WILD FLOWERS OF NEW HAMPSHIRE THAT FREQUENT OUR WET PLACES? WE DO--AND WE HAVE SEEN THEM IN BOGS, PONDS, LAKES, AND ALONG RIVERS. TAKE A GOOD LOOK--YOU MAY NOT SEE TOO MANY IN THE FUTURE WITH THIS TYPE OF POLLUTION.

2. This is not the river Styx, a one way road to hell--this is Blood River. Isn't it a wonder we haven't had an epidemic in Manchester?

3. Here, blood, bones, pieces of flesh and hay, along with paunch-manure and other manures from animals being slaughtered, mingle and speed along down a man-made creek, 25 feet wide and 70 feet long, eroded out of the earth over 35 or 40 years, along with man's disregard for our environment. It is hot as it hits the river, but cools rapidly with the settle-out of all but the fat, that goes on down the river, to kill plants, and coat the collecting screens of our neighbors' water supply to the south of us in Massachusetts.

4. Wouldn't you rather see the flowers? We would! They used to grow along the river. Here are the lovely Sundew once more, nestled in a bed of sphagnum moss with leather-leaf and water willow growing nearby. These photos were taken by Steve Hadlock on Kinnikum Pond, deep within an 1,800 acre swamp, seldom traversed by man. But it won't be long--snowmobiles got to them last winter.

5.

6. Here is some more blood and manure. Mosquitoes never bite you here. When they die, this is where they go. Mosquito Heaven! They are big here--real big! So are the rats. We have seen rats here, big around as a large cat, and a foot long, not counting their tail.

7. Back to Kinnikum Swamp and a beautiful wood-lily (Lilium Philadelphicum). What a relief from all that blood!

(See page 306 How to Know the Wild Flowers by Mrs. William Starr Dana, if time permits).

8. A view of Manchester's Watershed and Stevens Pond in fall foliage.

9. This spider-web contraption, we believe, was erected by the mill owners to keep people and children from progressing further along the banks, because just a short ways up the river, we come to a mill that was so loaded with Anthrax, it became the world's largest decontamination project.

10. These warning signs were posted by the ever-alert City Health Department, and others, as added safeguards for those who can read.

11. What have we here? The gate was open--and the little children playing nearby could not read.

12. Back in Kinnikum Swamp away from this madness, we soaked up some more beauty and cleansed our tired minds and eyes, with the lovely Viburnim-cassinoides, called wild raisins by our forefathers. What beauty one finds away from mankind!

13. We're sorry to bring you back to this after the wild raisins, but we could not get this out of our minds. Debbie LaFreniere slipped and stepped into this floating and submerged bed of fat. (Notice her boot tracks). She went to the top of her boots before we got her out. It was a hard pull and took two of us, with her help, to do it. It measured five feet deep. If you are longing to catch a fresh salmon from the river and have it for breakfast, may we advise you not to hold your breath.

14. Tears glistened upon the faces of many students and a couple of teachers the Saturday we came upon the two blue herons, birds that will become extinct in our lifetime, birds we are fighting to save. These graceful herons, landed upon the river on a hot August night when the fat was melted and colorless. The herons were coated, and by the time they reached the river bank, they were too covered to survive. They floundered about until death stilled them forever. We saw more than one dead bird that day.

15. Rest In Peace! This brown gull ate fish near a yarn mill, where chromium was so heavy, our dilution factor was too great to go on. We had to return to school for more distilled water. The fish enter this area and are slowed down at once by the poison. The gulls swoop down and eat them, and then the gulls die or are killed by rats as they are dying--then the rats die!

16. Paunch manure, blood and bone build-up, as it enters the river.

17. This is a little of every kind of pollution meeting as it enters the river.

18. Let's go back to Kinnikum! What a relief! Feast your eyes upon the beautiful pitcher plants snuggled in sphagnum moss. (There are three different varieties in this scene). The tubular pitchers recall the biblical scenes found in the Old Testament of Ruth at the Well. They were of this shape and from whence they got their name.

This is a carnivorous, meat eating, or perhaps we should say, insectivorous plant. It is also called Sidesaddle-Flower Cup, and Huntsman's Cup. Its scientific name is Sarracenis purpurea. Insects attracted by the bright colored veins that lead them to the sweet smelling and sweet tasting nectar, enter the cup and find themselves trapped by the opposing bristles, and thus flounder in the water of the cup that becomes more and more stronger with the plant's enzymes, and drown, to be digested by the plant who feeds upon its nitrogenous wastes.

