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ABSTRACT

This is one of a series of 14 instructional components of a semester-long, environmental earth science course developed for undergraduate students. The course includes lectures, discussion sessions, and individual learning carrel lessons. Presented are the study guide and script for a learning carrel lesson on water, specifically water quality and water resources. The slides, audio-cassette tape, and other materials necessary for this lesson are not included. (BT)

SCIENCE EDUCATION CENTER

STUDY GUIDE AND SCRIPT

SECTION IV: NATURAL RESOURCES

LESSON 6.13: WATER

ENVIRONMENTAL STUDIES

A Cooperative Project of The Department of Geological Sciences and the Science Education Center

The University of Texas at Austin

ENVIRONMENTAL EARTH SCIENCE

"Environmental Earth Science" is a new course developed at The University of Texas at Austin by the Department of Geological Sciences and the Science Education Center. It is offered at The University of Texas at Austin as Geology 361K and has been tried out during the spring semesters of 1972, 1973, 1974, and 1975. Revisions have been made as necessary after each tryout. The project within which the course has been developed has been supported by the National Science Foundation.

The course includes lectures, discussion sessions, and individualized Learning Carrel Lessons. Extensive use has been made of multi-media technology in the presentation of the course. Learning Carrels for individualized instruction have been especially designed for this program. The lectures introduce specific topics, suggest problems or questions, and provide background information. The discussion sessions provide the student an opportunity to ask questions and clarify ideas. The discussion sessions also provide input and feedback to the instructor.

The Learning Carrel Lessons have been written by faculty and graduate students in the geological sciences and in science education. Writers and resource contributors include Dr. Robert Boyer, Dr. Rolland Bartholomew, Dr. Keith Young, Dr. Samuel Ellison, Dr. James Underwood, Dr. David Butts, Dr. Addison E. Lee, David Keller, Melanie Lewis, Wayne Schade, Ann Lee, and William McLoda. Technicians involved in production of scripts, sound, and photography were Stan Prescott, Lee West, Charles Geffen, and William McLoda. Artists were Jesus Rivas, Alice Canestaro, Aly Knox, and Javier Flores.

Each Learning Carrel Lesson consists of a set of 2 x 2 slides, an audio cassette tape, a study guide, a script, and other materials necessary to the lesson. The study guide and script are in this booklet. Students may set their own time schedule within an announced period when slides and tapes are made available.

The student should note the list of Learning Carrel Lesson topics to place in proper content the lesson in this booklet, and then read carefully the introduction, rationale, prerequisites, and lesson objectives in the study guide. The student should follow the instructions in the study guide for the entire lesson. In some instances, these instructions are also repeated on the audio cassette tape. The slides and tapes have been synchronized to automatically advance the slides appropriate to the audiotape. However, there is a tone signal given before the change of each slide so that the lesson can be used outside of the carrel if automatic facilities are not available. When the student is ready to start the lesson, the "on" switch should be pushed. If the slides and tape are operated manually, both will need to be turned "on." The first slide is always a title slide or a blank solid colored slide. If

the slides and tape are manually operated, this title or blank slide should be on view before the tape is started. For automatic operation, the slides and tapes will be set up by the Instructor or Proctor before the lesson and between each use. It is most important to start each lesson according to these instructions in order to provide synchronization of the slides and tape. Remember that slides placed in the tray to be used with a rear view screen are reversed from those to be used with a front view screen.

The student will be instructed by the study guide and/or the tape to stop at various places to carry out certain activities. Usually the audio-tape will say, "Please stop the tape now and restart only when you have finished this exercise." Therefore, the student should wait a few seconds to finish hearing the instruction after the word "Stop." However, one should not wait long enough for the tone signal or automatic change to the next slide. This signal should be heard after you restart the tape. If the lesson is moving too rapidly, the student may stop the tape and slides at any time to consult the study guide or script, but it is NOT POSSIBLE to back up and re-examine a given slide without completing the entire cycle of the lesson.

It is particularly important for the student to carry out the instructions for activities given in the study guide. In order that a record may be maintained of these activities, each student should pick up a copy of the STUDENT RESPONSE SHEET which include questions to be answered and the other activities requiring responses. These should be completed and turned in to the instructor as required for grading, feedback for the instructor, and to provide a basis for student interaction in the discussion group.

Each Learning Carrel Lesson is independent within the context of the course. Some of them provide direct information on a given topic, but in an individualized mode requiring some activities and thought on the part of the student. Others place the student in a role-playing situation where some position must be taken on provocative questions or issues. Others deal primarily with applications of environmental information. In all the lessons, the student is expected to receive basic information that is coordinated with the lectures, the small group discussions, and the readings.

ENVIRONMENTAL EARTH SCIENCE

LEARNING CARREL LESSONS

Section I: Man's Effect on Nature

Lesson 6.1: Population
Lesson 6.2: Land Use
Lesson 6.3: Urban Crisis (Field Trip)

Section II: Energy

Lesson 6.4: Energy
Lesson 6.5: Energy Resources
Lesson 6.6: Future Projections

Section III: Processes Through Time

Lesson 6.7: Geologic Time
Lesson 6.8: Long Term Events
Lesson 6.9: Short Term Events

Section IV: Natural Resources

Lesson 6.10: Minerals
Lesson 6.11: Conflicts of Interest
Lesson 6.12: Soils
Lesson 6.13: Water

Section V: Oceanography

Lesson 6.14: Ocean Resources
Lesson 6.15: Pollution of the Oceans

STUDY GUIDE FOR LEARNING CARREL LESSON

6.13

WATER

ENVIRONMENTAL STUDIES

A Cooperative Project of the Department
of Geological Sciences and the Science
Education Center

THE UNIVERSITY OF TEXAS AT AUSTIN

TO THE STUDENT:

This booklet contains two sections: (1) the Student Study Guide for this lesson, and (2) the Script or printed copy of the discussion recorded on the audio cassette tape.

