

SOIL AND WATER CONSERVATION



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Soil and Water Conservation

By

BERNHARD A. ROTH

United States Department of Agriculture, Soil Conservation Service, Upper Darby, Pennsylvania; with advice and suggestions by Bert D. Robinson, National Merit Badge Counselor in Soil and Water Conservation, and other personnel of the Soil Conservation Service.

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A MAN-SIZED JOB

You don't have to be in the Armed Forces to fight a war. Conservation of soil and water is a world-wide battle campaign, and needs stout hearts, clear heads and adventurous souls.

If you like history roving back into the mists of time, you will find it here: What happened to fabulous cities, where camel caravans of old carried their precious spices, gems and cloths of rare weave; why are their ruins buried in deserts of the Old World? What fate visited the long ago peoples of Central America; why are their proud temples—where bejeweled and feathered priests once offered up their cruel sacrifices—fallen into the mud and dank vines of the tropical jungle?—These and countless other exciting stories are linked with conservation.

If you like outdoor action, work in earning the Soil and

Water Conservation Merit Badge is going to be "right up your alley." It will teach you the ways of earth, water and weather on hill, mountain, field and forest. You'll get better acquainted, too, with wildlife. They are all part of the conservation story.

And if it should finally happen that you make conservation of soil and water your life work, there is much to look forward to. Perhaps, some day, you'll join the men who go high into the Rockies each winter to measure the snow harvest. Maybe you'll help survey a rushing river to prevent floods and wasted water. More likely, you'll work beside some farmer, testing his soils, mapping his fields and giving him your technical knowledge for better harvests, and an agriculture that will keep your America strong and free. There's plenty of interesting work for a conservationist.



WHAT IT ISN'T

One of the best ways to find out what soil and water conservation is is to learn what it *isn't*. You could start by visiting what is left of Timgad in North Africa. Timgad was once a great city, part of the Ancient Roman Empire. It had paved streets, beautiful temples, homes, gardens and public buildings. Thousands of people once thronged the bustling market places. It had a huge open air amphitheatre where plays were staged. It even had a vast stadium for chariot races and fights between gladiators and wild beasts. But there hasn't been a chariot race in Timgad for 2000 years.

Today, the streets are littered with stones from the crumbled buildings, and wind-blown sand. Hardly more than the foundations of the amphitheatre and the stadium remain above ground. The homes are fallen in and the gardens full of coarse desert weeds. The hillsides surrounding the city are bare and scarred with gullies. Seldom is

there a drop of water in the wells dug long ago. Gone are the farmers who supplied fresh fruits, vegetables, meat and milk. The whole place is forsaken and almost forgotten.

History detectives believe that Timgad was ruined by its own hand. Its people did not practice soil conservation.

As years went by, Timgad farmers produced less and less. The unchecked top soil washed and blew away in the hot desert wind. In time, they could raise hardly enough food for themselves. Trade gradually came to a halt in the city and camel caravans no longer stopped there. Family after family moved away. Finally, Timgad was dead, a curiosity for the occasional traveler.

You are probably wondering if such tragedies could happen to your America, your home town—to you and your family. To tell you the truth, it has already started happening. The soils and waters of this wonderful country show the same unmistakable signs that pointed to ruination in old times. Four-fifths of our best farmland has been hurt by soil erosion and water waste; probably one-half of the organic matter that made soils fertile and workable for the pioneers, has been squandered. Most of our large cities are finding it harder and harder to get enough good water for industries and homes. Disastrous floods continue to do millions of dollars worth of damage each year.

You can find soil and water troubles reported in almost any issue of your daily newspaper or hear about it on the radio. You can see their symptoms in your own back yard, on your way to school, or on a Sunday ride in the country. Your counselor can show them to you. Here are a few to look for:

In the Woods

1. *Clear-cutting* of trees, leaving none for seed. Poor growths take over. Gullies start in torn-up soil and steep, logging roads.
2. *Cattle grazing* damages trees, undergrowth and forest duff that normally protect soil. Soil washes easily



It will take many, many years to rebuild this land, damaged by erosion due to poor farming methods.

and cannot hold usual amounts of moisture. Tree growth rate is slowed.

3. *Fire hazards* created by failure to thin out dense stands; neglect to dispose of brushpiles and trimmings; carelessness and indifference with grass, rubbish and campfires and smoking. Destruction invited by no firebreaks and firefighting equipment.

In the Fields

1. *Gullies and rills* cut by water running off bare soil—usually happens with poor farming methods such as plowing steep slopes; cultivating off contour levels (up-and-down-hill); failing to maintain vegetation on waterways and exposed soil; destroying of soil structure by “using up” all organic and mineral matter.
2. *Wind erosion*, seen mostly in flat, windswept areas, where unprotected soil has blown away.



Even on relatively flat land, sheet erosion and loss of water may occur unless precautions are taken.

3. *Raindrop splash*, the displacement of soil that will be moved away by water.
4. *Poor drainage*, wet and dry spots in fields, where there has been no provision for waterways, ditches, terraces outlets or soil conditioning for moisture conservation.

In Streams and Ponds

1. *Polluted water*, useless to man, fish or wildlife, caused by dumping of factory and community wastes, and poor management of nearby soils washed off by rain.
2. *Bank erosion*, the cutting away and gulying of stream and pond edges by water and ice action. Condition is caused by lack of protective vegetation or engineering structures such as dikes and rip-rap.
3. *Sediment*, deposits of mud and waste matter, form in streams, reservoirs and harbors, making dams use-



Dust storms and stream bank erosion both may result from the same cause—land unprotected by plant cover.



Floods, too, frequently are the result of unprotected soil in the uplands.

less, causing floods, harming recreational and wild-life uses and preventing movement of boats. Eroded soil and lack of treatment for sewage and industrial wastes cause sedimentation.

Along Roads

1. *Roadbank erosion*, gullies and rills cut by water in unprotected shoulders and areas near roads, often cause deposits of mud on roadways, washouts and clogging of drains and culverts. The condition may be due to failure to plant shrubs and grass on raw banks or improper grading.

While you are scouting around for soil and water trouble spots, don't forget the camera or sketch pad. (See Requirement 3 for the Merit Badge.) You might also want to locate your findings on a map; take one along.



WHAT IT IS

Now that you have seen samples of what soil and water conservation *is not*, perhaps you have your own way of saying what it is. You might cover it pretty well by calling soil and water conservation *the sum total of everything done to keep soil and water useful to plants, animals and people, in sufficient quantities, in the right location, at the right time.*

Everything being done for this purpose these days in the U.S.A. amounts to a powerful effort, compared to only a few years ago. Although great Americans in our history—including George Washington and Thomas Jefferson—tried to do something about the problem, the country was slow to follow their leadership. Loggers and farmers went about chopping down trees and recklessly plowing land as though they would never run out of resources.

About the time the country began to notice there wasn't much new land left to settle, a young man from North

Carolina went to work for the U. S. Department of Agriculture. He had come from a farm and he was interested in what was happening to the soil. He tramped, road mule-back and drove a horse and buggy over thousands of miles of countryside. His studies of soil samples, measurements of slopes, vegetation and farm production told a story that he was almost afraid to repeat. It was a story of terrifying waste of the Nation's most valuable assets—soil and water. When Americans grasped the meaning of their muddy streams and gully-scarred hillsides they were shocked. And finally the efforts of the tireless young man got action from the Congress, which set up a nation-wide program to answer the challenge.

The young man was Hugh Hammond Bennett, often called "Big Hugh, Father of Soil Conservation." The agency Congress ordered him to organize is the U. S. Soil Conservation Service, and he was its Chief until 1951. Since 1933, it has worked with farmers throughout the 48 states and the Territories. Its men have begun the task of helping farmers plan the soil and water use and treatment of fields in 1¼ billion acres of agricultural land.

Farmers own most of the land and can make soil conservation succeed or fail. Through their own Soil Conservation Districts they are being assisted by hundreds of organizations which, like the Boy Scouts, realize that it's everybody's job. Many state and federal agencies, farm clubs and businesses sponsor conservation programs and encourage good practices. Banks have given extra help to farmers who follow conservation plans; so have insurance companies and railroads. More and more schools have bought special books and equipment, and hired conservation teachers. Farm machinery companies have designed new implements to make conservation work easier. Others have made movies, printed booklets, held contests and offered scholarships to arouse interest.

The effort to save soil and water nowadays reaches people in almost every walk of life. On any conservation job in the field, you are likely to find soil scientists, engineers, sur-

veyors, weather men, plant specialists, foresters, equipment operators, drainage experts and wildlife managers.

The bigness and importance of the undertaking has touched people who ordinarily have little to do with the management of land and water. Sportsmen from the towns and cities have learned to create better hunting and fishing by helping to plant wildlife areas on farms and public land. Manufacturers have become aware of the value of keeping their wastes out of streams so that all may enjoy the blessings of good water. Cities are doing their part for conservation by building better sewage treatment plants. Communities are joining hands to get conservation treatment for entire river valleys—effective programs where townfolk, farmers, industrialists and ordinary citizens work together side by side to make their neighborhoods more beautiful and useful.

The help of everyone—man, woman and child—in conserving soil and water is needed, if for no reason than the ever-growing demand for food. There are about 2 million more people living in America every year. Populations of other countries all around the world are also getting bigger—some faster than ours. The chances are you, yourself, did not go to bed hungry last night. Many people outside of the United States are hungry *all the time*. By developing superior farming methods and conservation, our fields have the highest production ever known. We have friends in other lands who depend on our fields for food—and numerous other soil products—without which they face disaster.

In spite of the conservation work that has been done thus far on more than a billion acres, we have less than 500 million acres of high grade farmland left. All but 100 million acres of this is suffering from wastage of one sort or another. And half a million acres are still being spoiled for further use, by reckless land operations every year.

We need to act fast. But first, let's find out how to go about the task.



LEARNING THE LAND

Time was when our world ancestors were satisfied to take life just about as they found it. They fed themselves by hunting and fishing and did little to disturb the ground, grasses, shrubs and trees, and the waters that quenched their thirst. Their soil and water conservation problems were few—and their lives were short and not much fun. They were hungry, sick and uncomfortable most of their days.

From the moment men decided they could put the earth to work for them, they have been better off in many ways. You are getting the best of everything you need these days from the soil—better foods for your diet, fiber for comfortable clothing and shelter—even medicines to keep you healthy and fit. And there is also a price to pay for these benefits.

Plowing the soil, chopping down trees, drilling wells, and building dams to get the earth's riches has often run against

Nature. She has struck back by taking away her good soils—sweeping them off the croplands with every rain and dumping them in the rivers and oceans; and making good, clear water hard to find.

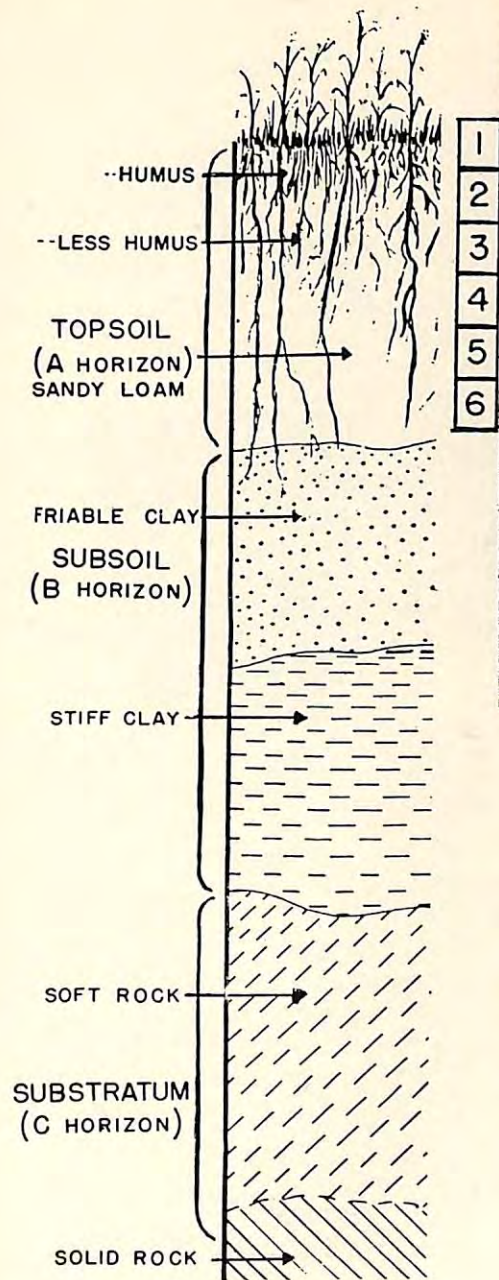
Luckily, men have finally had the vision to see that this would not do—that they had to *get along with Nature*—without giving up all the advantages to be gained from her resources. *Soil and water conservation is the modern way of working on friendly terms with Nature.*

To do this, we've had to find out how we can best use various sections of the earth—for row crops, grains, grasses, orchards, forest, etc.—without getting into trouble with natural laws. We've had to learn land capability—the kind of production we can get from each individual acre.