Aren't they beautiful? If we could only keep them! But cultural eutrophication, man-made pollution, tells us another story.

19.

20. Oops! Sorry about that! This is one of Manchester's many sewers, where the sewerage is neither primary nor secondary treated. It enters the river to mingle with the blood and animal manure to give the river one of the highest coliform counts of any river in the East. Last winter, on one of the year's coldest days, it was 110,000 per 100Ml. This was confirmed by the State Water Pollution Board, because we could not believe our own accurate readings, using Millipore Equipment.

21. Other strange things enter the river also. This heavy mucoid, to use the vulgate-snotty material, hanging, stretching from the limbs, is a resin, from one of our plastic factories. When this reaches water, strange developments happen.

22. This is a scene of feces and fat embedded in plastic waste products and it slowly--and we mean slowly--decomposes. The tree died--we wonder why!

23. What a relief! Our friends, the pitcher plants, along with water willow, sphagnum and the American Cranberry (Vaccinium Macrocarpon).

24. Pipes not hooked together from whence drip many pollutants, is a typical scene on the Merrimack River. Many are under bridges--especially the larger ones.

25. Oil and coal tars.

26. This oily water contains a coal tar type product, and anilian dye near a knitting mill.

27. Sulphuric Acid-----along with-----

28. -----formaldehyde enters the river in this area, really doing a job on all living things-----

29.

30. We return to the clean place called Kinnikum--to refresh our minds and souls with nature in all her loveliness, as she was meant to be.

31. We tarried longer this time to look at Drosea Rotundifolia-round leaved sundew all around us.

(See pages 91 and 92 in Dana).

32. Anyone for cigarettes? As for me, I shall scurry back to the pond to look at a relic of the ice age.

33. White-Flower Grass in this beautiful Polar Pond, in a glacierated setting, about to become extinct with the help of snowmobiles.

34. More sewers-----

35. -----rushing to the Merrimack River and producing this-----

36.

37. Back for another view of the beautiful lillies and leather-leaf and water willow.

38. Nature supplies beauty even in decomposition--the beautiful soprophytes at work.

39. Another form of destruction.

40. Back to blood again.

41. New carts cost $47.50 each.

42. Do shopping carts grow on trees?

43. Shopping carts wheeled to the bridge by the "little people" were run off the bridge to rust and add its litter-bit to the scene.

44. Now, for a moment's change of pace, we went to a patch of Rhododendrons maximus, located in Manchester by this team, and judged by authorities to be the fifth largest lode in New England. We are not telling their hiding place because they are scarce--only about eighteen plots in all of New England of any size. These are relics of an earlier age and are protected. We caught two or three in bloom and are sorry we missed the big show--but we will be there for opening performance next July.

45. More pollution of the river--human feces--human manure in all its grossness-----

46. -----to join with blood river-----

47. -----and the sewers that earn the Merrimack River the title of one of the ten most dirtiest rivers in America.

48. Even the paint on the Budweiser cans could not stand the acid here-----

49. -----and the Pepsi Generation came in strong at the coffee break at this mill and threw the cans, cups, and bottle over the wall to the river bank. Who ever heard of garbage barrels in mill yards?

50. Yarn and dye plus Bud-----

51.

52. -----forced us back to Kinnikum and a lovely grove of Osmunda Cinnamonia (Cinnamon Fern).

53. This is some more resins.

54. Resins from a plastic company.

55. PO_4 algal bloom--death of a wood lot.

56.

57. Dye from a knitting mill.

58. A broken pipe with an oil and dye leak--all to enter the river.

59. Beauty once more in Sundew and Sphagnum.

60. An open sewer at GoffsFalls with a blend of toilet paper, detergents and other sewerage.

61. More beauty at Kinnikum--Lycopodum obscurum-- princess pine.

62.

63.

64.

65. Mold--putrifaction--blood and guts rotting at high noon--advanced decomposition-----

66. -----and sometimes on the banks via broken pipes to mix with other foul matter to rot in the sun.

67.

68. People have things back to normal on the river (Ahem!)

69. This sewer was so heavy with detergents, we had a job with the dillution factor.

70. A check-back at Kinnikum pond shows the yellow grass flowers, also of polar origin, in bloom and along with Sundew and Sphagnum, make a pretty scene.