You are expected to begin with the printed instructions in the Study Guide and follow them continuously as you study the lesson. In many instances the same or similar instructions may also be heard on the audio cassette tape. Refer to the script only if you need to refresh your memory as to something that was said. The script is provided because you cannot back up the tape if you need to review something already said on the tape.

Specific instructions will be given in the Study Guide as to when to stant and stop the tape. Do not restart the tape until instructed to do so in the Study Guide.

Questions requiring written answers should be completed on the STUDENT RESPONSE SHEETS provided by the Instructor.

INSTRUCTIONS:

1. Read the Introduction, Rationale and Objectives for this lesson that follows. If you have questions, check with the Instructor or Proctor.

INTRODUCTION:

Water is so plentiful for our personal needs we seldom think of it as a natural resource. However, when man needs water and does not find it readily available, water becomes a precious natural resource. Another aspect of water that we often forget about is its costs. Monthly water bills are higher than they used to be, but the amount paid for all the water we use in our homes is a small percentage of our total living expenses.

Is water conservation a problem worth considering? Is water quality of importance to us? Is there a water shortage? How is man using water and how does this use of misuse of water affect man? In the future will man find other sources of water? This program will introduce you to some of the answers to these questions.

RATIONALE:

Because water is so basic to all of man's activities, it is worthy of study as a natural resource. In fact, geologists studying some petroleum producing areas have proposed that the water resources in these areas may be worth more money to the owner than the oil that is currently being removed.

The need and cost of water is increasing at a rapid rate. If man is to make effective use of this natural resource, he must learn to treat it as a precious resource -- something to care for and use without waste. Therefore, the focus of this program is on man's use or misuse of water -- a natural resource.

OBJECTIVES OF THIS LESSON:

After completing this lesson you should be able to:

1. identify areas where water is precious or bountiful depending upon how it is used
2. describe where large cities get their water
3. list five factors affecting the water quality where you live
4. classify the major factors affecting water quality in one of three categories -- physical, chemical, or biological factors
5. define water pollution
6. explain five basic steps in municipal water treatment
7. describe a solution for water shortage problems in cities and agricultural areas
8. explain two sources of water that will be available to man in the future

INSTRUCTIONS:

2. Start the audio cassette tape and slides. (For manually operated slide carousels, be sure the slide on the screen is the title slide or the blank colored slide in slot number one. Otherwise, the slides and tape will not be synchronized. However, in this particular lesson, the first slide is neither, it has a message.) Relax and listen to the music for the next 15 slides and you are told to stop the tape. Then STOP THE TAPE AND SLIDES and follow the instructions that follow.

INSTRUCTIONS:

3. Restart the audio cassette tape. Listen to the tape and view the next 7 slides. Locate the appropriate STUDENT RESPONSE SHEET and check the appropriate space under Frame 1 on your STUDENT RESPONSE SHEET. Each slide will be on the screen for seven seconds and the tape will not stop during these showings.

Frame 1

Identify the following slides as precious or bountiful. (USE STUDENT RESPONSE SHEET)

Slide: Drawing water from well

Slide: Children playing in fountain

Slide: Baptism scene

Slide: Cover of Lawn Care magazine

Slide: Windmill

Slide: Washing clothes

Slide: Family in bathtub

Slide: Woman washing at sink

INSTRUCTIONS:

4. Following the slide showing a woman washing at a sink, restart the audio cassette tape. Listen to the tape and view the slides until reference is made to Frame 2 and you are told to stop the tape. Then STOP THE TAPE AND SLIDES. Study the factors that alter the composition of water identified on the next page and complete the activity under Frame 2. List your selection of factors on your STUDENT RESPONSE SHEET.

Frame 2

You are probably surprised to learn that there are so many factors that alter the composition of water as listed on the next page. From this list of 22 factors, select five factors that are most likely to affect the water quality where you live and rank the five factors by placing the appropriate number in the space provided on your STUDENT RESPONSE SHEET. Also list the least important factor.