Let's start our land capability survey with the soil. You can examine it closely by digging a hole large enough to look conveniently, or perhaps you can locate an excavation like a gravel pit or cellar hole already dug. The first thing you'll notice is that the soil is built up in layers. Scientists call them horizons, and they're of different colors and texture. The upper one is the topsoil. Below is subsoil. Keep your eye on the topsoil; that's where most of our wealth and food comes from. Like the frosting on a cake, it is the richest portion of the soil. Without it, we would be in sad shape.

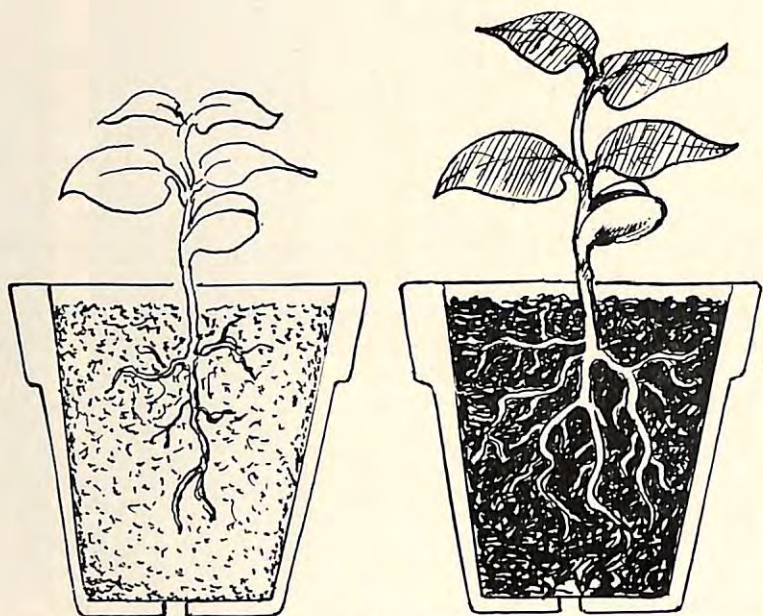
Take a ruler and measure the topsoil depth. The best grades will run 10 to 15 inches deep. You can figure it took nature 500 to 700 years to form each inch—centuries during which weather broke up rocks and minerals—plants and animals gave precious elements to it—and tiny micro-organisms processed it for mankind's eventual productive use. Keeping that topsoil in good condition is one of the biggest conservation jobs. Over 2 billion people in the world owe their lives to those slim few inches. The subsoil beneath it is not nearly as rich and productive.

Feel the soil with your hands. If it's sandy and dry, the chances are it doesn't hold enough moisture to supply plants through dry weather. If you have trouble crumbling it—if



SOIL
PROFILE

Dig a hole or find an excavation or road cut where you may examine the soil. The thin, dark layer on top is topsoil and from it comes all our food. In the photographs above note the difference in top soil depths—The profile on the left having 2 inches less.



Place some topsoil and some subsoil in flower pots or boxes, and plant 2 bean seeds in each. Water occasionally for a month and discover which is best for plant growth.

it sticks together in chunks of clay—it's likely you're holding a heavy soil that water and air won't penetrate well. If the soil feels somewhere in between—not too heavy and sticky—not too light and runny—you probably are holding a nice loam, the kind farmers and gardeners love.

You'll have to test the soil this way several times before you get the hang of it. Meanwhile, you can make other observations such as the presence of rocks and erosion. Both will help determine the land's capability, too. Rocks are plainly no encouragement for cultivation. Erosion is a little more tricky but you'll have no difficulty locating the gullies and washouts. There's also a fairly simple means of discovering how much erosion has affected a field. Dig a hole in the middle of it and measure the topsoil layer. Go to the

closest woodland or fencerow—wherever the ground has had little or no cultivation. Measure the topsoil there. Comparing the two measurements will give you an idea of the number of inches of soil lost. See if you can find any little chunks of subsoil that were brought up the last time the field was plowed.

To get on with your survey, look at the slopes. Steep slopes are usually dangerous to plow. Rainwater will rush down them and tear them apart when the soils are bared. The gentler slopes can be opened to cropping—with conservation farming methods. Level or nearly level lands, of course, usually offer the best farm possibilities: water erosion is a minor problem; machines and men work easier. But no land is entirely safe. Wind and dust storms often do their worst in flat, open territory. In 1934, high winds picked up soil from thousands of farms and ranches in the Western prairies and blew it all the way to New York, Philadelphia and Washington, D. C. So doing, they drove thousands away from ruined fields.

The over-all influence in land capability and use is the weather. You have probably heard the old joke that originated with Mark Twain, author of "Tom Sawyer" and "Huckleberry Finn". He said, "Everyone talks about the weather, but no one does anything about it." That may not be quite true these days. Scientists are experimenting with ways of getting rain out of clouds by bombing them with dry ice released from airplanes; or by shooting silver iodide particles into the atmosphere with huge blowers mounted on the ground. Farmers in dry climates also compete with weather by digging wells deep into underground water supplies; or they store infrequent rains in reservoirs and ponds for irrigation when needed.

What men have learned to do to with weather is pretty puny compared to what weather can do to *them*. Rain, snow, ice, heat, humidity, cold, frost, wind, sunshine, cloud—all call the tune in man's relationship with soil. They affect what we can do with or for the soil; and what it can do for us.



HOW SURVEYS ARE USED

In the last section we studied soils, slopes, erosion and drainage features of land—for a very good reason. We want to know what we can do with it, or what it will *produce* for years to come. Also we want to know what we can do *for* it with conservation treatments, to keep it in good shape, or restore its usefulness if it has been harmed.

There are almost 2 billion acres in the United States (not including the Territories). More than half of these acres are farm and ranch land. Because of the overwhelming area it covers, this has gotten first consideration in land surveys.

However, the system of *land classification* that surveyors have developed primarily for farmers, is also used by many other groups: real estate men, military leaders, town and city planners, highway and public utility departments. Boy Scout Councils are using the system to lay out campsites.

The system is based on eight, separate classes of land. To keep them straight, on maps and other references, each has been assigned a number (usually a roman numeral) and a standard color of its own.

Class I is the very best for farming. It is almost level and nearly erosion-proof. Its soil is deep, easy to plow, moist and fertile. Class I is safe to farm any sensible way. For those reasons, it can be farmed more profitably than any other kind.

Class II is good land but has a few drawbacks for agriculture. It may be sloped enough to cause rain to carry off soil. It may be a little too wet, or too dry. Some simple conservation practices such as contouring, cover crops, water management, rotations and fertilizers have to be applied.

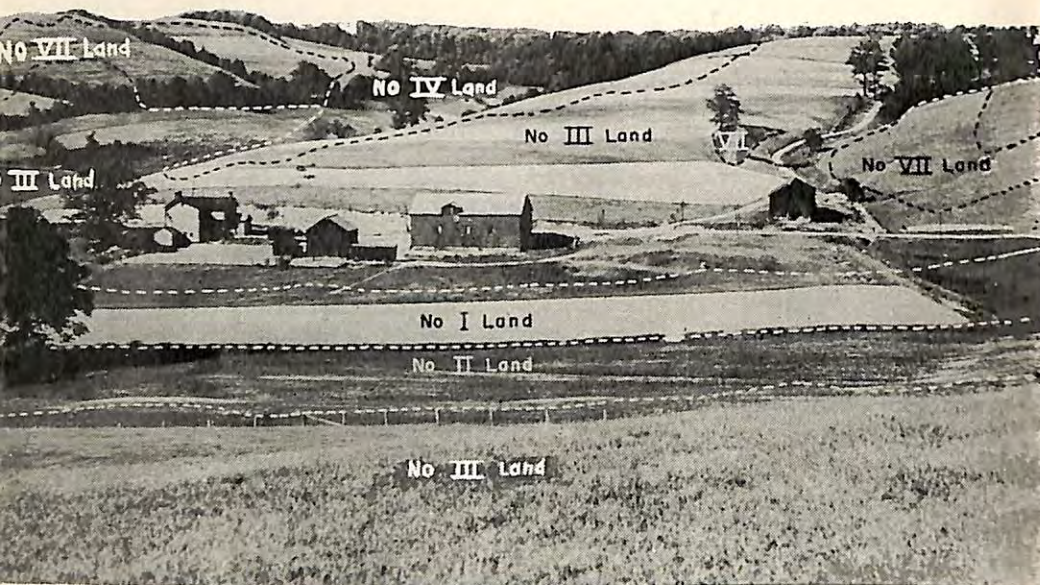
Class III is fairly good farmland, more limited for cultivation purposes than Class II. It will need careful conservation farming methods even though it can be cropped regularly. In some localities Class III is moderately sloping land which needs erosion protection and treatment. In other places, it may be poorly drained and require water management.

Class IV can be cultivated occasionally, only. Much of it is steep and erosion attacks it readily. Its best use is for pasture or hay. As a rule, it is good grazing land and also suitable for forest if the rainfall is adequate.

Class V is nearly level land. It is not good for cultivation because of some permanent difficulty, such as wetness, dryness, unfavorable climate or rock outcrops. The soil is usually deep and usable for grazing and forestry, with few limitations.

Class VI is not suitable for cultivation, and is limited in value for grazing and forestry. Limiting features are likely to be steep slopes, shallow soils, excessive wetness or lack of moisture.

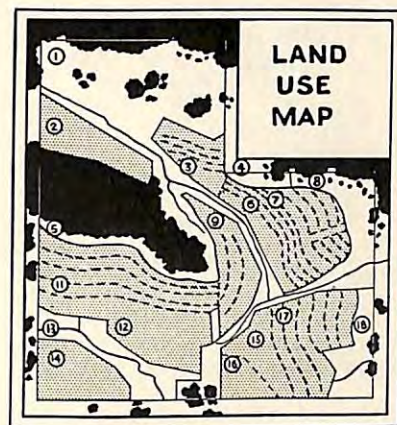
Class VII is not good for cultivation and is severely limited for grazing and forestry. Erosion protection has to be carefully applied. Management for grazing and lumbering requires special attention.



Here are five of the eight land classifications. Try to find actual examples of all eight in your neighborhood or at camp.

Class VIII is *extremely* dry, wet, sandy, stony, steep, rough or badly eroded and is ordinarily useful for wildlife, recreation or watershed protection. Sand dunes at the shore, desert areas, swamps and rugged mountain land are in this Class. It is unsuitable for cultivation, grazing and forestry.

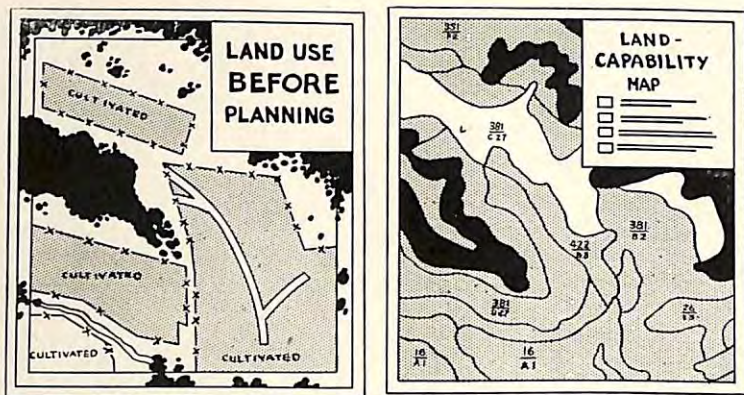
Specialists from several government agencies are at work on the tremendous job of classifying land in the United States, Alaska, Hawaii, Puerto Rico and the Virgin Islands. Other countries are doing the same thing, generally using methods developed in the United States. In many ways, the task is like looking in the pantry to see how much is left to feed the family. The big difference is that if all the world's soil and water is wasted, there won't be any more shopping trips for the human family—not on this planet, anyway.