71. Sludge buildup--4 feet deep.

72. We prefer "Button Bush", or Cephalanthus Occidentalis, a member of the Madder family, a truly All American Flower. It has a jasmine-like fragrance, giving the bog at Kinnikum a delightful odor throughout the Spring.

73. Fly ash of a type, blown from a pipe above-----

74. -----and the ever present pools of oil and dye-----

75. -----and pools of rotting fat and rapid growing fungus-----

76. -----plus open sewers, running raw with toilet paper and detergents, feces and urine-----

77. -----and back to blood once more.

78.

79. One more look before we decide for sure-----

80. WE ARE SURE! WE WILL TAKE KINNIKUM--SUMMER OR WINTER!

(DRAFT)

MANCHESTER WATERSHED SURVEILLANCE

SPECIAL REPORT - STEVENS POND

James A. Hall, Chairman
West High School Science Department
Manchester, New Hampshire

ST. ANSELM'S COLLEGE
USOE GRANT 1972-1973

AREA AND SCOPE OF STUDY

The area under study is the entire Manchester, New Hampshire Watershed, including the Merrimack River and its tributaries within our Watershed. We are not strictly confined to these areas, however, and frequently the class samples ponds, brooks, streams and rivers bordering our system. The following towns lie within the Manchester Watershed: Manchester, Candia, Hooksett, Auburn, and Chester. We say this because they all have ponds and streams draining into our Watershed. If we include the Merrimack River in our Watershed, which of course we must as we look to the future, then we must include the towns of Bedford, Goffstown, Londonderry, Suncook, and Concord, insofar as they drain into our system. Our sites for study on each pond or stream will be marked on a rough-out map of that particular area. We have written much more about Stevens Pond, because it is a last wild-life sanctuary within the boundaries of our city, Manchester, New Hampshire, and because it is the greatest in destruction of ecosystems. We hope, via Social Ecology, to get the message out to the citizens of Manchester, that it is PEOPLE that put this pond in the shape it is in at the present time. We further hope to show them what lies in store for the other little ponds that are a part of our Watershed, as population increases and people get to them. The entire Watershed encompasses a total of thirty-eight square miles. Samples were collected averaging one sample per day at each of the eight areas in one gallon jugs for five days, and each Saturday an extensive sampling at one of the eight areas.

THE APPROACH

The approach has been through testing over a period of one and a half years with the students of the Manchester Public School System and with the assistance from many Parochial and Private Schools. We have also had assistance from Public and Private Schools throughout the State. Rather than list or publish reams of daily figures on each pond or lake, river or stream, as is the usual approach, we have totaled and obtained monthly averages, to give one a bird's-eye view of our Watershed conditions at a glance. We feel the enumeration of cold, daily, statistics would be tedious to our readers as well as ourselves. Instead, along with our averages we have tried to include a write-up on each area, that has been compiled from the thoughts, expressions and observations of our students. Their papers are included for a review of any interested party. We will also include with this report, various graphs and samples of our work sheets.

EQUIPMENT USED

1. HACH Kits.
2. Millipore Equipment.
3. Basic Biological and Chemical paraphernalia.
4. Movie projector (8mm), 8mm camera, Video-cameras, 35mm slide cameras.
5. Home made ecological testing equipment.

THE STEVENS POND SURVEY

Stevens Pond is a small pond of about 39 acres lying in the great Massabesic Basin. It is a part of the Manchester, New Hampshire Watershed. This pond lies just about on the forty-third parallel north latitude. Its position is unique in that it lies within the boundaries of a city, and because that city, Manchester, New Hampshire, is the only city upon this continent, to be positioned exactly upon the forty-third parallel. Grace Blood gave mention to this in her book "Manchester on the Merrimack", and further stated that a rarity seemed to occur, perhaps because of this, in that plants of certain types and animals of certain types, that were to be found to the north of this imaginary line were seldom or never to be found to the south of that line. At any rate, it was listed in 1946 as one of the most luxurious--most profuse and diverse in fauna and flora of a .y pond its size, in the State of New Hampshire. The people that did this survey were Father Hubert Sheehan, (a botany professor) of St. Anselm's College, and Professor Albion Hodgdon, Ph.D., botany, University of New Hampshire, members of the New Hampshire Fish and Game Commission, and students of both colleges mentioned above. From

1950 to 1960, science teachers from Manchester, New Hampshire public schools collected samples from this pond to supplement class materials, and classes were taken on field trips to Stevens Pond to learn about nature in a real setting.