POLLUTION ENTERS THE WATER CYCLE

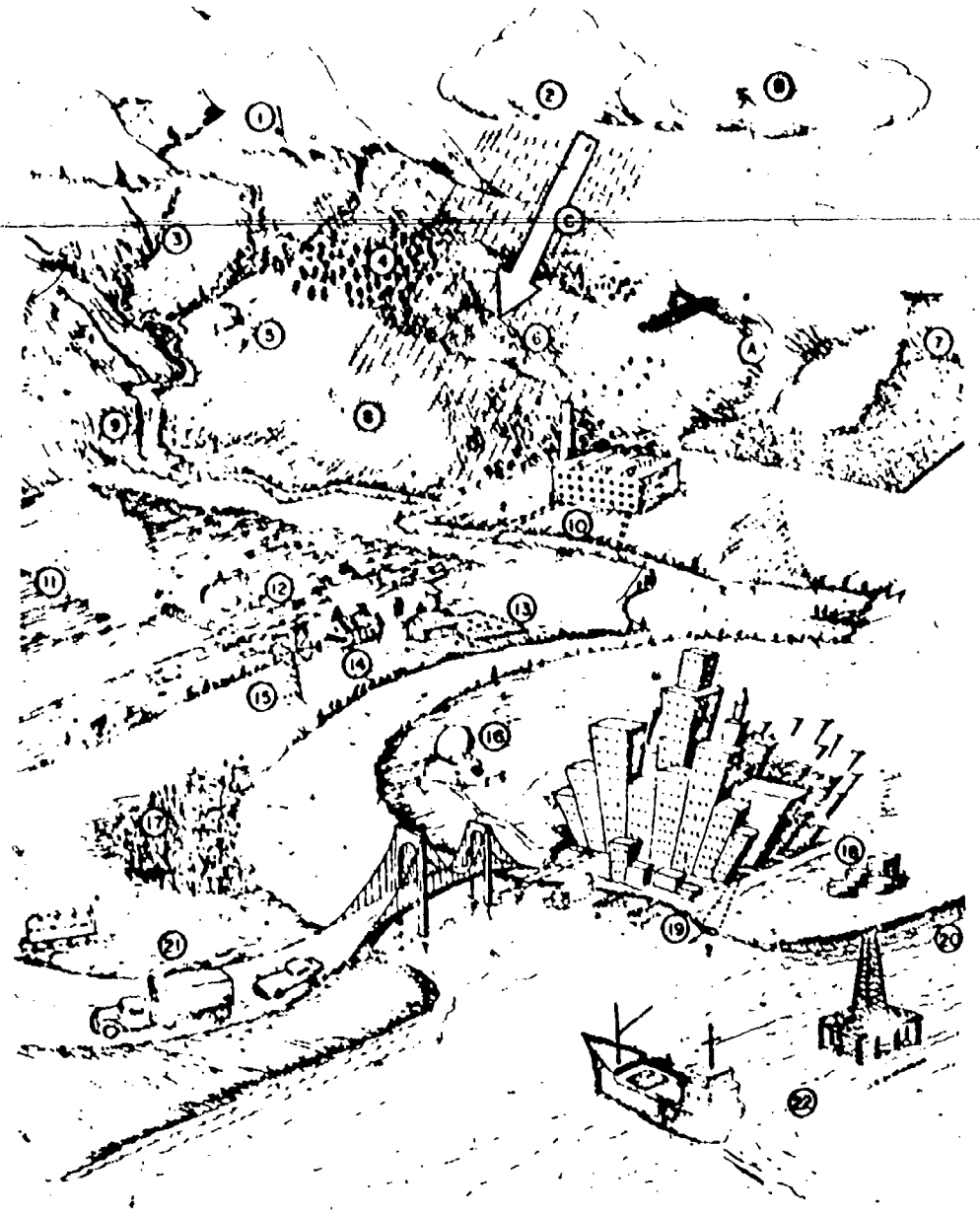


Fig. 7 This unique version of the Hydrologic Cycle shows the major sources of chemical and physical pollution. Note the important inter-relationship between air pollution and water pollution. Man-made pollutants upset the balance between natural pollution factors and natural purification processes.

Frame 2

The three primary stages in the Hydrologic Cycle are (A) Evaporation, (B) Condensation and (C) Precipitation.

Here are some of the factors that alter the composition of water.

(1) Dust particles and gases are filtered out of the atmosphere by falling snow and are trapped in the snow banks.

(2) Radioactivity in the atmosphere is usually carried by minute dust particles at high altitudes.

(3) Flowing water erodes rocks and soil, adding suspended solids to the water.

(4) Trees transpire terpene gas as well as moisture.

(5) Mine acid wastes have a severe effect on the pH and the chemical composition of the water into which they are discharged.

(6) Industrial gases are washed from the atmosphere by falling rain and snow.

(7) Crop dusting, an economical farming practice, contributes to both air and water pollution.

(8) Rainwater leaches chemicals from the soil and from decaying vegetation and these soluble materials are carried along in both surface and ground water.

(9) Natural aeration by rapids and waterfalls activates changes in the dissolved gases content of the water.

(10) Industrial waste water can vary greatly in its composition depending upon the industrial use of the water and the waste treatment processes employed.

(11) Dust particles caught by winds can drift great distances before being redeposited.

(12) Large quantities of soluble fertilizer salts, plus insecticides and herbicides are washed into surrounding water supplies.

(13) Barnyard wastes contribute both organic and chemical pollutants.

(14) Domestic septic systems ultimately pass to ground water supplies.

(15) As wells draw off usable ground water, undesirable brine can enter the water table from marine estuaries and the sea.

(16) Heat laden waters from power plants introduce thermal pollution.

(17) Marsh gas (methane) is manufactured naturally below the surface of marshes and swamp lands.

(18) Municipal water treatment plants must be carefully managed to prevent their discharge from causing a disease outbreak.

(19) Storm sewers carry away water that has bathed an entire city.

(20) Particles of salt from marine wave action are carried to amazing heights by coastal wind currents.

(21) Automotive exhausts are continually adding hydrocarbons that are adsorbed by the moisture in the atmosphere.

(22) Oil leaks from vessels and offshore drilling operations can be disasterous.

(Reference: Dr. Charles E. Renn, Our Environmental Battles, Water Pollution, LaMotte Chemical Products Company, Chestertown, Maryland, 1969)

INSTRUCTIONS:

5. Restart the audio cassette tape. Listen to the tape and view the slides until reference is made to Frame 3 of your Study Guide, then STOP THE TAPE AND SLIDES. Answer the question under Frame 3 on your STUDENT RESPONSE SHEET.

Frame 3

Define water pollution.

INSTRUCTIONS:

6. Before starting the tape look at Table I in Frame 4. You will be asked to complete this table by using the information shown on the next few slides. Restart the audio cassette tape but stop the tape after each slide (5 slides) and fill in the information in Table I on your STUDENT RESPONSE SHEET. Then continue to the next slide. Start the tape when you are ready.

Frame 4

Table I

Factors Affecting Water Quality

Physical Factors	Chemical Factors	Biological Factors
_____	_____	_____
etc.	etc.	etc.

You will be asked to check your results with a completed Table I shown on the next slide. STOP THE TAPE AND SLIDES and check your results.

INSTRUCTIONS:

7. Restart the audio cassette tape. Listen to the tape and view the slides until reference is made to Frame 5, then STOP THE TAPE AND SLIDES. List the steps in treating water for drinking purposes under Frame 5 on your STUDENT RESPONSE SHEET.

Frame 5

List the steps in treating water for public drinking purposes.

INSTRUCTIONS:

8. Restart the audio cassette tape. Listen to the tape and view the slides until reference is made to the Texas Water Plan and you are told to stop the tape. Then STOP THE TAPE AND SLIDES and study the Texas Water Plan as described on the following pages under Frame 6.

Frame 6

Study the Texas Water Plan as listed on the following pages.