CONSERVATION PLANS

The object of soil conservation surveys is to develop a plan for use and treatment of each acre. Shall it be cultivation, hay, silage, pasture, fruit culture, forestry—or none of these? Shall it be contour strips, terraces or diversion channels? Those questions are in a land owner's mind when he asks for a conservation plan. In most of United States territory he can get help from his local Soil Conservation District. In this manner, a million American farmers and ranchers have secured complete plans for about 275 million acres.

The land capability survey map is the key to the plan. On it, soil conservation technicians put symbols and colors showing land classes and characteristics observed during the survey. Farmer and technician go over the fields, map in hand. The technician tells what he knows about the kind of land the farmer owns—what experience and experiment have shown is the best way to operate it.



On the left is a map of a farm showing land use before conservation farm planning. The land capability map on the right shows recommended land use based on slope, soil, moisture and other factors.

Recommendations are based on hundreds of years of farming history studied by scientists. Additional knowledge and advice comes from scores of agricultural experiment stations, where, year in and year out, the effects of farming on hundreds of different soil types are recorded. From these findings, technicians are able to give farmers helpful advice as to what the various soils and soil conditions will do for the farm enterprise.

Fortunately, there are choices. Farmers and ranchers usually are free to select from many types of agriculture that will fit their lands, the amount of capital or labor they have available to invest, and the market where they will sell their products.

When the plan has been fully developed, the farmer thoroughly knows his land and what he can or cannot do with it. Best of all, he has a "blue-print" that will help him run his farm operations successfully the whole length of the calendar. Specifications that remind him of his seasonal work include:

Where to use strip crops, cover crops and terraces; how

much and what kind of fertilizer and lime to put on fields and pastures; what crop rotation system to use; location and type of drainage and irrigation systems; grazing plans for each pasture; a schedule for harvesting and managing trees in the woodlot; areas to attract and encourage wildlife production; location of a farm pond; how to get rid of gullies and other signs of soil erosion; where to plant windbreaks and shelterbelts; when and where to use mulch and green manures; plus all measures and methods that will secure the maximum benefits from soil and water without destroying their effectiveness.

Ordinary farm and ranch equipment will do most of the jobs called for in conservation farm plans. And the man on the land with plain "horse sense" can follow through much of the way without further help.

Putting their plans in operation, farmers and ranchers have gotten remarkable results. Planned farms in South Carolina have increased cotton yields by 275 pounds per acre in the same manner. In Colorado, conservation-improved fields have grown twice as many sugar beets as before. One conservation farmer in Tennessee built up his corn yields from 25 to 40 bushels per acre, cotton from 1000 to 1500 pounds, wheat from 10 to 15 bushels, and was able to increase his beef herd from 14 to 30 head.

Conservation plans, as such, have thus far been used mostly by individual farmers and agencies administering public land. Expansions in their use in other fields are continually interesting. Not the least of these is the current conservation planning of Boy Scout camps, including the vast Philmont Scout Ranch in New Mexico. Game and fish organizations and sportsmen's groups are turning to land-capability maps and conservation plans to improve wildlife habitat.



THINGS TO DO

Through the years, farmers and agricultural scientists have found specific ways to save soil and water. Some are simply improvements on practices that date back thousands of years. For example, irrigation systems were used by Indians in the dry Southwest in pre-historic times. Terracing of steep croplands in Asia has been going on for so many years, no one knows when it started. Draining and reclaiming farmland by means of dykes and canals has been established in Europe since the beginning of recorded agriculture. These conservation principles are still in use.

Colonial American farmers experimented with ditches to relieve wet fields, hedges to stop sand-blows and cover crops to stop erosion. Patrick Henry, fiery leader of the revolution, once commented, "He is the greatest patriot who stops the most gullies." A few early Southern planters deliberately plowed their sloping fields horizontally, now a common soil-saving practice.

At this point, you may be wondering why soil conservation and water conservation are lumped together. The fact is, they are almost always one and the same thing. Whether you call a land or water management program soil conservation, or water conservation, depends on what the main, immediate purpose is—to save soil, or save water.

More often than not, when you conserve soil, you conserve water, too. Good soil is like a sponge. Altogether, there is probably more water held in our American soil than the combined capacity all our brooks, creeks, rivers, lakes and artificial reservoirs. The best way to protect water supplies is to take good care of the soil.

Managing water correctly, on the other hand, results in conservation of soil. Unmanaged water allowed to rush pell-mell across bare slopes will wash away valuable soil and sap its fertility. Poorly handled on a big scale, water can flood entire valleys, causing death, disease and destruction.

What can you do to soil and water, to conserve both? You will have a better idea of what you're doing if you keep your aims in mind. Your aims with soil and water are very similar to your aims with anything you eventually want to use, whether a model airplane, a tent or a fishing rod: You want — (1) *Storage* and (2) *Control*. "You want what you want when you want it, and where you want it, too."



MANAGING SOIL

Someone said, "Soil is like a bank account. Keep borrowing from it—never re-paying—and pretty soon the land is flat broke." Every crop removes a certain amount of wealth from the earth. Every harvest of grains, vegetables, grass and fruit takes something away—moisture, minerals, physical structure—something that affects the soil's ability to produce. If these elements are not restored, then, surely the soil (and its owners) are heading for bankruptcy.

Whenever you see a carload of tomatoes or a vanload of corn heading for market, you can justifiably observe that someone's soil is less rich—has lost value in the process. A trainload of sheep, hogs or cattle on their way to the stockyards represents a similar soil value depreciation. Just as surely as do fruits and vegetables, animals also carry off the chemicals and moisture from soils on which they grazed. They get it from forage plants they eat while growing bone and

tissue. Humans get the same materials in steaks, chops and hamburgers.

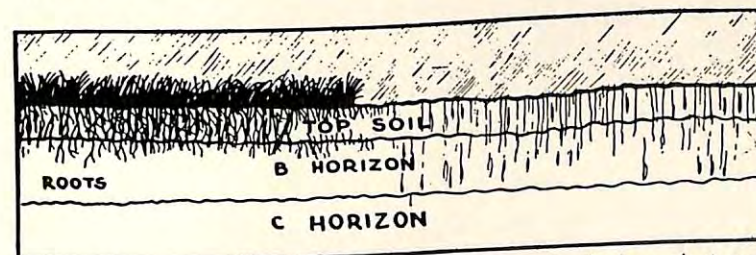
Long experience has shown that farmland soils have to possess—(a) suitable amounts of organic matter or humus; (b) plenty of plant nutrients; (c) good structure; and (4) sufficient topsoil depth. A good soils manager will look after all of these qualities.

Fertilizers

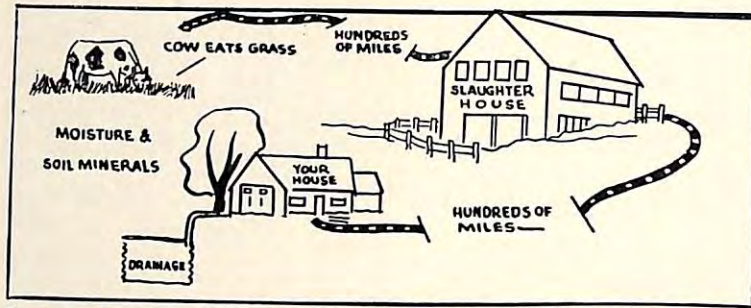
Probably the most commonly seen soil management work around the farm is the use of fertilizers. City folk are apt to think first of animal manures in connection with fertilizer. Droppings from livestock and poultry are vitally important in restoring land fertility. They are one excellent means of giving back to soil what animals and birds have devoured. There is not enough manure, unfortunately, to go around.

Most farmers use commercial fertilizers, especially prepared for their needs. Materials come from processed organic matter—refuse from slaughterhouses, meat, fish and other food-packing plants—and from chemical compounds. Most fertilizers are composed mainly of three chemical elements—nitrogen, phosphorus and potash. These nutrients are used in the largest quantities by growing plants.

Chemists and fertilizer companies have symbols to indicate kinds and amounts of nutrients. If you are to dig a little deeper into the subject, you might as well learn what



Rain carries minerals from the topsoil down into the subsoil where plant roots cannot reach them. This is called leaching.



Plants and animals depend on soil minerals and moisture for growth. When the plants and animals are harvested and shipped away, the minerals go with them. New mineral supplies must be added or the soil will soon be depleted of these necessary growth elements.

they are: N stands for nitrogen; P for phosphorus; K for potash. In the fertilizer business, they always occur in just that order—N-P-K.

Thus, the next time your farmer friend tells you he used "2 tons of 3-12-12" on such-and-such field, you'll know he means fertilizer containing 3 pounds of nitrogen, 12 pounds of phosphorus and 12 pounds of potash per hundred pounds. The remainder of each hundred pounds is "filler" matter to preserve or "carry" the principal nutrients.

Besides N, P and K, scientists have found that plants also feed on other elements in the earth. These are sulfur, calcium, magnesium, iron, manganese, boron, copper and zinc. They may be mixed with ordinary fertilizers where needed, or applied separately as sprays and solids. To round out the plant food story, we should mention that in addition to the fertilizer and trace elements described above, there would be no production of crops without carbon, hydrogen and oxygen. Plants get these particular nutrients from water and air.

Lime

Sooner or later you will hear a farmer or gardener remark that he has "sweet" or "sour" soil on his place. Farmers traditionally call acid soils "sour"; alkaline soils "sweet".

Neither has anything to do with taste as we know it. Rather, it is a chemical problem and is usually referred to as the *soil's pH value*. Extremely acid soil will test at pH 4.0. Extremely alkaline soil will register at pH 10. Neutral soil is—in the middle—pH 7.0. Below pH 7.0 all soils are acid. Above, all are alkaline.

When soil acidity causes trouble, farmers fight it with applications of lime, in several different forms—ground limestone from quarries, burned lime and slaked lime. Lime is not put on the soils each season as is fertilizer. The effects of a thorough job of liming farmland may last 3 to 10 years.

In "sweetening" soils, lime makes more soil minerals available to plants and actually creates favorable conditions for growing certain types of plants, especially *legumes* like alfalfa and clovers. Moreover, it reduces plant diseases and improves soil structure for cultivation.

Most farm crops thrive in soil slightly on the acid side—around pH 5.5 to 6.5.

How Much, When, and Why

Although some farmers still apply fertilizers and lime "by guess and by gosh", the vast majority today are quite scientific about it. They take advantage of soil tests offered through agricultural colleges and experiment stations, or they have the tests made in private laboratories to learn exactly what their soils need. Farming is a big, important business and farmers cannot afford to take chances.

You can probably arrange to have some soils tested while working on your Soil and Water Conservation Merit Badge. You are bound to pick up information from the experience. For instance, you'll probably be amazed to learn that getting your soil properly tested is not just a matter of throwing a spadeful of dirt into a can and gaily sending it away, labelled with your name and address. Here's a rough idea of what a soil scientist may want to get from you (and your soil) before he can make recommendations.

1. Soil samples of various parts of your field or fields—

selections from hilltops, slopes and low places. Soil needs often differ considerably in locations only a few feet apart.

2. Data on the kind of farming system you use—when you plant, what you plant, or any use you may intend for the soils. Reasons: Plant diet varies from one type to another, and from one end of the season to the other. Again, the soils expert wants to get some indication of your crop's possible value. He doesn't want to recommend a fertilizer costing more than the crop is worth.

3. Details on moisture conditions of the fields. Plants can't get the full benefit from fertilizer when the ground is too wet or dry.

4. Samples of plants growing on your soil. Trained eyes can often see plant diet needs from appearance of leaves: the telltale yellowing of corn leaves starved for nitrogen; the yellow-rusting of soy bean plants lacking potash; the purpling undersides of potato and tomato vines short of phosphorus.