The Plants at Stevens Pond

In this section I will list some of the plants that were classified by Memorial High and West High School students since 1960, and those found in parenthesis are those that have been obliterated by man's carelessness and unconcern for our wetlands and water places. Starting at the southwest side of the pond and proceeding toward its southeast aspect, all of which parallels a busy street, Bridge Street Extension, there once was a swamp. This swamp was wiped out in 1971 by a road building crew. It was a very pretty swamp in the eyes of a botanist or a nature lover. As we approached the swamp, we entered a fern glade of (Osmunda regalis) Royal Fern. They were stately to say the least, and some of our smaller students would have been almost lost from sight if we had let them wade through this once beautiful glade. Today there are very few scattered ferms of this species and only near the pond's margins. To the left of this was a small rise with a few white oak (Quercus alba) and as this dipped downward again the beautiful Cinnamon Fern (Osmunda cinnamonea L.) called "Brake" and Fiddle-head

Fern by the children of New England. This entered even out into the wetter portions of the pond and would be found upon tussocks and rises within the swamp. Here, at the edge of the swamp, Cattails (Typha latifolia) were abundant. At one area along the road just before entering the swamp, there used to be a gentle slope covered with Field Horsetail (Equisetum arvense). As we entered the swamp we found a little brook running through the swamp and many fine specimens have been taken from this brook. The following list includes but a few (Myriophyllum) (Proserpinaca), (Chara), (Ceratophyllum) or Coontail, (Utricularia vulgaris) common bladderwort, various mosses and algae. All have, of course, gone with the destruction of the swamp ecosystem. The swamp was always a swirl of color with (Rosa palustris) the swamp rose and (Celastrus) bittersweet in the higher spots, along with (Ilex verticillata) or black alder called winterberry with its bright red fruit. Then throughout the wet areas, (Galium palustre) bed straw, (Dulichium arundinaceum) (Decodon verticillatus) or Swamp Loosestrife, (Lythrum or spiked loosestrifė), (Hypericum boreale) St. John's-Wort, and many, many others, too many to be mentioned in this paper, have been wiped out with the bulldozing and filling in of this pond. Needless to say its effects have been felt in the bogs that border the pond and the pond itself. Moving easterly we came upon a grassy bank and a small landing with a sandy bottom. There used to be upon this bank many (Marchantia), and other liverworts; these, however, have been gone for ten years.

Here in the littoral zone, there are a few duckweed, and occasional Sagittaria latifolia, and still quite a bit of Anacharis canadensis. One plant that has been long gone from this area is the graceful (Sagittaria Engelmanniana). An occasional Scirpus or bulrush may be found in this area and a few Sparganium clusters; but, for the greater part, the only remaining plant of accord in this area is the white pond or water lily, Nymphaea odorata. Large floating mats of these extend from the bank almost out to mid-pond. The water area to the east seems to become more sterile as far as plants are concerned. The area is a sandy bottom littered with countless beer bottles, beer cans, cold drink bottles, tabs from cans, oil cans, old shoes, metal scraps, articles of clothing, and even an old bath tub. It is the area of easiest access, the place where man can be found most often. It is also a place where man shows his true character--when he tosses his beer can out into the water or crashes his glass beer bottle against the large rock we used to sit upon. Here all the trees, Populus grandidentata, and the common poplar or Populus tremuloides, rock maple or Acer saccharum and the Eastern Red Oak, Quercus borealis maxima, have all been cut, carved, chopped into or chopped down. No animal except man could have left such ugly scars. At the great landing the litter is so vast I will not attempt to describe it here. Last year the students picked up more than five thousand beer cans in this area, and today there are at least that many more littering the area.

Here in the water are a few Typha and Potamogeton that have survived. Off in the water and still within the littoral zone are some eel grasses and a few more pondweed. Twenty years ago, there was quite a few species of (Sagittaria) in this area, whereas now "S.latifolia" is all that remains. To the right and still easterly along the banks are quite a few Vibernum, including "arrow-wood" and "Wild Raisin". There is also a sprinkling of Betula populifolia, or gray birch. There is also a large stand of Alders, Alnus incana or speckled alder plus an occasional smooth alder or Alnus rugosa. Mingled with these are a few skunk cabbage and now and then a grassy tussock. Oil slick enters here from two oil drums dropped into the brook above, along with a rust coating from varied tin cans dumped here a few years ago, of everything including the plants. The signs are there to my students and myself--"Death of an Eco-system" in a few years.