THE TEXAS WATER PLAN

INTRODUCTION

Water planning is a means to an end and not an end in itself. Its objective is the development of water resources as effectively and economically as possible to meet man's needs while at the same time protecting him from flooding and periodic drought. The high dams and man-made rivers that stand as monuments to man's ingenuity and technical skills conserve and distribute the water which is vital to his life and well-being, and shield him from its detriments. These works are conceived and planned to overcome the sometimes severe disparities between water resources as provided by nature and the timing and places of man's needs for water supply.

In the past, Texas citizens generally have been able to live wherever they chose without concern for the availability of water. Where other resources were available, a water supply was also generally available, either in the immediate vicinity or at relatively short distances. People settled, developing these supplies where they were found; investments were made, economies developed, and social and cultural values accumulated to the benefit of all citizens of the State.

Texans now, however, are able to see the limits of the State's developable water resources. Seeing these limits, recognition has also come that wise use of the available water resources is vital to the continued expansion of Texas population, economy, and culture.

By far the bulk of the water resources remaining available for development in Texas occurs in the East Texas river basins. By contrast, large future water needs will occur in areas to the west and southwest, several hundred miles distant, and in some areas over 3,000 feet higher in elevation, where available water supplies are limited and diminishing. Cities and industries in many areas throughout the State will need more water or water of better quality than can be made available from local fresh water sources.

Furthermore, studies for the Texas Water Plan show conclusively that presently available water resources are grossly inadequate to meet Texas' future economically justified water needs. Importation of water from out-of-State sources will be essential. Without it, retrogression must inevitably occur in some sectors of the State's economy, particularly agriculture and associated agribusiness, with attendant severe social problems of unemployment and forced population relocation, and loss of financial investments.

As a result of the Texas Water Plan studies, the Congress has authorized the U.S. Army Corps of Engineers and the U.S. Bureau of Reclamation to investigate a possible import of water.

The Bureau of Reclamation is conducting studies of importing surplus water from the Mississippi River System into water-deficient areas in West Texas and eastern New Mexico. The Corps of Engineers is participating in these studies to determine the availability of water from the Mississippi in coordination with affected States, the locations and types of conveyance channels required for movement of water to these water-deficient areas, and the effects of such withdrawals and conveyance facilities. The Corps of Engineers was authorized in May 1966 also to determine, in cooperation with other Federal agencies, whether any modifications or additions should be made in proposed Federal projects in relation to the Texas Water Plan, and to determine the effects of upstream developments on pollution or changes in salinity in the bays and estuaries and to recommend such improvements as are necessary to maintain or improve the quality of water in the bays.

Concurrently, the U.S. Geological Survey is conducting a study of the Ogallala Aquifer in the High Plains of West Texas to determine the hydraulic and hydrologic conditions in the aquifer important to its effective utilization in conjunction with an imported water supply.

By 1972 the above Federal agencies, the Water Resources Council, and the Office of Water Resources Research will have spent several million dollars for studies and investigations including the potential import of water to Texas and eastern New Mexico, and the conditions of the Ogallala Aquifer of significance to continuing use.

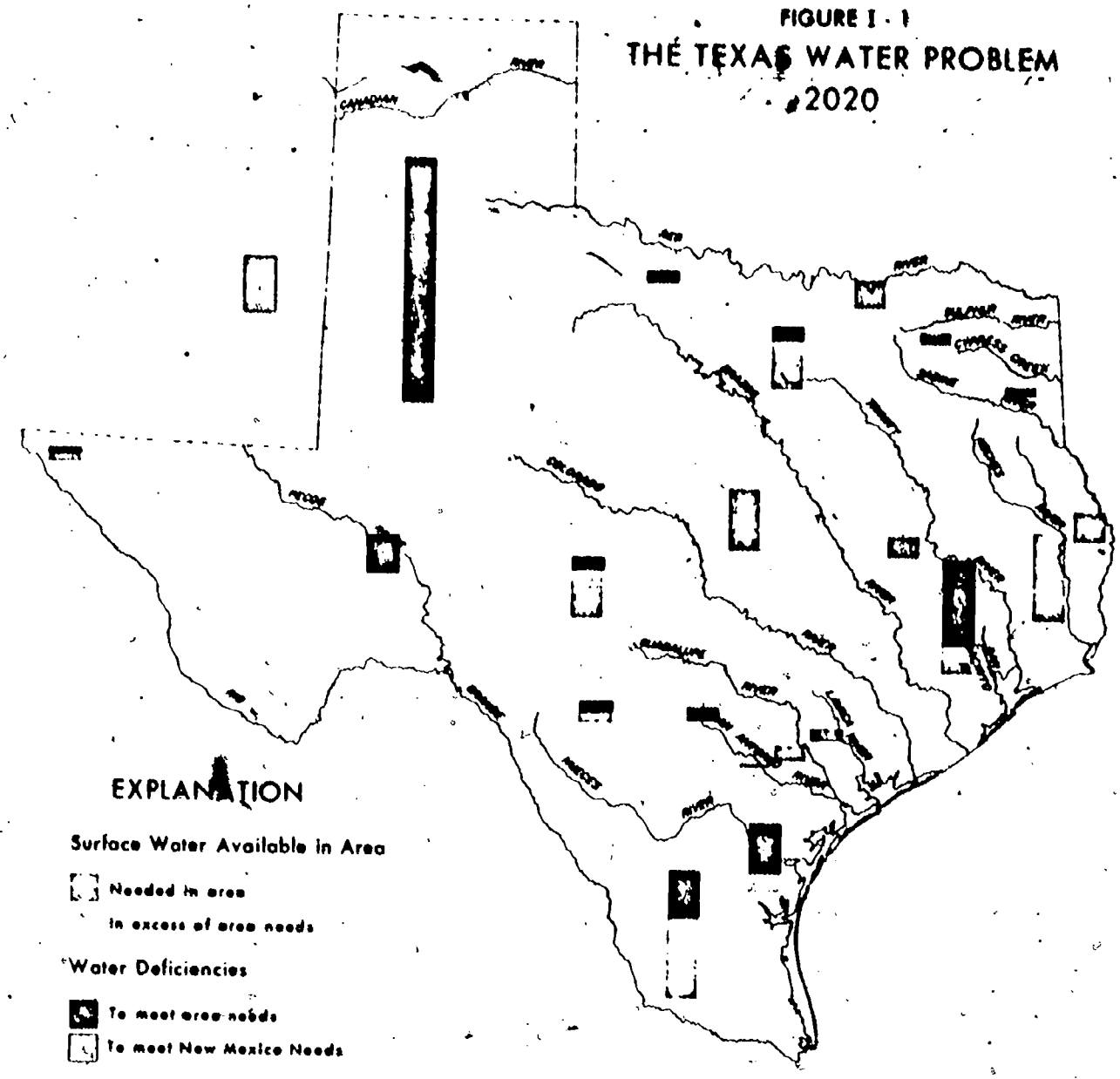
Texas must continue to bear its full share of responsibility for developing and implementing plans for water import, and providing for the equitable distribution within Texas of waters now or potentially available for use. Since August 1964, the State has expended approximately $10 million in these planning activities. The time has now come to decide whether this investment in the future is to bear fruit or to be thrown away.