5. Crops you intend to use in rotation. This influences the amount of liming recommended. Generally, amounts of lime are governed by the rotation crop having the greatest need for "sweet" soil. But where certain rotation crops, such as potatoes and tobacco, are harmed by heavy liming, lime amounts are lowered accordingly.

Should the "curiosity bug" bite you, there are a few rapid soil testing kits frequently advertised in garden, farm and science magazines. Perhaps you'd like to get a moderately priced one and see what kind of soil scientist you'd make. You might get a real "kick" out of mixing the chemicals and soils—watching for color changes that tell the story. The same sort of thing goes on in the big soil laboratories.

"Living" Soil

Anyone who is really acquainted with soil, discovers that it is very much "alive", however strange that may seem. It has "body", physical structure like all living things. To remain alive and valuable for any purpose, it has to retain

its body and structure. It must be able to breathe in and accept the elements brought to it by water and air, which, in turn, it passes along to growing things. It must be in good condition to hold these elements long enough for plant use. It needs to be healthy to provide living quarters for tiny micro-organisms while they work during the growing seasons. Without the latter, incidentally, nothing would get above ground.

Soil managers who know their business treat the land the way a trainer handles an athlete. They give it plenty of food and conditioning exercises in the form of fertilizers and lime. They give it sufficient useful workouts when it is actually producing crops. And then like a trainer with his charge, they give the earth rest. Soils have to "take a break" every now and then like anyone else. They, too, can be worked to death.

Crop Rotation

One way of resting soils is to rotate crops . . . seeding different plants, rather than the same ones year after year. In this way, soils get a chance to renew their supplies of certain nutrients that one-crop systems would exhaust. Another advantage of rotations is the beneficial effects of varying root patterns. Some row crops, for example, have shallow roots, leaving much of the soil untouched and tending to pack down. Introduction of a long-rooted plant such as alfalfa helps to break up deeper layers of the soil, providing better passage for air and moisture.

Conservation farmers deliberately use at least one crop in rotation to cover the land—to protect it from erosion. Cover crops have close-knit root systems, stems and leaves that blanket the soil, defending it from the attacks of wind, splashing rain and swift water run-offs. They also help reduce extremes in heat and cold that cause puddling, crusting and breaking up of exposed soil surfaces. Thus, cover crops not only play a role in rotations, but also guard cropland through the non-growing seasons. By preventing



1st yr. corn 2nd yr. wheat 3rd yr. hay 4th yr. hay 5th yr. corn

A good rotation for Class III land—1st year, corn; 2nd year, small grain; 3rd year, hay; 4th year, hay; 5th year, corn again.

erosion, they help preserve soil depth necessary for best production.

A possible rotation for some Class I land is—row crop, cover crop. A possible recommendation for Class II is—row crop, small grain, hay. A good rotation for Class III might be—row crop, small grain, hay, hay. Class IV would be kept well covered with this rotation—small grain, hay, hay, hay.

In these sample systems, notice that the Class I land rotation covers two years; Class II, three years; Class III, four years; and Class IV, five years—one year (or growing season) being the unit for each phase of any rotation.

Even though lands are rested by rotation, they are not actually taken out of production and the farm income need not suffer. Cover crop land can be furnishing forage for livestock while row plantations are growing produce required for direct cash income.



On this Class II land in Georgia, corn and peanuts were planted following Hegari sorghum in a two-year rotation.

Soil Body-Building

Soil derives much of its "life" from things that once lived—from organisms such as plants, trees and animals that die, fall to earth, decay and become a part of the topsoil. Patterns created by the rotting of leaves, stems, logs, animal bones and tissues—also brand new chemicals improve the body of the soil. They give it a structure that admits air and moisture.

Gardeners appreciate the value of organic improvement when they dump or bury garbage in their soils; and so do home-owners who allow their lawn clippings to stay and rot where they fall, and who refrain from burning old growths in favor of letting them decay and fall into the earth.

Farmers use the principle to maintain and better their soils' condition in several ways. For example, a dairyman



Stubble mulch is the practice of plowing or discing plant stems and leaves into the soil, as protection against erosion.

will take his hay, grain straw, sawdust from his woodlot, or shavings from a mill and use it first for cattle bedding. Later, he will scatter the combined manure and waste material on his fields, fertilizing and rebuilding soil structure in the same operation.

Another example is the use of stubble mulch. Harvested plants are left on the land to protect it between seasons and renew soils. Their stems and leaves act as a buffer against erosion. When they decay or are plowed and disced underground in cultivation, they provide new vigor for soil's physical qualities.

Here again cover crops are of value. They can be cultivated into the soils to replace organic structures and productive substance lost during growing seasons. Legumes—alfalfa, in particular—are very often used for this purpose. In the Corn Belt they are an important means of adding



Legumes such as cow pea, alfalfa, clover and soy beans store nitrogen in nodules on their roots, and thus add it to the soil when they are plowed under.

nitrogen to earth, for they have the ability of collecting the vital nutrient from the air and storing it in nodules on their roots. The nitrogen is released to the soil when alfalfa is plowed under as a "green manure".

The Complete Job

We have talked of many things under MANAGING SOIL and many more items could be mentioned. It must be obvious by now that there is no one way of doing the job thoroughly. Fertilizer won't do it alone; neither will lime, organic amendments, mulches, rotations, cover crops and special machines, by themselves. Altogether, these are the vastly important rudiments of "doctoring" soils successfully. Mastering them, you are well on your way toward the complete science and art of soil and water conservation.



WORKING ON THE LEVEL

Sure signs of conservation ideas at work on the American landscape, are the long, graceful, curving strips of crops seen in many modern farm communities. These winding ribbons, alternately in dark green of grasses, gold of grains, and lighter colors of earth showing through open rows, can be best observed from an airplane. In steeper territory, the bands of cropland can occasionally be noted rippling along contours of far-off hills.

Contour farming, as the practice is generally called, originates with a very simple principle: Water runs downhill. That probably isn't news to you, but the way conservationist-farmers take advantage of that fact is ingenious.

First they realized that the means to hold back running water is ordinarily a dam. Use a big, high dam to stop a lot of water for a long time. Use a small, low dam to hold back a little water, or to slow down a lot of water for a little while. All dams, of course, are located across the

slope—at right angles to the direction water runs. Even with these A-B-C's figured, farmers still wondered how to use them in managing soil and water. Farmers in rainy regions sought to apply the knowledge to fields where storms sent waters rip-roaring down slopes, pushing crops and soils out of their path. In the drier sections, other farmers thought about how to catch and hold the precious drops of rain that fell only now and then, and how to get the water into the soil.

One day—nobody knows just how long ago, or even in what country—some farmer noticed that water collected in his plow furrows, wherever they were lined across the slope. The furrows acted like tiny dams, blocking the runoff of rain water. There were many such furrows, and, altogether, the farmer discovered they held back a considerable amount of water. His neighbors copied his style, as neighbors will, only after calling him crazy a few times, and then gradually admitting that his contour-plowed corn yielded more bushels than their "quilt-patch" acres.

The thing that interested most farmers in contour cultivation was that it helped control soil and water, and could be done right along with their regular farm chores, with no extra labor, material and machinery. It started them thinking about other methods of farming profitably and saving soil and water, without doubling their efforts.

Contour furrowing discovery set off a whole chain of developments in contour farming. From the furrow device, farmers went to planned ditching; then to ridges of earth, called terraces of one kind or another; then to combinations of terraces, ditches and furrows; sometimes a simple engineering device such as a check-dam was added to the system. Merely running farm equipment on contour levels strengthened the basic principle of damming up or slowing down running water.

For a long time, farmers had noticed that woodlots and pastures suffered little from water troubles. Trees and grass always held up the rate of runoff from slopes, and they resisted erosion of soils on which they grew. Close matting



The use of contour strips to preserve moisture and protect the soil is shown on this Minnesota farm.

grass, leaves and stems formed a screen of miniature dams that baffled swift running water—retarded it long enough to force some into the ground. Forest brush and the litter of leaves, needles and fallen branches did much the same thing.

Strip farming was the outcome of farmers' decision to make their own crops allies in the fight to save soil and water. Strips of close-growing grain or grasses planted upslope from open row crops create, in effect, living check-dams that restrain water from rushing and cutting across exposed soils downslope. Alternate grassy and open row crop strips account for the "layer cake" appearance of many farm hillsides, today.

In early strip farming, the strips were simply laid out roughly at right angles to the slope. Nowadays, the practice is to follow curving contours as closely as possible. In flat prairie lands, straight field strips are still largely used



Contour farming increases corn yields by increasing the amount of rainwater held in the soil.

to prevent wind erosion. Close growing grass and shrub strips are positioned at right angles to the prevailing winds screening open soils and trapping dislodged soil particles before they have blown any great distance.

Conservation by Contour

In the few short years that "conservation on the contour" has been widely recognized, it has appeared in many forms and values. In farm operation, field arrangements have often been greatly altered to get the best advantage of long, contour strips. Farm machinery operating constantly on the level is less costly to maintain, requiring less gear-changing, fuel consumption and other wear and tear suffered on the old-time, up-and-down-hill farm.

Ranchers of the West use the contour principle to spread water and conserve moisture in rangeland management, as

do irrigators of orchards and truck croplands. In flood control, conservation engineers are often able to predict high-water peaks and damage from the amounts of contour farming practiced on a watershed. Backyard gardeners these days frequently plant their vegetable rows along the contour, using home-made levelling devices.

Of all practices associated with contour strip farming, the most common is probably the use of terraces. Scouts who mow lawns in many, hilly parts of the country are likely to be familiar with at least one form. They're the back-breaking "steps" one saves for the shady shank of the day. Quite probably, they are bench terraces very similar to those used by farmers in Japan, China, Puerto Rico and elsewhere that good, easily worked cropland is scarce and people are so plentiful even sheer mountainsides must provide food, somehow.

In the Southeastern U.S.A. benching originally copied from the Old World has given way to terracing more readily adapted to local terrain and agriculture. Graded and level terraces are the more usual types seen on conservation farms.

Any terrace is essentially a ridge of earth raised at right angles to the slope. It is designed to block the path of run-off water. Earth fill to make the terrace is normally scooped from one or both sides, thus leaving adjacent ditches or channels; also, level areas for cultivation, in the case of bench terraces.

Additionally, graded terraces are built to shunt water sideways. Their channels are inclined slightly off the contour. The sidewise movement of water, therefore, is slow and deliberate, instead of destructively rapid. There is time for maximum amounts of moisture to sink into soils for temporary storage or immediate crop use. The surplus is conducted off the field.

In flat country—particularly the Great Plains of our West—level terraces serve mainly to catch and hold water from the infrequent rains. This is because land is never absolutely true level and some running off occurs almost



Terraces such as this one on a Kansas farm, slow up water so that it cannot wash away soil.

everywhere. Sometimes extra ridges of earth are thrown up at connecting points between adjacent terraces. In this manner, a ranch terrace basin may impound rainfall until soils absorb all water not lost by evaporation.

Terrace systems are laid out to handle the heaviest expected rainfall. This has to do with the watershed area; the larger it is, the greater will be the volume of water to control. Another guiding factor is the pitch of the watershed slopes; steeper slopes generally cause swifter rates of run-off than gentler ones. This may also depend on the water-absorbent quality of the soils; soils that "blot up" rainfall quickly will make the job easier for the terrace builder; water-tight soils will make it harder.



WHAT'S A WATERSHED?

