League of Women Voters of Minnesota Records

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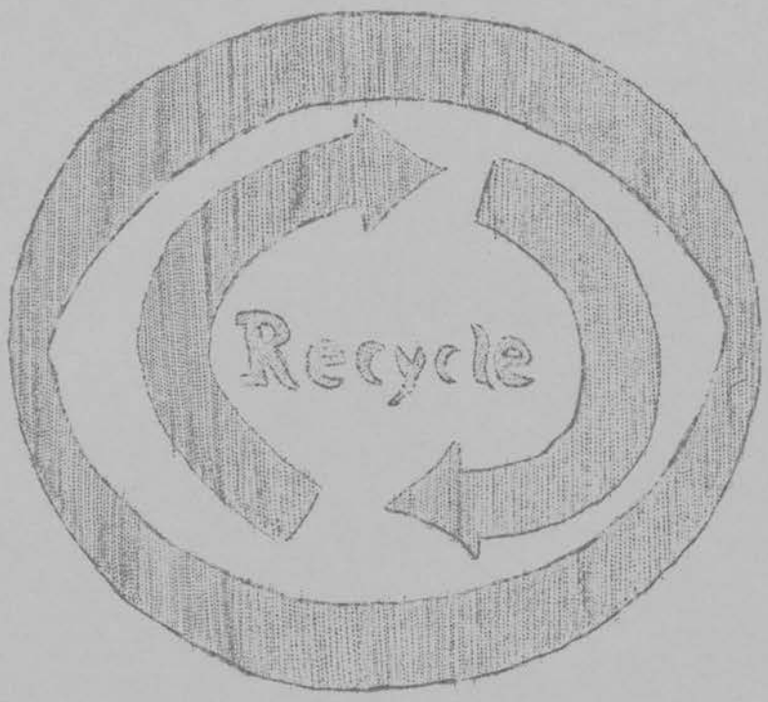
(1960s?)

Give Our Earth A Chance



Help Stop Pollution

START AT HOME

THE LIFE YOU SAVE MIGHT BE YOUR CHILD'S

DO YOU WANT TO SAVE YOUR ENVIRONMENT?

START AT HOME!

What to do?

1. Check your soaps and detergents for phosphates and nitrates.
   (See list on other side)
2. Avoid purchasing overpackaged products
3. Be aware of electricity uses. Shut off unused lights.
4. Beward of automobile pollution.
   a. Don't use it unless absolutely necessary.
   b. Keep it tuned up. A poorly tuned car makes more pollution.
   c. Make sure a new car has pollution control equipment.
5. Stop smoking! Don't pollute your friends as well as yourself!
6. Avoid using pesticides.
   a. Don't spray shrubbery for bugs.
   b. Tell your neighbors that some of the bad pesticides are still on the market.
7. Don't use herbicides.
8. Build martin houses to attract martins. Do you know that a martin can eat a thousand bugs in a very short time?
9. Don't overdo fertilizers. Fertilizers run off lawns, into the gutters, and down the storm sewers into the lakes.
10. Save your cans and non-returnable bottles to be taken to a collection area, where they will be processed to be sent to a recycling center.
    a. Save different kinds of metal separately. Cut aluminum tops from beverage cans, and save separately from the iron sides and bottom.
    b. Glass will be crushed at the processing center.
    c. This is a non-profit project, and your contribution to the saving of our natural resources.
11. Let your lawn go natural. Don't use weed killers on them - they just might also kill our birds. Prepare your lawn for periods of dry weather by the kind of grass you plant, because the day of rationing water for sprinkling are not too far away.
12. Keep your pesticides and poisons and medicines that you want to get rid of, out of the water systems. Don't flush them down your toilet or sink.
13. Save your money and the environment by using non-disposable dishes, napkins, towels, handkerchiefs, etc.
14. Remember that garbage disposalls add nutrients to your water system.
15. Make a compost pile of your garbage and leaves. Return them to <u>your</u> soil!
16. If your toilet overflushes, put a brick in your flush tank. This would be equal of a saving of 30,000 gallons of water each day in a town of 10,000.

ABOVE ALL, BE RESPONSIVE TO THE NEEDS OF YOUR AREA, AND WRITE YOUR LEGISLATORS, BOTH STATE AND NATIONAL, REGARDING YOUR IDEAS ON POLLUTION CONTROL. LET THEM KNOW!!!! MAKE THEM FEEL!!!! SHOW YOU CARE!!!! LET THEM KNOW!!!!! MAKE TH

NATURAL BEAUTY IS PRICELESS!

ACCEPT INCREASED COSTS IN BEHALF OF POLLUTION CONTROL!

USE IT UP----------WEAR IT OUT----------MAKE IT DO----------OR DO WITHOUT!!!!!!!

HOW MUCH PHOSPHATE?