Statewide planning on a comprehensive long-range basis provides a guide for problem solving in advance of need; it is essential in a water-short area such as Texas. The Texas Water Plan has been prepared as

FIGURE I - 1

THE TEXAS WATER PROBLEM

2020



such a guide for water policies and development, and for intergovernmental relationships affected by or affecting water resource development. The coordinated progressive Statewide development proposed will enhance the effectiveness of the large investments of capital, labor, and materials and of water related land resources required to meet Texas' water needs. It will allow a thorough and systematic evaluation of those projects which are to receive State financial aid, and will provide a basis for selection of those which are in the Statewide interest.

Water requirements have been projected for a 50-year period and means of satisfying these requirements are proposed. It is recognized that if this Plan for water development, completed in 1968, is to provide for water to meet people's needs to the year 2020, it must be subjected to continuing study, refinement, and alteration as changing needs, priorities, and wishes of the people of the State may dictate. Thus it is a Plan that is flexible, retaining freedom of choice as to future actions as long as possible.

In developing the Texas Water Plan, the Board has used all historical data that could be accumulated; the resources of a qualified and dedicated staff; and the advice of Federal and State agencies, universities, in-State and out-of-State consultants, river authorities, cities, water districts, and representatives of the various economic segments of the State, as well as the opinions of the citizens of the State expressed during the hearings held by the Board in the summer of 1966.

Recognizing that continuing study and investigation will be needed of future water needs and problems in Texas, the Board nonetheless believes that sufficient information is now available on which to base this comprehensive Statewide Water Plan.

INSTRUCTIONS:

9. Restart the audio cassette tape. Listen to the tape and view the slides until reference is made to Frame 7. Then STOP THE TAPE AND SLIDES. List the steps under Frame 7 on your STUDENT RESPONSE SHEET.

Frame 7

Solar Distillation

Step I (think of the sun's energy)

Step II (think of what's happening to the water)

Step III (think of what's happening to make the water in liquid form)

Freezing Process

Start with the sea water as it enters the system and follow through the process

The first step is to (?) the sea water.

The second step is to (?) the ice.

The third step is to (?) the ice to obtain fresh water.

INSTRUCTIONS:

10. Restart the audio cassette tape. Listen to the tape and view the slides until reference is made to the review of the major ideas in this program and the activity to be recorded in Frame 8, then STOP THE TAPE AND SLIDES. Record the result of your activity under Frame 8 on your STUDENT RESPONSE SHEET.

Frame 8

The major points developed in this lesson are to be summarized on your STUDENT RESPONSE SHEET. Look at each slide and try to recall the big ideas associated with that slide.

Storm Picture
Personal/Industry/Agriculture
Distribution and Timing
Demand is High
Recycle
Water Quality
How you look at it
Plans
Technology

INSTRUCTIONS:

11. Restart the audio cassette tape. Listen to the tape and view the slides until the end of this lesson. Then STOP THE TAPE AND SLIDES.

ANSWERS TO QUESTIONS IN STUDY GUIDE

FRAME 1 Answers

Identify the following slides as precious or bountiful.

		Precious	Bountiful
Slide:	Drawing water from well	X	
Slide:	Children playing in fountain		X
Slide:	Baptism scene		X
Slide:	Cover of Lawn Care magazine		X
Slide:	Windmill	X	
Slide:	Washing clothes	X	
Slide:	Family in bath		X
Slide:	Woman washing at sink		X

FRAME 2 Answers

You are probably surprised to learn that there are so many factors that alter the composition of water. From this list of 22 factors, select five factors that are most likely to affect the water quality where you live and rank the five factors by placing the appropriate number in the space provided.

Most important factor 18

For Austin, Texas, the ranking would be as shown. Other localities would likely have a different ranking.

14

19

8

Least important factor 3

FRAME 3 Answers

My definition of water pollution is: water becomes polluted when natural or manmade materials are added to the water faster than natural processes can remove them and the water cannot be used for its intended purpose.

FRAME 4 Answers

Table I

Factors Affecting Water Quality

Physical Factors	Chemical Factors	Biological Factors
Turbidity	Nitrogen content	Odor
Total solids	Dissolved metallic ions	Algal count
Radioactivity	Oxygen content	Taste
Temperature	Fluoride content	Coliform count
		BOD

FRAME 5 Answers

The steps in treating water for public drinking purposes are:

Step I Primary settling

Step II Mixing of basic chemical treatment materials

Step III Secondary settling and clarification

Step IV Filtration

Step V Chlorination and final chemical treatment

FRAME 6 Answers

Study the Texas Water Plan.