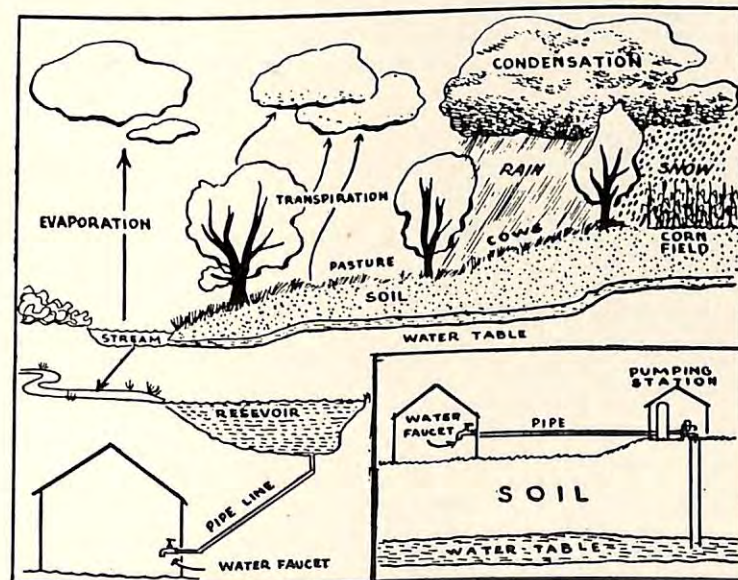
On U. S. Route 50 at the boundary between Chaffee and Gunnison Counties, Colorado, there is a sign that would help you get the watershed idea. At the top of the sign, large letters proclaim, "CONTINENTAL DIVIDE—MONARCH PASS—ELEVATION 11,302 FT." Below that, the sign is split by a black, vertical line down the middle. On the left side of the line it says, "Atlantic Ocean Watershed"—and an arrow points eastward toward the town of Salida, 22 miles away. On the right side, it says, "Pacific Ocean Watershed"—and another arrow points westward toward Gunnison, 43 miles distant.

The meaning of that Rocky Mountain sign is merely this: All the rain or snow that falls west of the Continental Divide eventually runs into the Pacific Ocean. East of the Divide, water drains into the Atlantic Ocean (or the Gulf of Mexico which is really part of the Atlantic). Like the ridgepole of a tent, the Divide splits the water that falls on it, sending part of it down one slope face—the rest of it down the other.

Within the huge Atlantic and Pacific watersheds are thousands and thousands of smaller ones, sometimes called sub-watersheds. They may be as large and well known as the watershed of the giant Mississippi River that carries the run-off from 1,243,700 square miles of land. They may be as small and unheard of as the 4 or 5 square miles of



Map on opposite page shows the Schoharie Watershed, part of the New York City Watershed.



Here is how rain falling on the watershed finally gets to your home.



Poor farming and forestry practices on the uplands may result in floods in spring and dried creeks in summer.

wooded hillside that feeds clear, cool water into your favorite trout brook. In fact, those few square feet in your garden where a puddle forms in a heavy rain is also a tiny watershed.

Modern conservationists think in terms of watersheds. That is because a watershed makes neighbors of everyone living on it. Anyone who abuses the community watershed's soil or water strikes a blow at the community's welfare. For example, Industrialist Jones empties poisonous chemicals into the river, thereby endangering local health. Farmer Brown does nothing to stop gullies from ripping his lands, and lets his mud fill in and ruin the town reservoir.

On the other hand, watersheds provide people with the opportunity of working together for benefits all can share. Townsfolk can help manufacturers work out their waste



Watersheds protected by plant cover have a gradual runoff of melting snow and rain, so that streams are clear and full the year round.

disposal problems. Farmers can unite in protecting watershed lands by following conservation plans. Young folks, including Boy Scouts, can join hands with landowners in planting trees to conserve soil and water. In fact, community watershed associations in the U.S.A. are doing all these things today.

If you can read topographical maps, the chances are you can outline the watershed of your local stream simply by drawing connecting lines between high points of land surrounding it. A good field day for you would be to walk around the watershed of a little brook or pond in your neighborhood. You can determine for yourself the slopes that drain toward it—and those that drain into an adjoining watershed. Make a rough map on a sketch pad if you don't have a topo sheet.



MANAGING WATER

In some ways, water is to land what chocolate cake is to small boys. Too much water—or cake—often causes trouble. But land must have water; and boys must have their chocolate cake. The problem is to arrange the supply in terms of need. An over-supply of water requires *drainage*; an under-supply calls for storage and *irrigation*.

Most farm crop plants don't like "wet feet"—areas where their roots or stalks are constantly in sodden soil or pools of water. Excessively wet soils are often cold and don't promote growth. They are hard to cultivate with modern farm machinery. Many such soils can be drained and cropped to increase farm income.

Drainage

Conservationists advise farmers to "look before they leap" into a drainage project. Complicated underground

drainage can be costly. It's smart to figure all the angles to make sure the job will be worth the expected returns. Soils should be tested to be sure they're good crop-producers.

Especially where wildlife and recreation enter the picture, should long, second thoughts be heeded. Possibly, the waterfowl, fur-bearing animals and fish attracted by sloughs, pot-holes, swamps and swales are of much greater value in the long run than any agricultural purpose that might be served by drainage.

Farm and Ranch Ponds

More than one farmer has turned his attention from drainage to pond-making. The latter is often one good way to lick the problem of what to do with a persistent wet spot. Ponds are of genuine value to conservation and farm operation. They furnish water for cattle, irrigation and fire protection. They produce fish and aid wildlife. They're nice to have around for fishing, bathing—even boating.

There are records of American farmers and ranchers making more than 200,000 ponds in the past 15 years. They add useful beauty spots to the landscape. One of the easiest types to build is over a naturally wet piece of land.

A spring-fed pond may be wherever supply from springs is ample. A by-pass pond draws water from an adjacent stream. Another common variety is the "sky pond"; it depends solely on rain. The average, "family size" home-made pond in the U.S.A. is about a half-acre in area. They cost anywhere from \$150 to \$800 to construct, depending upon location.

Pond-making has become a popular project with sportsmen's clubs and other groups associated with conservation. Constructing one is a worthwhile effort and there is much to learn about managing one.

A good many ponds can be entirely built with ordinary farm machinery. The first consideration is finding a site with a suitable source of water. The drainage area should not be large; and don't attempt to dam a stream. The water has to be free of pollution if the pond is to be truly useful.

The proposed pond bottom must not be leaky. A layer of tight, clay soil has to be found for this purpose. Earth is scraped and scooped away until one is reached.

The kind of fish to be placed in a pond will depend upon the locality. The number to be stocked will vary with the ability of the pond to produce fish food.

Ponds are fertilized in the same way—and with the same material—as a farmer works his fields. The recommended nitrogen-phosphate-potash ratio is 8-8-4. Broadcast on water it speeds the growth of tiny plants and organisms called plankton, a food for insects. Fish feed on insects and each other. Plankton also shuts out sunlight and thus kills underwater weeds. That makes snag-free angling and fish don't get that "fishy" flavor imparted by over-weedy waters.

Two years after stocking, a well-fertilized pond should be carrying its limit of fish—up to 450 pounds per acre. More than half of any catch will be pan-size. It is possible to fish a farm pond as long as they "bite good". That leaves more food for uncaught fish. Domesticated bass and panfish will challenge a fisherman just as keenly as their wild cousins. They're just as scrappy and often a lot harder to tease—because they're better fed.

Migratory birds now make farm and ranch ponds regular stopping places in their wanderings throughout North America. Fur-bearers haunt them and supply spending money for the farm boy trapper. Plantations of shrubs and trees set up around ponds often contribute better hunting and fishing for the general public.

Ponds require care, like any other conservation practice. Grass around the borders and in the spillway must be mowed. Sod has to be maintained on the dam to keep soil from washing. Brush and rodents must be kept out. Cattle must be fenced off (and confined to watering troughs) to prevent them from breaking down the banks and dam. Pond watersheds must be treated if they're sending too much mud into the basin. There's plenty of work in a well-managed pond. Call *fishing* work, if you wish!



Farm or ranch ponds are easy to construct in many places and provide recreation as well as water for stock, and homes for wildlife. The earth dam (below) holds back water from the surrounding watershed.





Irrigation is the method of supplying water for plants where there is insufficient rainfall. This is a sprinkler system near Yakima, Washington.

Irrigation

Anyone who has hosed the lawn or garden knows something about irrigation. It's man's way of doing a job Nature decided *not* to do—distributing water to thirsty soils. Crops respond. Citrus fruit, nuts, beans, potatoes, rice and berries are among scores of crops that now grow in former semi-deserts. In 17 Western states, many of the Nation's richest orchards, beef and dairy farms thrive on irrigated land.

Far from the dry West, Atlantic Seaboard and mid-Western farmers irrigate to boost yields. The mid-West uses irrigation to get an extra 10 bushels per acre of corn; an added up to 200 bushels of potatoes; or to double the carrying capacity of clover pastures.

Irrigation saves soil by making it useful to agriculture. Moisture makes vegetation possible that protects soils from



Alfalfa and brome growing on the drainage ditch-bank protect the bank from erosion and help the ditch fulfill its purpose.

wind and wash erosion. Irrigated soil takes on an effective structure and "liveliness" as contrasted to the "dead" earth of barrens and deserts.

In the West, most irrigation water comes from melting snows of the high mountains. Each year, specialists with skis and rugged mountain climbing equipment go into the high country to check the "snow harvest", the amount of water that can be expected to flow down streams from snow drifts and ice sheets. With this information, farmers know how much they can draw off from storage reservoirs and dams.

Water in the Earth

Houston, Texas, supplies most of its 600,000 citizens from wells drilled into broad, underground "rivers"—masses of water particles that move through rock and soil layers under the earth's surface. Such formations make farming possible

in large areas of the world where there is little or no rain, or running water. The United States has tapped these groundwater resources to get one-sixth of its moisture needs.

Conservation of these hidden reservoirs is now regarded as a major problem. Levels of some have dropped considerably, with increased farm and factory use—boosting the costs of wells and pumps. Others have been polluted by salt water and industrial wastes. Here and there, groundwater has failed to reach streambeds for base flow during dry weather.

Encouraging water to soak into the ground is a prime goal of modern soils management. Contour cultivation, cover crops, terracing, mulching and fertilizing are a few of the common practices that induce water to soak in the earth rather than run off from it. Other methods, such as new farm machinery and chemicals to improve the soil's intake and storage capacity are constantly being developed. All are needed to recharge and sustain the vital water supplies in the earth.

Water for irrigation (and many other purposes) is one of the biggest challenges facing Americans today. Millions of idle acres could produce food and fiber—millions of low production acres could produce more—IF more water could be supplied. Plant use of water alone is startling. One crop of cotton will consume 800,000 gallons per acre. An acre of alfalfa requires over 1 million gallons for each cutting. Oranges and grapefruits take over 1½ millions of gallons per acre to ripen. Ten pounds of potatoes use up 100 pounds of water before they go into the grocery bag.

TREES TAME WATER

The best, natural managers of water are trees. Vast areas of this country and others were skimmed of their tree covering via the axe and fire—before this fact was realized. People learned the hard way. They are still learning as in the California valley where, not too long ago, a careless smoker set off a blaze that cleaned off over seven square miles of forest.

Only a few months later a heavy rain fell. Hard rains had fallen before and the people living in the valley hadn't



Proper forest practices provide a continuing income from timber and at the same time protect the soil and help control water.

been bothered particularly. This time, a flood came roaring down off the burned slopes with such destructive force that hundreds were driven from their homes; several were swept to their death; the community was cut off by road damage for days.

The same sort of thing has happened in many places all over the world, wherever and whenever trees have been abused. The forest has ways of dealing with water that are infinitely more practical than other, known methods.

Anyone who has taken shelter under a tree may have had cause to marvel at the length of time required for rain to penetrate that living roof of branches, leaves and twigs. Much falling water actually sticks to trees and is held there until it evaporates. Still more water is caught in similar fashion by the undergrowth common in woodland. The leaf mold and litter beneath trees absorbs great amounts of moisture.

The spongy, organic soils of well managed forest land is a tremendous reservoir for water. The bulk of the moisture percolates it before it has a chance to run off and start a damaging flood. Finally, trees themselves drink in gallons and gallons of water, releasing it slowly to the atmosphere as a vapor, where it may again collect in clouds for future rains.

The great power of trees to tame water is consistently used by those charged with protecting huge watersheds on U.S.A. public lands. Forest rangers maintain constant watch over 200 million acres, suppressing fires, preventing overgrazing by cattle and game animals, seeing to it that logging or improper trail construction does not encourage erosion and landslides. Many state agencies and farmers are busy reforesting abandoned, worn-out farmlands.

Farmers and private concerns holding 270 million acres of woodlands are receiving technical assistance in putting woodlands to best possible advantage in production for cash as well as soil and water conservation.