A few other plants of varied species appear here and there and at the most easterly point of the pond there is another brook. This contains a large yellow splash of paint where the road crew emptied the left over paint after completing the yellow line in the road. To the right of this is a large dump that has been used by the neighborhood for years. Some of the plants here are quite pretty however. Violets grow along the brook, and butter-and-eggs upon the bank. A few pines are in this area and a large field around the corner as we headed northward. To our right for some distance there was a large field that used to be full of many beautiful flowers, but they have long since past. Motorcycles have trails through the field and the steep hill due east. The people that ride the bikes do not have an ounce of ecological interest. They get a running start in the field and try to make the hill, often spinning and ripping up sod. Large gullies have been formed and during rain storms the soil is washed into the pond, helping to fill it up and alter its pH. After playing around for some time, these boys have a few beers and toss their cans into the nearby pond or swamp. The bushes in this area are filled with beer cans and bottles, paper, pornographic magazines and food particles. A once beautiful pond has been scared by the filth of our society. It seems these boys are protected because through the years we teachers and students have entered many complaints but to no avail. At the end of the field the_ is a wooded area of mostly oak, sprinkled with maple and birch and an occasional pine or hemlock. This is quite clean to the right because it is hard to ride the motorcycles in the woods and up hill. However, there is a trail through the area that follows the pond. This is evident by the broken bushes and the litter of all types. At the most northern side of the pond, a grassy lawn is littered with broken beer bottles. A large rock at the ponds edge supplies a handy source upon which to break the bottles. Twelve years ago there wasn't a piece of glass here; in the spring and fall we used to set up our portable field microscope tables, and our students waded barefoot collecting samples for study on the spot. One would not do that today with all the glass and rusty tin. The plants are few and very sparse in this area, long since destroyed by people.

A short distance from here is the other side of the pond, or the most northern side. Here the plants are quite healthy, as they are not easy to get to. They are protected in that there are no access roads on this side of the pond. Water willow, high and low bush blueberries, Button Bush or Cephalanthus occidentalis, swamp grass, a few of the plants that were previously destroyed on the other side of the lake are starting up, along with sundew and the insectivorous pitcher-plant and sphagnum moss, all add to the beauty of this area, and suggest that there is hope if we can stop people from coming to the pond for a year or two, or if only responsible people were allowed there.

Moving across this end of the pond to the northwest side, there is the largest feeder brook to the pond. It is the widest of the brooks and is polluted with septic tank runoff, and usually has lush growths of algae and chara. This whole area is a floating sphagnum bog, and used to be loaded with Pitcher-Plants, Sundew, Viburnhams, blueberry bushes, cranberries, water willow, violets, payola, and many other plants too numerous to mention in this paper. They are gone for the greater part, and a scattering of each is to be found. Trails cut through dumps from nearby houses, and children playing who have not been educated to conservation factors, have taken a toll.

It is obvious why this pond is in such a condition--PEOPLE--and more are coming. If the report by the Arthur D. Little Company of population boom in Merrimack and Rockingham Counties is true, we just have to close our eyes and other feeder lakes and ponds will become like this one, and we will lose our rating of being the "Sixth Cleanest Water System in America". Remember these little ponds that all feed into beautiful Massabesic Lake: Hinman, Clay, Kinnikum, Tower Hill, Clark, and Little Massabesic Pond. These, plus the 1800 acre Kinnikum Swamp, with Maple Falls Brook, Sawyers Pond and Sawyers Brook, plus Moose Meadow Brook, are for the greater part our water source. At the moment it is clean. But for how long? People are already starting to move into the area. Homes are being built upon its edge, and snowmobiles are penetrating deeper.

We call this the Stevens Pond Survey, but this report covers all the above mentioned areas. We called it thus because we started at Stevens, as it was the most polluted and within a city, and obvious. It further offered an area close by which was accessible during the school day and after school, before darkness set in. The other areas have been worked by teams of teachers and students on week-ends and vacations. We have, however, had a group of teachers bring in daily samples by jug, so our monitoring could be more accurate. A brief description of the other areas is included, but not as extensive as Stevens Pond, as the pollution is nowhere near as bad. It is just starting!