FRAME 7 Answers

Solar Distillation

Step I (think of the sun's energy) Warms the water

Step II (think of what's happening to the water) Water evaporates in vapor form

Step III (think of what's happening to make the water in liquid form) Water vapor condenses on the glass.

FRAME 7 Answers (continued)

Freezing Process

Start with the sea water as it enters the system and follow through the process.

The first step is to freeze the sea water.

The second step is to scrape the ice.

The third step is to melt the ice to obtain fresh water.

FRAME 8 Answers

The major points developed in this lesson are to be summarized. Look at each slide and try to recall the big ideas associated with that slide.

Each student should formulate his own ideas as suggested by the information on the slides. The ideas will be similar to those shown on this answer sheet.

Storm Picture: the atmosphere is the source for our fresh water

Personal/Industry/Agriculture: major water users

Distribution and Timing: water problems develop because of the uneven distribution of water and the problem of obtaining the water at just the right time

Demand is High: 157 gallons per day per person

Recycle: water can be used over and over provided it is treated properly to meet the requirements of the next user

Water Quality: water quality requirements vary depending upon the intended use of the water

How you look at it: water quality depends upon the point of view of the intended user

Plans: many plans have been formulated to redistribute the water across the western United States

Technology: desalination plants will be used more extensively in the future

SCRIPT FOR LEARNING CARREL LESSON

6.13

WATER

ENVIRONMENTAL STUDIES

A Cooperative Project of the Department of Geological Sciences and the Science Education Center.

THE UNIVERSITY OF TEXAS AT AUSTIN

1

This program begins with a musical interlude. Relax and enjoy the music.

2

Title Slide

3

Thunderstrom approaching

4

BC Cartoon.

5

BC Cartoon

6

BC Cartoon

7

Storm picture

8

BC Cartoon

9

BC Cartoon

10

BC Cartoon

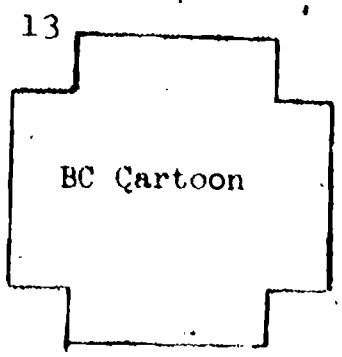
11

Storm picture

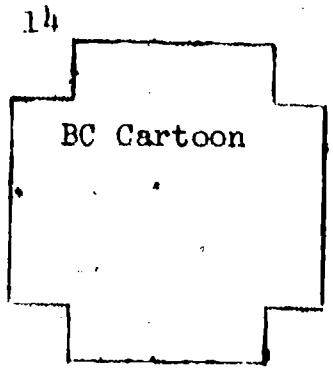
12

BC Cartoon

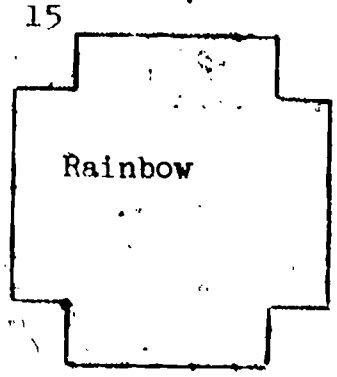
13



14

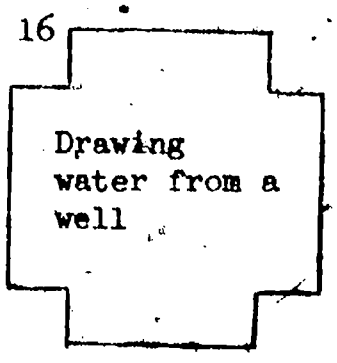


15



What kind of mental picture did you create? If you recalled some earlier experience in a rainstorm as I did, you probably asked yourself, "Where did all the water come from? How can so much water fall from the sky?" I won't be able to answer these questions in this program, but I do want to reinforce the idea that most water on the surface of the earth came from the atmosphere.

16



This program is about the use and misuse of water -- a natural resource of man. A study of the way water is used at any one location will tell you whether water is precious or bountiful. Study the next eight slides carefully. If you feel that water is precious or bountiful at that location, check the appropriate space in Frame 1 of the Study Guide. Stop the tape now.

17

Children playing in fountain

18

Baptism scene

19

Cover of <u>Lawn Care</u> magazine

20

Windmill

21

Washing clothes

22

Family in bath-tub

(Japan)

23

Woman washing at sink

24

Beaker of water

Let's consider for a moment some of the ways our lives are affected by our use of water. We drink it -- sometimes even from a beaker.

25

Recreation photo

We enjoy it for recreation.

26

Shot of a dam

We use it for irrigation and power.

27

Ocean vessel

We use it for transportation.

28

Catching crabs.

We obtain food from the water,

29

Houston ship channel

and we use it to carry away industrial and personal waste.

30

Map of U.S. showing average precipitation

This map of the United States shows the average precipitation within our country. Notice that most of the western half of the United States receives the smallest amount of rainfall. Thus, this area will have different kinds of water problems than the eastern half of the United States.

31

Flood Potential (the mean annual flood)

In this slide the mean annual flood potential of the United States is shown. The darker colored areas show where water is available in large quantities. However, this water may not always be available for man's use. At flood times, too much water comes in a short time interval and the water gets beyond our control.

32

Flood scene

As the old farmer used to say, "It's either feast or famine." Putting this saying in the perspective of this program, "It's either flood or drought." For only at a few locations on the earth do we obtain from the atmosphere all of the water we need at the exact time we need it.

33

157 U.S. gallons/day

The demand for water is enormous -- 157 U.S. gallons per person per day. This figure is determined by estimating the total number of gallons of water used per day for all purposes -- drinking water, agricultural usage, industrial usage, and all other uses -- and dividing by the number of people in the United States.

34

70-100 x.10^6 gallons/day

In some large cities water plants must supply as much as 70 million gallons of drinking water per day and there are 35 municipal systems of this size or larger. The demand for water in New York City is more than 100 million gallons per day.