Even so simple a matter as listing detergents according to their phosphate cont ent raises confusing questions. A high phosphate detergent whose label calls for only ¼ cup per wash load could well be less polluting than a low phosphate detergent that calls for a cup per load. For instance, ¼ c. of a 40% phosphate detergent would pollute less than 1 c. of a 20% phosphate detergent. Therefore, the following list includes both the % phosphate and the recommended amount of detergent to be used per wash load. This list will change as the companies change their products to reduce phosphates. This list was published by The Minneapolis Tribune on Sept. 6, 1970, and is the latest official listing available. In making available these listings to the public, the Department of Interior said they were not asking housewives to boycott high phosphate detergents.

LAUNDRY DETERGENT	% PHOSPHATE (STPP)	RECOMMENDED AMOUNT PER WASH LOAD
SALVO	56.6%	2 tablets
TIDE	49.8%	1½c.
Amway SA8	49.3%	(recently announced as reduced)
DRIVE	47.4%	1¼ c.
OXYDOL	46.6%	1¼ c.
BOLD	45.4%	1¼ c.
COLD WATER ALL (powder)	45.4%	1¼ c.
Ajax Laundry	44.6%	1¼ c.
COLD POWER	44.6%	1¼ c.
Punch	44.2%	no amount given
DREFT	41.9%	1½ C.
RINSO w/chlorine bleach	41.0%	1¼ c.
GAIN	39.5%	1¼ c.
DUZ	38.3%	1½ c.
Breeze	37.2%	2 c.
CHEER	36.3%	1¼ c.
FAB	34.8%	1½ c.
Wisk liquid	14.2%	½ c.

The following are all below 10% phosphate:

PAR PLUS	BASIC L	NO-PHOS
ADDIT LIQUID	BASIC I	THE UNPOLLUTER
IVORY LIQUID	AMWAY LOC	ECOLO-G
NEW AMWAY SA8	LUX LIQUID	RED OWL LAUNDRY DETERGENT
BASIC H	COLD WATER ALL LIQUID	SEARS ENZYME LAUNDRY DETER.

Some of the above, however, may cause irritation to the skin, such as Ecolo-g which was recalled by the Food and Drug Administration to put this on the label. Therefore, it would be a good idea to read the label.

Generally, presoaks are extremely high in phosphates, as are most of the electric dishwasher detergents. Electrosol and Basic D are the lowest of the latter. Household cleaners for general use with low phosphates are pinesol, and Basic I with less than 1%, Whistle with 3.1%, Mr. Clean with 27.0% and Ajax All Purpose with 28.%. All dish washing liquids that are used without automatic dishwashers are extremely low in phosphates.

Each person must decide which product to use, because the hardness of the water might make a difference. Some of the products do not need as much as the manufacturer recommends: for instance, Cheer recommends on its package to use 1½ c., but a person with complete soft water systems could only use about ¼ cup without clogging up her washing machine. Therefore, in that case Cheer would pollute 1/6th less with the use of soft water.

EACH OF US MUST THINK AS WE PLAN OUR GOALS, HOW MUCH TO POLLUTE, HOW SPARKLING CLEAN MUST OUR WASHING BE, AND MAKE OUR DECISION IN FAVOR OF THE ENVIRONMENT!

PREPARED AND DISTRIBUTED BY GIRL SCOUT CADET TROOP #255, BEMIDJI

WHAT CAN YOU DO AT HOME TO HELP STOP POLLUTION?

Every year Americans junk 20 million tons of paper! These are made of trees. You wouldn't be in Minnesota if you didn't like trees! Where will the paper come from thirty years from now - without re-use - when 30-35 million tons of trees will be needed for the paper industry? Aside from their beauty, trees do change carbon dioxide to oxygen through photosynthesis - thus building our oxygen supply! So, avoid excess use of paper. It will decompose, but it takes 25 to 100 years to grow a tree!

Plastics are even worse! They neither decay nor decompose! They are made of valuable non-renewable natural resources!

SO WHAT DO YOU DO?

1. Use cloth napkins and rags for cleaning, the detergent used in washing them will probably cause less pollution than the solid wastes.
2. Use washable dishes and utensils, instead of paper and plastic.
3. Recycle paper - a problem just now, but hopefully only temporary.
4. Use washable regrigerator containers for products to be saved. Do not use throwaway plastic bags. Use waxed paper whenever possible, when wrapping food. Aluminum foil is not pure aluminum, and is not recyclable as yet.
5. Use cloth diapers. Not washing may save water and detergent use, but disposable diapers help increase the mountains of waste solids.
6. Use returnable glass milk bottles instead of buying in plastic containers.
7. Complain about excess packaging to every merchant or grocer. Excess packaging causes excess waste - even though it might cut down on shop-lifting! (It also often causes frustrations and irritations when you try to open it at home!)

RE-USE OR RECYCLE OTHER THINGS!