Good woodland conservation practiced by many farmers include fencing out cattle; getting rid of poor trees to promote better growth rates in valuable timber; *selective cut-*



Sloping, liming, fertilizing, seeding and mulching eroded roadbanks is an excellent Scout and Explorer conservation project.

ting rather than *clear-cutting*; and harvesting no more trees than the known rate of growth. Millions of farmers now treat their woods with all the care they give their field crops. They plant seedlings suitable for their soils. They plant a few by hand, or thousands with speedy, mechanical planters.

Aside from the practical values of woodland already mentioned, there are many others better described in the numerous excellent books already written on the subject. Most people just plain and honestly love trees—their year round beauty. Scouts look at them and dream of the good, gay summer days of camping in the open. Others think of birds and other wildlife that trees shelter.

In recent years, tree—and shrub-planting “bees” have gained great popularity among folks. Accomplishments have been remarkable. Inexperienced two-men (or boy) crews can plant as many as 500 trees per day. Not long ago, 100 Boy Scouts probably set a record when they planted, seeded and fenced 20 acres near Shawnee, Oklahoma, in just one-half day.



WILDLIFE, SOIL and WATER

People are often surprised to learn that the harvest of many conservation farms generally includes increased numbers of wild birds, animals and fish. It is true that animals such as bison, antelope, bear, bobcat and panther have diminished as their large, range areas have been reduced. However, many of today's most hunted American game—rabbit, fox, pheasant and bobwhite quail have actually become more numerous as land has been cleared and farmed.

Today, a great percentage of small game is taken from farmlands; and almost half of the fur-bearers.

One reason is what game experts call the *edge factor*. Anyone who hunts will notice he sees more game along field and forest *edges* than anywhere else. Wildlife lurk there concealed by grass, brush and shrubs, yet handy to sources of food such as plants and seeds in the nearby crop fields. Conservation farming with its long, contour strips of alternate hay and row crops, provides far more edges. Game

managers have counted more wildlife in contour-stripped fields than in the old-fashioned, square fields where a single crop covered the entire area.

Again, conservation practices promote bigger, better crop yields, and birds and animals have shared the bounty and multiplied accordingly. Sometimes, they become so active that they are a nuisance. Farmers can then enjoy the sport of hunting them.

Most farmers regard their wild "guests" as part of the reward of carefully conserved soil and water. It is often a considerable cash reward where farmers have elected to prepare wildlife areas around artificial ponds, potholes, swamps, and watercourses. Pelts of muskrat, beaver and fox have helped put many a farm boy through school. Fur "farmed" this way brings over a million dollars annually to several mid-Western states.

While some farmers get added cash by renting "hunting

Farm ponds and marshes provide homes for fish, waterfowl and fur bearers—sources of recreation and income for the farm Scout and his family.





Living fences, such as multiflora rose are stock proof; and they provide cover and food for wildlife on the farm.

rights" most of them count their wildlife blessings in other ways. Pest control is just one of the blessings. Many song and game birds feed on worms and insects that harm crops; so do fox and skunk. Rats and mice, arch-enemies of agriculture, are eaten in sizable quantities by hawks and owls and are part of the diets of scores of small fur-bearers.

Several bird species prefer to eat weed seeds and thereby save farmers many hours of extra work in the fields. Seeds in bird droppings frequently serve to establish plantations of desirable bushes and shrubs. Finally, it is one of the unmixed pleasures of life to see and know wild creatures are in the neighborhood. Their presence assures mankind that all is well with the land—that the land is being put to its best productive use.

There are usually a number of odd, idle areas on land where only wildlife can be encouraged. Gullies, ditch—, road- and stream-banks are often in this class; also rocky



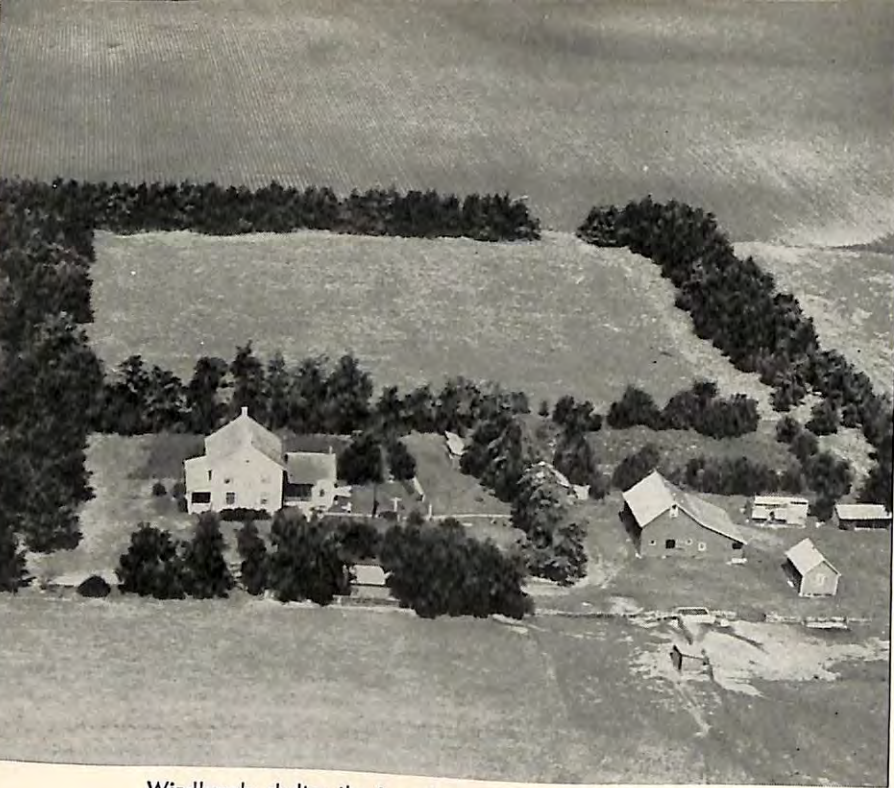
Field borders of sericea Lespedeza and native shrubs supply wildlife food and cover in a place that is not suited for cultivation.

shoulders in fields; irregular field corners and low-yield edges where ordinary farming doesn't really pay. Protective vegetable and food-furnishing plants established in these places pay a double indemnity. Wildlife will thrive; and serious land damage may be prevented or neutralized.

Here are a few sample projects of this sort:

"Living fences" of specially selected bushes now harbor wild life and protect land on many conservation farms. Some are thorny and tough like the multiflora rose which halts the larger farm animals when the hedge is five or six feet high. It also shelters wildlife and offers a barrier to fastrunning water.

Combinations of grasses, low and high shrubs are planted as *wildlife borders* between fields and woods. Such areas are usually poor crop-producers anyway, as they are frequently shaded and sapped by nearby trees. Special border plantations make safe escape routes for game, furnish them



Windbreaks shelter the farm from wind and at the same time provide homes and food for wildlife. Photos from National Audubon Society.



with nuts and berries and nesting places; in addition to preventing farm soils from washing.

Shelterbelts and windbreaks used in the Plains states are really variations of the wildlife border idea. They help game and at the same time slow up wind erosion and send cold or hot winds away from houses and farm buildings.



Bicolor Lespedeza and other shrubs planted along farm roads frequently result in more birds and other animals on the farm.



All true conservation practices ultimately help aquatic wildlife by keeping mud out of streams and ponds. Unless checked, mud covers fish-spawning beds and prevents hatching. Muddy waters are sunless and stop underwater plant growth, exhausting fish and waterfowl food supplies. By halting soil-wash at its source on the land, wildlife area plantations curb these dangers.



STOP THAT GULLY!

On a map of the United States, what appears to be a multi-fingered hand extends far out in the Gulf of Mexico. This is the vast Mississippi Delta country, made of soils dumped there by the longest river in the world. Farms of the Delta are high producers of sugar cane and beets, sweet potatoes and yams, cabbage and melons. They should be. They are grown on rich soils washed from over half the Nation's land by all of the rills, rivers and creeks that empty into Ol' Miss'

Unhappily, all the soil swept off the Mississippi watershed *doesn't* contribute wealth to the Delta farmers—or anybody, anywhere. Much of it rolls onward into the Gulf, a brown-stained tide seen far offshore. More of it piles up in the stream channels, damaging navigation facilities, fisheries and human recreation, forever threatening to spill over the banks and destroy. River towns are often lower in

elevation than boats passing only a few hundred yards away!

That is why "gully fighting" now engages millions of public and private land-owners who recognize the place to stop soil waste is at its source, on their own precious acres.

A gully is a hole gouged out of the ground by running matter that occurs during rain or snow-melt. It's a form of erosion easiest to see. Little gullies are usually called rills. Rills can become huge gullies in an amazingly short time. Newspapers front-paged a picture a few years ago that opened many Americans' eyes to this fact. The photo showed a yawning chasm the dimensions of a football field and 75 feet deep on a hillside in West Virginia. Startling information was that the chasm had been ripped out of the earth in just 4 hours of rain.

One of the most famous (or infamous) gullies is the so-called Providence Cave of Stewart County, Georgia. It is



Brush dams help control a gully until grass grows on the sloped slides. Such gully control projects are suitable for Troops or Neighborhood Patrols.



Grassed strip between contour rows of corn provides a waterway that is protected against erosion.

a vast cavity in the land more than 100 feet deep, said to have engulfed a schoolhouse and several farm buildings during its formation. Seventy years ago, according to local people, Providence Cave started from a tiny hole scooped out by water dripping from a barn roof. One-fourth of the land in this county has been ruined for further immediate practical use by gully and sheet erosion.

Gullying and cutting action of erosion has been so severe and extensive in some areas that the appearance of the landscape has actually changed. Old-time settlers of New Mexico and California rangeland, for example, might have trouble recognizing their former haunts. Hills have completely disappeared, here and there. Deep dry gulches have been carved out of formerly nearly level, productive grass lands. Weeds and scrub brush have replaced lush, native forage plants.

From an airplane, land erosion looks similar to a creeping scarring disease. Like any disease—as doctors often say—

it is easier to prevent than to cure. But the job has to be done.

One way to halt the march of gullies is to remove or guard against the forces that cause them. The cause, in most cases, is the stripping away of soil's natural blanket of vegetation—particularly on sloped lands. The moment raw soil is exposed, run-off water has the chance to go to work. The first rain may cause a pocket so small as to be hardly noticeable. The third rain may enlarge it. But, bite by bite, the young gully will chew its way uphill as each succeeding downpour tries to scour out a level watercourse for itself.

One gully leads to another, as exposed brittle edges break down, until a whole network of gullies and rills has sapped the richness of the soil.

Rangeland and pasture gullies occur where animals are permitted to crop the forage plants so closely that the earth becomes naked, an easy prey for erosion. The same thing happens on trails hard-worn by sheep and cattle hooves. Modern stockmen avoid these difficulties by carefully controlling sizes of grazing herds; by deliberately driving animals along various trails, rather than a single route.

Long out-moded farm practices of up-and-downhill plowing, letting fields lie bare and exposed season-long, and unprotected ditches, helped many a gully to a head start. Logging trails located without regard to contours have been the source of many a washout, as well as many a steep-pitched country road. Contour farming, contour road-laying and cover-cropping have proved to be specific preventives for many land troubles. Remedies for existing gullies often tax the combined skills and knowledge of several types of soil, water, plant and engineering specialists.

Woody vegetation—trees, shrubs and vines—grows readily in low-grade, eroded soils. Frequently it establishes itself without assistance, if cattle are kept out and run-off is not excessive. Farmers plant many species that protect soil and attract wildlife, also. Those who intend to reclaim crops from gullied farm areas usually plant grasses and legumes.



Weeping lovegrass, planted on the contour of this Texas rangeland, supplies food for livestock and protects the soil.

Grasslands

Reseeding of pasture and rangeland is often necessary to improve forage for cattle and provide enough cover to stop erosion. Seed species used will vary widely with locations. Amounts of lime and fertilizer should be based on local soil tests. However, a typical reseeding method is as follows: Lime is scattered on the old sod. Then, a disk or cultivator is used to prepare a finely-worked seed bed, 1 or 2 inches deep—a shallow bed if there is poor drainage—a deeper bed if drainage is good. Application of fertilizer comes next. Reseeding follows, with a grass-legume mixture appropriate for the area. Lastly, a roller or other firming device is used to cover and keep the seeds emplaced for the moisture and protection they need to germinate.