35

Map of California

Where do cities get the water they need? The five largest take water from the Great Lakes. Ten other large cities take water from major rivers. This slide shows that every major river flowing out of the Sierra Nevada mountains is dammed. Notice the network of canals showing how the water is distributed throughout California. The canals along the western side of California primarily carry water for serving cities. Other canals carry for irrigation.

36

Water can by recycled

Fortunately, water is not destroyed by man's use. It can be used over and over again provided that it is treated when necessary and it does not escape by infiltration, run off, or evaporation.

37

Picture from Renn's book

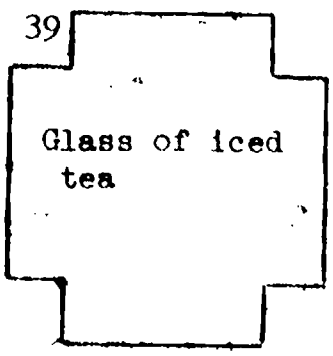
In the Study Guide you will find this picture. Complete the Study Guide activity in Frame 2 before continuing the program. Stop the tape now.

38

Water quality

Welcome back. In the next part of this program we will look at some of the ways that pollution of our water supplies reduces water quality.

39



The water you see here has organic compounds to produce flavor and provide a mild stimulating action. Would you say this water is polluted? Would an underground aquifer containing tea be polluted? What is a good definition of polluted water? Write your definition in Frame 3. Stop the tape now.

40

Physical
Chemical
Biological

The factors affecting water quality fall into three categories -- physical factors, chemical factors, and biological factors. In the Study Guide (Frame 4) you will find a partially completed table -- Table I. As I read some of the factors affecting water quality, write the name of the factor under the category heading that best characterizes it.

41

Odor
Nitrogen content
Turbidity
Algal count

The first four factors are:

Odor
Nitrogen content
Turbidity
Algal count

42

Total solids
Taste
Coliform count
Dissolved metallic ions

The next four factors are:

Total solids
Taste
Coliform count
Dissolved metallic ions

43

Oxygen content
Fluoride content
BOD

Classify these factors:

Oxygen content
Fluoride content
Biological-Oxygen-Demand

44

Radioactivity

Temperature

and finally

Radioactivity
and
Temperature

45

Slide of completed Table I

Let's see how well you did! Match your results with the completed table shown here.

If you misplaced more than three, you should stop the tape and talk to the Proctor. Stop the tape now.

46

Welcome back

The exercise you have just completed illustrated some of the factors that affect the quality of drinking water. Excessive amounts of any combination of these factors makes the water unsuitable for drinking and makes the water polluted. A different set of factors have to be considered if we were looking at water pollution in industry or agriculture. We'll illustrate this point in the next few slides.

47

Coors can

On this slide you see one of the more selective water users. Not only does the water to make beer have to meet public water standards, it cannot be chlorinated. The chlorine would impede the growth of yeast -- decreasing the quality of the beer.

48

Electric power plant

The electric power plant on this slide has one of the most stringent water standards of all. Because of the high temperatures and pressures of the water used in this plant, almost any impurity in the water will lead to some kind of mechanical failure. The high degree of purity of boiler water requires that most plants of this type have their own purification equipment.

49

Irrigation shot

On this slide you see a water user that some would say requires water of the lowest quality. This is sometimes true to the eventual sorrow of the farmer. Water used for irrigation that contains a high concentration of iron, copper, zinc, or salt will build up in the soil rendering it infertile unless fairly expensive measures are taken to prevent this problem. It is often cheaper in the long run to use water of higher quality.

50

Water treatment plant

We'll return for a moment to a more detailed discussion of water treatment for public drinking supplies. A modern treatment plant -- like you see here -- is designed for the intended water source and the intended user. Each plant will be different because of this. However, most water treatment plants remove solid suspensions, certain biodegradable compounds such as nitrates and phosphates, and pathogenic organisms.

51

Schematic of water treatment

This slide shows the five basic steps in municipal water treatment. In Frame 5 you will find space to copy down the five water treatment processes. Complete Frame 5 before continuing. Stop the tape now.

52

Water quality

The following summarizes our discussion of water quality in a few words. If man or nature adds impurities faster than natural processes can remove them, we must treat the water in some way. The treatment process is related to what impurities must be removed and the future use that we expect to make of that water.

53

Water surpluses and deficiencies in the U.S.

Let's look at water problems on a broader scale. The slide you see here shows the water surpluses and deficiencies in the United States. Obviously, some areas -- particularly in the Midwest and Western part of the United States lack water. Is this water problem then primarily a shortage of water in the United States?

54

Hydrologic cycle

This slide shows the hydrologic cycle. In a general way, the cycle can be described by starting with atmospheric water vapor that changes into liquid and/or solid form as precipitation, thence along or into the ground and finally returning in the form of atmospheric water vapor by evaporation or transpiration. There are several shortcuts in this cycle but the general idea will suffice.

55

Some data

It has been estimated that one and one-half thousand trillion gallons of water is precipitated in the United States -- not including Alaska and Hawaii -- each year. This is almost 8 million gallons of water for each man, woman, and child in the United States. Water usage in the United States is between 45 to 55 thousand gallons of water for each person each year -- far less than falls to the earth from the atmosphere.

56

Is there a water shortage?

By now you are probably ready to admit we do not have a shortage of water. The problem is not one of total amount of water, rather it is a distribution problem. We have a water shortage when man's activities require water but it is not available at the time he needs it.

57

Four ideas

This program will suggest four solutions to the water shortage problem. First, I'll discuss a solution for urban areas; second, a plan for providing water primarily for agricultural areas; third, an idea for improving the distribution of water across the United States, and fourth, an idea for improving the distribution of water throughout the world.

58

View of city

Some parts of the United States are heavily populated. New Jersey has about 800 people per square mile. Population concentrations put high demands on water sources. One thing we can do to relieve the problem of a water shortage for cities is to recycle the water.