Steven Hadlock
December 28, 1972
Ecology II B,D,E,F,G,H,J

REFLECTIONS ON STEVENS POND

It is a small pond. One could possibly miss it, while going down Bridge St. Extention. The only two clues to its existence are a runoff trench which affords the only clear look at it from the road, and a small turnaround flanked by mailboxes. This is Stevens Pond.

Today, it is not used by many. Named after George Stevens, an engineer for the Amoskeag Mills, the pond was considered as a source of fresh water for the City of Manchester. As a Manchester Water Works report of the 1880's put it, "It has an altitude of 105 feet above City Hall, from which point it is distant, in a straight line, about two miles . . . the altitude is not quite sufficient for our purpose." On some maps, it is listed as Stevens Pond Park. This is a fallacy. The area listed as a park was once a bog, teeming with plant life, but it is now a landfill that is dormant, collecting litter. As the Water Works report put it,

> " . . . The area of the pond is perhaps 20 acres, and it is in large part surrounded by a peat bog of equal extent, and which is in some places more than thirty feet in depth. The same bog underlies the pond . . . the area of land draining into the pond does not exceed two square miles."

The two square miles of drainage bear the scars of Man's exploitation. The water in the bog is tinged with oil slick from two rusting 55 gallon drums, submerged. The swamp across the road is thick with algal bloom from inefficient septic tanks, and detergents. The brook that runs under the road runs through a "golden gulley" which was created by Public Works employees dumping the yellow paint from road stripes. The swamp is flanked by Navarone-like cliffs of surplus asphalt which has no further use. The hills surrounding the pond are criss-crossed with a latticework of dirt-bike trails. These at first may seem harmless, but the ph of the soil washed down from these trails is different from that of the bog, and the resulting change could be disastrous to any stenoacidic or stenoalkalinic organisms present. Also, what price can be put on the thousands of plants destroyed in the rush to create the now dormant landfill. Is this not a case of 'Hurry up and wait'?

The pond was threatened by a proposed highway off ramp, but it has been spared. However, the largest threat lies from the salt put on the roads. All the runoff water is laden with it. Action must be taken soon to protect this precious little piece of real estate. In 1946, it was named the most luxurious bog in the area. Can we sit back and let this become a parking lot, shopping center, or housing development? The past two years I have become very close to, and very protective of Stevens Pond. Every one of the 5,000 beer bottles we collected out there was a wound in me, and all those who helped. Let us spare our children these wounds by starting "preventive medicine" today.

RECOMMENDED USE CLASSIFICATIONS [1]

AND

WATER QUALITY STANDARDS

AS OF JANUARY 1, 1970

BASED ON CHAPTER 149 REVISED STATUTES ANNOTATED [2]

NEW HAMPSHIRE WATER SUPPLY AND POLLUTION CONTROL COMMISSION

	Class A	Class B	Class C	Class D
	Potentially acceptable for public water supply after disinfection. No discharge of sewage or other wastes. (Quality uniformly excellent).	Acceptable for bathing and recreation, fish habitat and public water supply after adequate treatment. No disposal of sewage or wastes unless adequately treated. (High aesthetic value).	Acceptable for recreational boating, fishing, and industrial water supply with or without treatment, depending on individual requirements. (Third highest quality).	Aesthetically acceptable. Suitable for certain industrial purposes, power and navigation. (Lowest allowable quality now less than 1/2 mile in entire state).
Dissolved Oxygen	Not less than 75% Sat.	Not less than 75% Sat.	Not less than 5 p.p.m.	Not less than 2 p.p.m.
Coliform Bacteria per 100 ml	Not more than 50	Not more than 240 in fresh water. Not more than 70 MPN in salt or brackish water.	Not specified	Not specified
pH	Natural	6.5 - 8.0	6.0 - 8.5	Not specified
Substances potentially toxic	None	Not in toxic concentrations or combinations.	Not in toxic concentrations or combinations.	Not in toxic concentrations or combinations.
Sludge deposits	None	Not objectionable kinds or amounts.	Not objectionable kinds or amounts.	Not objectionable kinds or amounts.
Oil and Grease	None	None	Not objectionable kinds or amounts.	Not of unreasonable kind, quantity or duration.
Color	Not to exceed 15 units.	Not in objectionable amounrs.	Not in objectionable amounts.	Not of unreasonable kind, quantity or duration.
Turbidity	Not to exceed 5 units.	Not to exceed 10 units in trout water. Not to exceed 25 units in non-trout water.	Not to exceed 10 units in trout water. Not to exceed 25 units in non-trout water.	Not of unreasonable kind, quantity or duration.
Slick, Odors and Surface-Floating Solids	None	None	Not in objectionable kinds or amounts.	Not of unreasonable kind, quantity or duration.
Temperature	No artificial rise	NHF&GD, NEIWPCC, or NTAC-DI -- whichever provides most effective control. [3]	NHF&GD, NEIWPCC or NTAC-DI -- whichever provides most effective control. [3]	Shall not exceed 90°F.