Stream Banks

Conservationists long ago discovered that streambanks are active zones of erosion. Gullies and rills attack the unprotected banks from the one side; the stream, itself, attacks the other, cutting eternally with torrents of water, hacking away with sharp chunks of ice in winter.



Cover crops protect soil from erosion, and when plowed under improve it for future cultivation.

Washed soils create a nuisance and danger wherever deposited along streams. They also represent heavy losses of valuable land. Recently a New York farmer showed the author the remains of a crop field perched on the cut-bank of lower Buffalo Creek. Barely three acres remained of an original ten. The missing 7 acres were somewhere between the farm and Buffalo Harbor. Unattended cutting, slipping gullying and rilling of stream-banks are an open invitation for streams to do their worst.

The task of getting the best possible service from rivers for industries, homes, and agriculture—of preventing floods and land damage along river banks—is a big one that occupies much of the energy and resources of many Federal and State agencies. From the forest-bound streams of Maine to the orchard-lined banks of California waters—there is a good chance you can personally observe one or more stream projects underway in your own neighborhood. In fact, it would be a worthwhile, special trip to make.

It is customary to think of stream control work in terms of towering dams, piles of masonry, hundreds of men and fleets of noisy, powerful, earth-moving machines. But it is also amazing what can be done by a few people with strong



Protected streambanks (in contrast to streambank on page 10) result in clear water, prettier scenery, better fishing or swimming and fewer floods.

backs and willing hearts. Improvement of little streams and brooks is often a real necessity for farmers and their neighbors. It can also furnish fun and lasting rewards, as Scout Troops, school children and sportsmen have discovered. Better fishing, guarded land and prettier streams are just three possible results.

Measures used on the little waters are exactly the same, in principle, as those applied to the big, engineering projects.

Some banks take such a pounding from floodwaters that simple vegetation will not give enough protection. In these cases, piers and dikes of rock and logs may be emplaced at the water's edge. A common practice also is to rip-rap the "toes" (lower portions) of exposed banks. This consists of laying stones and broken rock from a point below the waterline, continuing up the bank to any anticipated flood level. This level is frequently 2 or 3 times the height of normal flow.

Other bank protection devices include building of log, brush and stone deflectors—jetties angled out from the vulnerable bank intended to cushion or break up the shock of rapids.

Another, popular type is the straight log dam. A single, large, heavy log is placed across the stream and anchored to a pier of log and stone at each end. A notch may be chopped from the center of the log to guide the stream to a straight overfall. Some clubs and Government agencies have even imported beavers to build dams for them!

Dams of the sort described here should be low to have the least possible effect on downstream water levels—also to avoid flooding large areas difficult to control. Wisely built and located, they are of real benefit to fish and wildlife and may even serve as miniature de-silting basins that protect lower parts of the watershed.

In the final analysis, the best way to launch a stream improvement program is at the top of the watershed where troubles usually start. No better first move is possible than to plant trees and shrubs wherever bare soil is found.



The best flood control and stream improvement program starts at the top of the watershed with planting trees and shrubs on bare soil.



Industrial waste dumped into streams and rivers ordinarily is a violation of health and welfare laws. It goes on just the same and frequently results in the death of thousands of fish. *Photo from Fish and Wildlife Service.*

Pollution

While the mud from uncovered earth pollutes many streams, other pollutants must not be overlooked. Water will never be truly useful if stream-courses are used as handy places to dump household rubbish, industrial wastes, barn drainage, mine spoilage and similar foreign materials. Watersheds should be carefully inspected for sources of such pollution. Those responsible should be requested to stop their activities.

Road Banks

Gullies, rills and other forms of erosion are less evident along highways. Road builders and supervisors are now well aware of the dangers from soil exposed through scraping, digging and blasting. Many plant specialists and conservationists are being employed on road programs. Their efforts are



Gullies may be controlled with plantings of Kudzu vines and as on this Georgia farm may control erosion as soon as two years after planting.

very noticeable to motorists as pleasing landscapes of shrub and evergreen plantations on the roadbanks.

Gully Tamers

The cheapest and often most satisfactory way to hold runaway soils is through use of protective vegetation. Local recommendations will vary and should be sought, but there may be some interest in the following list of species advised by the U. S. Soil Conservation Service. These plants have proved effective in gully, stream- and road-bank control:

Trees and Shrubs—black locust, willows, pines, honey locust, poplars, eucalyptus, wild plum, and buckbrush.

Legumes and Vines—clovers, alfalfa, Lespedeza, Kudzu, Virginia creeper, dewberry, blackberry, and raspberry.

Grasses—Bermuda, bluegrass, Johnson, centipede, redtop, orchard, brome, Sudan, Kikuyu and wheat.



Airplanes and helicopters are among the latest and most valuable gadgets for studying the problems of erosion control; also the many practices for soil and water conservation.

CONSERVATION GADGETS

Soil and water conservation is becoming a more exact science every day. The era of "guess-timating" land and water treatment work is over. Costs in mistaken planning measuring and executing of conservation jobs run too high. Therefore, the modern conservationist is equipped with precise instruments and effective tools, a professional kit of "gadgets" that enables him to deal with any land problem.

Many instruments and tools have been developed from devices engineers and farmers use; otherwise they are quite specialized, such as those useful in sampling and testing soils.



Draglines are excellent for water conservation jobs such as dug-outs, ponds, ditches and canals.



Tile ditchers were designed for sub-surface drainage jobs. They are used for laying tile drains as well as sewer, gas or water pipes.



Top left—soil testing kits tell how much lime or soil nutrients to use for best plant growth.

Top right—Hand levels are used in the first steps of laying out terraces, diversion ditches, crop strips, irrigation systems and pasture furrows.

At left—Conservationists use bulldozers to clear woodland; to build farm or ranch ponds or drainage ditches; or to move rocks or stumps from cultivated fields.

Top right—Soil technicians use soil augurs to get samples of soils so that land use maps may be made.

Top left—A planimeter measures the area of odd-shaped fields on a map.

At right—Some soil scientists work in laboratories developing new products for soil improvement.





The grader does its best work in the construction of diversion terraces and ditches. Its blade can be raised and lowered, angled and tilted, and the wheels "crabbed" so the machine moves sideways.



The backhoe does a lot of earth-moving in a short time. It is used for making open drainage ditches with sloping ditch-sides or vertical walls.



ALL-AMERICAN LAND TOUR

"See America First" is a catchy slogan used by many U.S.A. travel agencies. It's also a good one for anybody interested in the Nation's soil and water conservation. Certainly, nothing can surpass the learning value of personally observing the work going on in farmland, forest, stream-courses and watershed basins scattered from the Atlantic Ocean to the Pacific—from the frosty potato fields of Alaska to the warm pineapple plantations of Hawaii, and on into the Caribbean where the sugar cane waves in winds of Puerto Rico and the Virgin Islands.

Most of us must content ourselves with the glimpses of our America that ordinary living provides. For that reason we have asked Boy Scouts in 10 different sections of the United States and Territories to get together on-the-spot reports of soil and water conservation needs and programs they have taken part in, seen or know about. Through their responses the reader can take, in fancy, at least, an All-American Land Tour.



Northeast

"One-third of all Americans live here on a small part of U.S.A. soil. Factories are never far from our farms. Glaciers left a lot of shallow, rocky soil. Early settlers cut timber off steep slopes and plowed hillsides, causing plenty of erosion. In New England, we have trouble with the 10 thousand miles of stone fences the pioneers left, whenever we want to install strip cropping.

"Our farm enterprises furnish well-known Vermont maple syrup, New Hampshire wood products, Maine potatoes, Long Island ducks, Massachusetts cranberries and vegetables, and New Jersey tomatoes. We have a lot of specialty crops that find ready markets, too—such as tobacco from Maryland and Connecticut, grapes and tree fruits from New York, and beef and lamb from West Virginia. Our farmers have gone in heavily for dairy farming on hilly pastures and their cows give three times as much milk as the average.

"We're cleaning up many of our polluted streams, putting poor farmland back to trees and forage grass, burying our old stone walls, rebuilding thousands of acres."



Southeast

"From Virginia on down to Florida—then back north and westward to the Mississippi River—there is real farm country and over two-thirds of us live in rural areas. We probably grow more *different kinds* of crops than any other U.S.A. region. Before modern conservation, Southeastern farmers concentrated on cotton, corn and tobacco, and wound up with serious erosion.

"We're making a come-back now. Soil conservation district farmers are rotating crops, keeping cows out of the woods, installing dams and other stream controls, and cooperating on big drainage programs.

"Truck gardeners of South Carolina are getting 25 to 100 per cent better yields with irrigation, and citrus fruit men of Florida get similar rewards. New conservation plants Kudzu, Lespedeza and various legumes and grasses—account for the boom in livestock farming. Dairy and beef cows, hogs, and sheep now thrive on improved pastures.

"Last but not least, we're guarding our precious forest wealth."



Upper Mississippi Valley

"We're in the heartland of America—the Great Lake States and the Corn Belt country, producing three-quarters of all the sweet corn, one-half the total meat, one-half the canned peas, one-half the cucumber pickles, one-half the milk and one-half the total tonnage of grain that reach U.S.A. markets each year.

"Good soils and markets have encouraged us to be among the nation's most productive farmers, and very much aware of our conservation problems. Our wide use of row crops in the past, without protective management, has cost us some of our best land. Flood damage and muddy streams have been the pay-off. The big floods get in the newspaper headlines; but three-quarters of the damage is done on little watersheds where farmers leave fields uncovered, fail to maintain their soil structure, or work the wrong kind of land. That is why flood control out here now includes crop rotation, contour farming, terraces, and diversions, as well as dams and other structures.

"Drainage is a big job with us in the Corn Belt proper."



Western Gulf States

"We're talking about Louisiana, Arkansas, Oklahoma and Texas—over 275 million acres where only one-tenth of the American people live. There's dry rangeland for cattle and sheep in the western sections—really wet cropland in the south and east. We get valuable timber from our uplands, including southern pine and high-grade hardwoods.

"Out in the big rangelands you will see rotation grazing. In the high plains you'll see stubble mulch—harvested plants left on field surfaces to stave off dust storms.

"In south central Texas, real progress in flood control has been made and can be observed in mile after mile of contoured farms, rotational strips, terraces, diversions, listers and improved grassland.

"A conservation-minded visitor can see infestations of mesquite brush in the cattle country and the modern methods of fighting it—particularly with sprays from airplanes. In the Rio Grande Valley citrus fruit, cotton, alfalfa and vegetables are irrigated—and drained, also."



Northern Great Plains

"Almost one-fifth of the United States total area is contained here in the Dakotas, Wyoming, Nebraska, Montana and Kansas. This is the land of the golden wheat, flowering flax and the green sorghum. Here, little more than one-twentieth of America's farmers work almost one-quarter of all U.S.A. farmland and produce more than 10 per cent of all the Nation's crops.

"One of the biggest conservation problems is the unpredictable rainfall and other weather influences. Wind attacks open soils in the dry sections; both wind and water have eroded lands where rainfall is heavier. Gully damages are serious in South Dakota, Nebraska and Kansas. Many former croplands have been converted to grassed livestock range to escape erosion.

"Irrigation is a necessity for much of our agriculture and is practiced on several million acres, usually near the permanent streams — the Platte and Republican Rivers of Nebraska, and the Arkansas River in Kansas.

"Over two-thirds of our section is natural cattle, sheep and timber country."



Southwest

"There's a soil and water story here that would be hard to tell in three or four books, but here's an idea. Most of the 3 million people living here in Arizona, Utah, Colorado and New Mexico depend on irrigated desert lands for their farm income. Water comes from mountains over 14,000 feet high and has to be distributed as carefully and fairly as possible. The region is organized into irrigation districts, groups of ranches who work out their needs together.

"Almost three-quarters of the area is forest and rangeland. In past years, forests were cut off, and the ranges overloaded with cattle. The result has been troublesome to stockmen and also to farmers in the lowlands where silt carried down from the hills is an expensive nuisance. To take better care of ranges, districts have organized.