59

Map of Ohio River

Another example of recycling. Before it reaches the Mississippi the water of the Ohio River is recycled on an average of four times. This cleanup work is done by agriculture, industry, municipalities, and other interest groups forming a voluntary interstate compact known as the Ohio River Valley Sanitation Commission. Cleaning up the river will make it suitable for recreational purposes as well as taking care of man's water needs.

60

Canal shot

How can we provide more water for agricultural needs? On an earlier slide you saw how canals in California have been built to transport water from Northern California to Southern California. The water is primarily used for human consumption and agriculture. This is an example of redistributing the water to fit man's needs.

61

The Texas Water Plan

Many different plans have been proposed to carry water long distances by canal -- for example, from the state of Washington to Arizona. Texas has developed a plan on a smaller scale to supply the needs of people in West and South Texas.

62

Map of the Texas Water Plan

The Texas Water Plan is shown on this map. To help you visualize the magnitude of carrying out such a plan, I want you to read the description in the Study Guide before the program continues. Stop the tape now. (Frame 6)

63

Map of U.S. showing water plans

Welcome back. You can now realize the immensity of the job man faces if he wants to redistribute water by means of canals. Truly, this is an expensive operation and we must ask ourselves -- is it worth the cost of time and money and resources? For the people without water, it is worth any cost.

64

Weather modification

A more speculative way of distributing water to areas that are water deficient is by weather modifications. We know that the atmosphere passing over many dry areas contains enormous quantities of water. The problem is how to make the atmosphere precipitate the water where it is needed and at the time it is needed.

65

Cloud seeding

At the present time, many efforts are being used to augment precipitation supplies by cloud seeding. Here you see the affect of seeding a cloud with dry ice.

66

?

What does the future hold for the success of weather modification? Some research studies confirm that weather modification techniques are successful; however, man cannot depend on this technique to solve his water problems in the forseeable future.

67

Desalination

Let's look at another promising process for obtaining fresh water -- desalination. This process produces fresh water by removing unwanted ions from seawater. Several different methods are currently being used.

68

Schematic of Desalination Process

This slide shows a schematic diagram that illustrates several desalination processes. Study the slide carefully and then write down the steps of these processes in Frame 7 of the Study Guide. Stop the tape now.

69

Cost
Energy Demand
Transport

What are some of the problems related to desalination? First, it is currently expensive but decreasing in cost as technology improves; second, it requires enormous amounts of energy --perhaps nuclear power will be able to supply enough energy in the future; and third, the water will have to be pumped to the location of usage. Clearly, this is a water source for the future.

70

Storm
picture

The major ideas developed in this program will be reviewed in the next series of slides. After each picture is presented, you are to stop the tape and write down the major idea suggested by the slide in the spaces provided in Frame 8 in the Study Guide.

Write your summary statement in Frame 8.

71

Personal
Industry
Agriculture

Write your summary statement in Frame 8.

72

Distribution
and
Timing

Write your summary statement in Frame 8.

73

Demand is High

Write your summary statement in Frame 8.

74

Recycle

Write your summary statement in Frame 8.

75

Water quality

Write your summary statement in Frame 8.

76

How you look at it

Write your summary statement in Frame 8.

77

Plans

Write your summary statement in Frame 8.

78

Technology

Write your summary statement in Frame 8.

79

$1.96/gallon

Whatever solutions we find in the future to our water problems, the cost of water for all purposes will continue to increase. Hopefully, not to the extent you see here.

80

The End of this Lesson

LESSON 6.13: WATER

STUDENT RESPONSE SHEETS

Name _____

Date _____

LESSON 6.13: WATER

STUDENT RESPONSE SHEET

Frame 1 Identify the following slides as precious or bountiful:

		Precious	Bountiful
Slide:	Drawing water from well	_____	_____
Slide:	Children playing in fountain	_____	_____
Slide:	Baptism scene	_____	_____
Slide:	Cover of Lawn Care magazine	_____	_____
Slide:	Windmill	_____	_____
Slide:	Washing clothes	_____	_____
Slide:	Family in bathtub	_____	_____
Slide:	Woman washing at sink	_____	_____

Frame 2

From the list of 22 factors that alter the composition of water, select five factors that are most likely to affect the water quality where you live and rank the five factors by placing the appropriate number in the space provided.

Most important factor _____

_____

_____

_____

Least important factor _____

Frame 3 My definition of water pollution is:

Name _____

Date _____

LESSON 6.13: WATER

STUDENT RESPONSE SHEET

Frame 4 Complete Table I below:

Table I

Factors Affecting Water Quality

Physical Factors	Chemical Factors	Biological Factors
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
		_____
		_____

Frame 5 The steps in treating water for public drinking purposes are:

Step I _____

Step II _____

Step III _____

Step IV _____

Step V _____

Frame 6 Study the Texas Water Plan. (No specific questions)

Name _____

Date _____

LESSON 6.13: WATER

STUDENT RESPONSE SHEET

Frame 7 Complete the steps below:

Solar Distillation

Step I (think of the sun's energy) _____

Step II (think of what's happening to the water) _____

_____

Step III (think of what's happening to make the water in liquid form)

_____

Freezing Process

Start with the sea water as it enters the system and follow through the process.

The first step is to _____ the sea water.

The second step is to _____ the ice.

The third step is to _____ the ice to obtain fresh sea water.

Frame 8 The major points developed in this lesson are to be summarized. Look at each slide and try to recall the big idea associated with that slide.

Storm Picture _____

_____

Personal/Industrial/Agriculture _____

_____

Distribution and Timing _____

_____

Demand is High _____

_____

Name _____

Date _____

LESSON 6.15: WATER

STUDENT RESPONSE SHEET

Frame 8 (continued)

Recycle _____

_____

Water Quality _____

_____

How you look at it _____

_____

Plans _____

_____

Technology _____

_____