Note: 1 The waters in each classification shall satisfy all provisions of all lower classifications.

2 For complete details see Chapter 149 RSA.

3 NHF&GD = New Hampshire Fish and Game Department

NEIWPCC = New England Interstate Water Pollution Control Commission

NTAC-DI = National Technical Advisory Committee, Department of the Interior

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Reflections on Stephens Pond

Stephens Pond has been among the most scenic areas in New Hampshire. Throughout the early years of its existence, it has reflected all of the color and beauty typical of the New Hampshire regime. It has been absolved by all animals for the truth and candor which the glistening pond seems to reflect. Stephens Pond was a full thirty-seven acres of natural beauty, surrounded by a plush bed of peat moss.

There was a time when man, the most domesticated of all animals, would have exalted Stephens Pond as a model: the model of the perfect ecosystem. Definite proof exists which states the fertility of this ecosystem. The life which has sprung from it is over abundant. It is my opinion that Stephens Pond held more life in it before 1950, than the Merrimack River (within the Manchester city limits) now holds.

Beginning at the approximate year of 1950, the pond had started toward the unfavorable condition of pollutance. The "local kids" had found Stephens Pond to be a cultural oasis. . .for beer blasts! The "locals" discovered a new source of knowledge at the pond. They learned how to hold their liquor, perhaps even up to the awesome amount of four bottles!

As the popularity of this cultural oasis spread, the contamination also spread throughout the pond. Beer bottles lined the banks as well as the floor of the pond—many were broken. Bags and wrappers have been strewn along the banks of this pond for more than two decades.

What are the motives which lie behind mans pollutance of such a beautiful 'cradle of life'? Why has man lowered himself beneath the most barbaric uncouth creature on earth to pollute the waterways? Soon man will crawl on his stomach amidst the countless remnants of a once great society. He will crawl through the filth and sewage if he continues to pollute areas such as Stephens Pond.

The projected population increase made by Arthur D. Little in 1970 for the next fifteen years has multiplied the Merrimack Valley population three-fold. The grossness of the pollutance and ruination of Stephens Pond has increased with the population. What will happen to all the "Stephens Ponds" in New Hampshire in the coming years?

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Ecology Student

Steven Hadlock
January 4, 1972
Ecology II B, D, E, F, G, H, J

REFLECTIONS ON CLAY POND

Clay Pond is probably one of the more fortunate ponds of the state and the country. It is far enough into the woods, that few people know of it, and even fewer visit. It is most frequented by hunters, who have reputation for keeping "their" areas to themselves. One finds few beer cans, gum wrappers, and discarded newspapers. Chemically, the pond is pleasingly free of cultural eutrophication, with only a light covering of detritus on the gravel bottom.

Clay is situated in the town of Hooksett, adjacent to the Chester Turnpike. Flanked on one side by a large swamp, it is a part of the Northern Manchester Watershed, along with Heads Pond, Lakin Pond, Maple Falls Brook, Moose Meadow Brook, and Kinnekum Swamp.

Its coordinates on the map are approximately 43°05' north latitude, and 71°23' west longitude. Elevation is approximately 450 feet above sea level.

Clay Pond, because of its present condition deserves the right to be protected from an onslaught of the public in the future. If it is to be saved from the grasp of eutrophication, actions should begin soon.

Little Massabesic Lake

Tests Performed	Sept. Avg.	Oct. Avg.	Nov. Avg.	Dec. Avg.	Comments
Dissolved oxygen	14-15	14-15	13-14	11-12	Expected constant over two yr. period
Coliform Bacteria per 100 ml.	8-10	10-15	5-10	2-5	Highest was Aug. 3rd 383/100 ml
ph	6.0-6.5	6.0-6.3	5.9-6.0	5.7-5.9	Normal seasonal flux rate
Potentially Toxic Substances	None noted at any time worthy of mention.				Mild oil slick from a boat in August
Color	Clear and colorless except in grassy areas. Straw to pale yellow.				
Turbidity J. T. U.	20-25	20-25	25-30	25-30	Quite Constant
Slicks and Floating Solids	None except for one slick this summer from a boat.				
Chlorides low range mg/l	25	25	25	25	Seldom Varies
PO_4	Neg.	Neg.	Neg.	Neg.	
Temperature	All reading well within seasonal fluxuations				
CO_2	All averages within normal range.				
NO_3	0-3	0-3	0-4	0-5	Within range of last two years readings
Alkalinity	1-3 grains/gal. usual reading-few outstanding times-rare-not worth recording				
Free Acidity	Neg.	Neg.	Neg.	Neg.	