"Contour farming has become more common here, and valley farmers often run their crop rows cross-wise to the wind to stop erosion. Visitors might like to see the remnants of ancient irrigation works used by the Indians and Spaniards."



Pacific Coast

"Here are a few points of interest for the conservation traveler through Washington, Oregon, Idaho, Nevada and California. One-half of all irrigated U.S.A. lands are in this region and the farmers earn more than one-fifth of the money received by all the Nation's farmers each year. Most agricultural land is located in the great valleys between the mountains.

"Westerly ocean winds drop most of their rain on the thousands of miles of mountains in the coastal ranges. Irrigators apply the run-off to the most valuable citrus fruit and nut orchards, and vegetable gardens, anywhere in the world. In the cooler, northern portions, large acreages are devoted to apples, pears and peaches, also the well-known Idaho potatoes, Oregon seeds and bulbs.

"Two thirds of the area is rangeland for cattle and sheep. Conservationists guard range conditions carefully to prevent over-grazing and erosion. High mountain areas are heavily forested and under public protection and management."



Alaska

"Only one-quarter of Alaska is in the Arctic. Much of it has a climate and growing season as favorable as places in the United States. Winters are milder in the Matanuska Valley, than in the Northern Great Plains. Fishing, mining and the fur trade are Alaska's great riches, but farming has grown by leaps and bounds.

"Alaska, including the Aleutian Islands, is one-fifth the area of the U.S.A. About 40 million acres have been inspected by the Soil Conservation Service. A good variety of field crops thrive on Alaska farms—pasture plants, vegetables, berries and ornamental shrubs—and get the advantage of the 'midnight sun' that shines 24 hours a day in June and July.

"Our soils have to be farmed carefully for best results, and to keep them from breaking down. We have to condition them with soil-building grass and legumes, in rotation and winter cover. We're learning a lot about terraces, contours and diversions, because we realize we have to."



Hawaii

"Most of our soils were made by action of the volcanoes, and growth of coral beds. Unprotected, they wash readily into the sea in our heavy rains. In dry seasons, soil loses moisture rapidly. Plantation owners are doing an excellent job of combating soil and water losses with special methods seen nowhere else. Pineapple companies have developed unique machines that convert stumps into mulch; apply fertilizer and pesticides; and lay strips of tar paper that prevent evaporation—all in one operation.

"Sugar refineries on Oahu and Maui reclaim soil from processed cane, and salvage water for irrigation. Hawaiian stockmen rotate cattle over steep rangeland to prevent erosion. On Molokai, they pipe water to stock tanks in various parts of the range.

"Contour farming is taking hold. Pineapples are grown on contour strips and drained safely with terraces and diversion ditches. Planning them is complicated on account of tricky run-off. We can have 10 inches of rain in one day; then wait 10 months for another drop to fall."



Puerto Rico and the Virgin Islands

"We have many difficulties in conserving soil and water because much of our land is steep and we need every acre to support a large population. Therefore, our people are farming slopes that would not ordinarily be cultivated. But we are able to raise sugar cane, tobacco and fruits.

"Puerto Rico is very mountainous and only 100 miles long. The Virgin Islands are tiny, mountain tops rearing their heads above water, arching out 75 miles to the east and south. Some places 200 inches of rain falls a year; other places are nearly deserts. We grow cane in the lowlands; coffee on deep mountain soils, and use rocky slopes for pastures.

"Our bench terraces are like steps going up the hills. They keep water from tearing away the earth, and force moisture to sink into soil. Where land is gentler, such as on Vieques Island, we use contour farm methods.

"Conservation technicians are showing our farmers how to get three and four crops a year from fields that used to produce just one."

COME AND GET IT

As you work toward achievement in soil and water conservation work, you will need numerous other odd bits of information and help of a specialized nature. Fortunately there is plenty of assistance. The following paragraphs may serve to guide those who want to go farther along this particular trail.

Several Federal agencies and scores of private organizations have programs related directly or indirectly to soil and water conservation. They provide booklets, movies, exhibits and speakers, and are also set up to answer questions. A letter or visit to any one of them would be profitable. Government agencies are listed below. Their headquarters may be addressed as—Washington, D. C.

U. S. OFFICE OF EDUCATION, Federal Security Agency. Write for bulletins and publications.

U. S. DEPARTMENT OF AGRICULTURE. Write to Extension Service, Forest Service, Production and Marketing Administration, or Soil Conservation Service, for bulletins, movies and technical advice regarding land management for soil and water conservation. Locally, get in touch with your Soil Conservation District Supervisors or District Conservationist; County Agent.

U. S. DEPARTMENT OF THE INTERIOR. Get in touch with the Bureau of Land Management, Bureau of Mines, Bureau of Reclamation, Fish and Wildlife Service, or Geological Survey for publications, movies and specific help with soil, water and wildlife conservation problems.

STATE DEPARTMENTS OF EDUCATION, FISH AND GAME, CONSERVATION, FORESTS AND WATERS, PLANNING AND DEVELOPMENT, and similar agencies should be contacted early in your program. They are usually located at your state capital and have local knowledge of your information needs. Many furnish published material, movies, photographs and other aids.

MAPS

Road maps are furnished by many filling stations but their scale is frequently too small for soil and water programming. The Geological Survey, Washington, D. C. furnishes topographic maps. They show land features in contour in large scale, and may be procured from the Survey or from large stationery stores.

TREES AND SEED

Materials for re-forestation and re-grassing are sometimes available through local Soil Conservation Districts, state nurseries and conservation departments.

FISH FOR FARM PONDS

Apply to state fish and game authorities. Stock may come from state or federal fish hatcheries and usually has to be purchased for private waters.

INFORMATION AND EDUCATION

Activities that keep soil and water conservation in the public eye have definite value. The more people understand aims and techniques, the sooner the job will be accomplished. Take reports on your project to the newspaper editor; perhaps he can print a story about it. Banks, libraries and other institutions are usually generous with space for conservation exhibits and displays.

CONSERVATION CAREERS

If you think you'd like to be a conservation specialist, ask your school principal, school guidance officer, or Counselor to check up on the kind of training needed and the colleges that provide it. Have a heart-to-heart talk with a conservationist and get his advice. While you're about it, look into your chances of getting help from scholarships and competitions. Several farm equipment and supply companies and educational foundations are keenly interested in sponsoring promising young people in the conservation field. Don't overlook this opportunity.

A LOOK AT THE FUTURE

There are now over 2 billion human beings living on Earth, including you and me. Every one of us requires a minimum of food nutrients and moisture, just to stay alive; and more than that to be healthy and really enjoy life. Each of us needs at least one to two acres of good soil to supply that food. High-grade acres become fewer with each passing year; yet the number of people continues to increase. It is like sitting in a boat while more and more passengers climb aboard. How long will it be until the decks are awash and we are all forced to swim or sink?

There are those who believe that men of science will save the day, as they have on many occasions past. Certainly they have extended Man's ability to live by the soil. They have developed farming methods, machinery, chemicals, plants and structures that have increased the productivity of earth and water—and the conservation phases of their discoveries are effective in renewing these resources and reducing losses.

Meanwhile, no one can foretell what secrets may be unlocked from the vast unknowns of science or what effect they may have on Earth's capability of sustaining life.

As of now, we know only that Man is a land animal—that there are 17 elements in his body derived from the soil beneath him—that, without them he would die. Therefore, he is presently as dependent upon the land and water, as upon the air he breathes and the sun that warms his blood and lights his days.

And Man is a reasonable creature, in the final analysis, with the ability to appreciate the natural blessings of the Earth, and is willing to serve as its appointed custodian. Most of his kind hold a true affection for lands and waters of their domain, and can find understanding in their hearts for C. W. Gee's Creed of the Soil Conservationist:

Creed of the Soil Conservationist

"As a soil conservationist, I believe God created the earth by His divine processes for the benefit of man, not one man, nor one generation, but mankind for all time.

"I believe the Almighty gave man an inheritance of the earth, not to be hoarded as a miser guards his treasure, but to be used with wisdom and in the fullest for the perpetual benefit of all men.

"I believe all of mankind, regardless of race or creed are entitled to a fair and equitable share of the earth's bounty commensurate with their own efforts. But in so believing, I hold the irrevocable conviction that man himself owes earth a debt of respect and fealty.

"I believe that whatsoever a man soweth, that shall he also reap; that he who manages his fields, pastures, woodlands, and streams with respect and wisdom shall reap the bountiful harvest and so shall his descendants; while he who uses them selfishly, thinking of his own immediate gain, shall bring to grief his land, himself, and his children's children.

"Holding these beliefs to be true I dedicate myself to the task of helping my fellow men realize their own personal responsibility in conserving the earth for the generations which follow them. To this end I shall devote my best knowledge in guiding the efforts of those who till the soil so that the land which nurtures us shall be fruitful without end.

"For truly, the earth is the Lord's and the fullness thereof, but the responsibility for its stewardship is vested in man."

REQUIREMENTS — INDEX

	PAGE		PAGE
1. Determine the depth of topsoil in at least two contrasting areas, such as grazed and ungrazed woods; cultivated fields and fields left in grass, grazed pastures and ungrazed haylots; well-kept lawn and heavily cropped garden; etc.	16	h. Find out what is done with domestic and industrial waste in your community and write at least 500 words on the methods used to prevent pollution and to purify your water supply.	72
2. Plant two bean seeds in a flower pot of topsoil, and two bean seeds in a flower pot of subsoil. Tend them for a month and report on difference in rate of growth in two pots, appearance of plants, and other differences.	18	i. Help to plan, survey, or lay out contour furrows or water spreading dikes on pasture or range land.	68
3. a. Describe the different types, causes and results of soil erosion.	7-11	j. Carry out any other water management project approved by your Counselor or representative of the local Soil Conservation District, National Forest, or Taylor grazing district.	
b. Show snapshots or rough sketches of two examples of erosion in your community.	64-73	9. Do ONE:	
c. Explain what is meant by soil depletion.	29	a. Help carry out a soil conservation project on a farm or Scout camp cooperating with the local soil conservation district.	
4. Explain the meaning of the following terms: (a) contour farming; (b) strip cropping; (c) rotation of crops; (d) terracing; (e) cover crops.	38-43	b. Plant 100 tree or shrub seedlings on school grounds, park, camp, or other eroding area that is unsuited for cultivation, or as a windbreak for buildings or a blowing field.	54
5. On a road map or similar map, point out the watershed area for your community.	44	c. Test the soil, fertilize, and as needed, lime, and plant grass or perennial legumes on $\frac{1}{4}$ acre of lawn, school grounds, camp, or other eroding area that is unsuited for cultivation.	29-37
6. Make a diagram-sketch showing how rain water falling to the ground eventually gets to your kitchen faucet.	45	d. Take an active part in the program for a "Farmer's Field Day," "Face Lifting," or other soil conservation demonstration project.	
7. Explain how man's use of land in the watershed affects your community's water supply.	47	e. Trace a conservation survey map of a local farm or Scout camp and describe the different land classes found on it and tell what each different area should be used for and what conservative measures are needed on it.	20
8. Do ONE:		f. Help survey and lay out a plot of land for terracing, or strip cropping, or contour ploughing.	38-42
a. Help build a stock pond or farm pond.	49	g. Help construct terraces on a field.	42
b. Make a study of plant, animal and fish species in a pond, and if necessary carry out such practices as will increase the fish population.	50	h. Help plan, lay out or construct a grass waterway for a field or other eroding area where a waterway is needed.	73
c. Carry out a bank erosion control or other improvement project on a stream, pond or lake.	68	i. Carry out any other soil conservation project approved by your Counselor or representative of the local Soil Conservation District, National Forest or Taylor grazing district.	
d. Control a gully by building necessary diversion ditches and brush dams or other structures, and planting to grass and shrubs.	67	j. Reseed one acre of pasture or rangeland on which the present grass cover is insufficient to guard the soil against erosion.	73
e. Take an active part in removing the cause of pollution of a stream, pond or lake.	72		
f. Help to plan, survey and lay out a drainage or irrigation system for a field or other area that needs drainage or irrigation.	48, 52		
g. Help build drainage or irrigation ditches on a field.	48, 52		

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