CLAY POND

Tests Performed	Sept. Avg.	Oct. Avg.	Nov. Avg.	Dec. Avg.	Comments
Dissolved Oxygen	15-16ppm	14-15ppm	13-14ppm	11-12ppm until mid-Dec.	Now 6-7ppm
Coliform Bacteria per 100 ml	0-25	0-25	0-15	0-10	Nov. & Dec. amount probably due to hunters & tourists
pH	6.4-6.6	6.1-6.3	5.8-6.0	5.4-5.7	
Substances Potentially Toxic	None were noted with the exception of chlorides which were a result of road salting.				
Color	This pond is usually light straw to colorless.				
Turbidity JTU	28-30	28-30	29-32	38.42	Increase due mainly to dead plant matte
Slick and Floating Solids	None were noted.				
Chlorides mg/L	50-100	50-100	75-125	100-150	
PO_4	No phosphates were present in the Ortho form.				
Temperature	The temperature has not fluctuated to any greater or lesser extent than the seasonal normals.				
CO_2	All averages have been within normally acceptable ranges.				
NO_3	0-1ppm	0-1ppm	0-2ppm	1-3ppm	
Alkalinity	1-4 grains per gallon has been the usual run at this pond.				

MAPLE FALLS BROOK

Tests Performed	Sept. Avg.	Oct. Avg.	Nov. Avg.	Dec. Avg.	Comments
Dissolved Oxygen	15-16ppm	15-16ppm	14-15ppm	12-13ppm	9-11ppm
Coliform Bacteria per 100 ml.	2-5	2-5	2-5	0-2	
pH	6.3-6.6	6.1-6.3	5.5-5.8	5.0-5.	
Substances Potentially Toxic	None were noted with the exception of chlorides which were a result of road salting.				
Color	Clear and colorless.				
Turbidity JTU	30-40	30-40	30-40	20-30	Noted amount due mostly to dead plan material.
Slick and Floating Solids	None were noted.				
Chlorides mg/L	25-50	25-50	25-50	25-50	
PO_4	No phosphates were present in the ortho form.				
Temperature	The temperature has not fluctuated to any greater or lesser extent than the seasonal normals.				
CO_2	All averages have been within normally acceptable ranges.				
NO_3	0-4	0-4	0-4	0-5	
Alkalinity	1-2 grains per gallon has been the usual run at this brook.				

CLARK POND

Tests Performed

	Sept. Avg.	Oct. Avg.	Nov. Avg.	Dec. Avg.	Comments
Dissolved Oxygen ppm	14-15	14-15	14-15	13-14	Fast running brook into this pond
Coliform Bacteria	0-18	0-10	0-8	0-3	Expected raw water
pH	6.0-6.5	6.0-6.5	6.0-6.5	6.0-6.5	Very seldom varies from this range
Substances Potentially Toxic	None noted at any time except one day in October we got quite a few suds and a positive on detergent. Never again.				
Color	Straw colored to colorless.				
Turbidity JTU or FTU	15-20	20-25	20-25	25-30	Exception being up near the bridge. Fast running water in this area.
Slick and Floating Solids	None observed on any trip, except foam, once.				
Chlorides Mg/L Low Range	25ppm	25ppm	25ppm	25ppm	This would be abou 50-60 on a HACH hi range. Road salted here.
PO4 Ortho Meta Poly	Ortho O Poly=0	Ortho=0 Poly=0	Ortho=0 Poly=0	Ortho=0 Poly= .05ppm	We cannot account for Poly averages for December
Temp-Air Water Fluctuated	No temperature fluctuation that varies from seasonal normal.				
CO_2	All averages are insignificant and within normal ranges.				
NO_3 ppm	0-2	0-2	0-3	0-1	Not significant.
[illegible]ity	1-3 grains per gallon has been the seasonal average at this pond				