With only 6% of the world's population, Americans use 50% of the world's products. That is partially why population growth is so important (or rather its control) in the United States.

1. Buy returnable bottles AND RETURN THEM!!! Non-returnable glass takes a lot of space in a solid waste landfill area!
2. If you cannot get returnable bottles, buy aluminum cans which can be re-cycled more easily. Those that are all-aluminum are preferable. These are distinguished by the fact they have no seams in the sides. They may be rinsed, the tops and bottoms cut out, flattened, and then sent or taken to a recycling center. Other soda and beer containers with seams are with aluminum tops and steel sides and bottoms. The top should be removed and stored with aluminum, and the sides and bottoms (cut out and flattened) and stored with other "tin" cans, such as those used for canned vegetables and fruits. These should all be washed out, the paper removed and flattened and taken to recycling center.
3. Outgrown clothing should be taken to a used clothing agency. All other clothing should be worn out and then taken to recycling center. Don't let the style-changers bother you!
4. Support laws that encourage companies to recycle.
5. Save items such as "good" cardboard, plastic meat trays, old magazines, old jewelry, etc. for Day Care Centers, Schools for the Mentally Retarded, Senior Citizen Clubs who can use these items for money-making and learning projects.
6. BE INFORMED!! READ LABELS WHEN SHOPPING!! KNOW WHAT YOU ARE BUYING!!
7. BE WILLING TO PAY HIGHER PRICES FOR PRODUCTS MADE BY NON_POLLUTING COMPANIES!!
8. DON"T TOLERATE SUB-STANDARD, UNSAFE, OR MIS-ADVERTISED PRODUCTS.
9. WRITE LETTERS, to companies to complain or compliment! Send these letters as well, to Major Appliance Consumer Action Panel, 20 N. Wacker Dr., Chicago, Ill. 60606, and the American Retail Federation, 1616 H. St. N.W., Washington, 20006, who will help you get action!!!

Prepared by the Environmental Awareness Committee, Mrs. Wm. Britton, Chairman
Bemidji, Mn. 56601

WHO IS RESPONSIBLE FOR THE POLLUTION OF THE ENVIRONMENT?
WHERE MUST THE FINAL DECISIONS BE MADE?
WILL JUST CLEANING UP THE MESS TAKE CARE OF THE PROBLEM?

UNFORTUNATELY, THE ANSWER LIES ONLY IN THE CONTROLLING OF THE INCREASE OF

NUMBERS OF PEOPLE - THAT IS, POPULATION CONTROL!!!

As the cartoonist so aptly put it in the comic strip, "B.C.", when one prehistoric man tells his friend to stop littering when he throws away a bone, he finishes by saying, "Just think how many bones there would be on the earth if everyone threw away his bones after eating?" His friend thinks a while and says, "Uh, nine?" Just as such a comic is funny in terms of the period in which it is written, it has a deeper meaning for today in terms of increasing numbers of people and the trash they toss away.

ALL OTHER METHODS AND MEANS OF POLLUTION CONTROL CAN ONLY BE TEMPORARY UNTIL POPULATION INCREASES ARE CONTROLLED.

THIS MUST BE THROUGH INTERNATIONAL COOPERATION.

THE UNITED NATIONS IS EQUIPPED TO PROMOTE THIS KIND OF KNOWLEDGE!!

PEOPLE MUST BE INFORMED!!! PEOPLE IN AMERICA, AND PEOPLE AROUND THE WORLD.

WHAT ARE THE ALTERNATIVES?

1. Famine
2. Disease
3. War (people who live too close together have a tendency to fight, especiallly if they are hungry111)
4. Genetic manipulation - (It has been proved that genetic change by the scientist is now possible. Are we going to wait to do something about the use of this knowledge before a Huxley's Brave New World, or an Orwellian 1984 becomes a fact? Do we want to remain a people free to make choices, perhaps choices forced upon us by the times, but at least our own choices, or become a people who are robots with no opportunity to dream great dreams?

In thirty years, the world's population will double. In light of this, all production must double. Twice as much food, clothing, housing, buildings for education and industry, water to drink (and the basic amount of water is stable), use of natural resources, disposal of all wastes air, liquid and solid, doubled power needs - and even more as electric power extends to other areas of the world - double the doctors, hospitals, and nurses. Where can this be put? Where will the food be grown?

THESE ARE NOT FANTASIES!!!!

THESE ARE THE FACTS!!!!

Of all species of animals on earth, only Man has the capacity and intelligence to prevent his own death, thus unbalancing Earth's natural life system. Only Man has the medical and technical know-how to save himself from natural death.

All mankind suffered in compassion for the 500,000 Pakinstani who were killed in the 1971 floods. Only a few realized that within a few hours enough children were born to double that number in population.

OUR IDEAS ABOUT IDEALS AND PROLIFERATIO N OF THE EARTH MUST CHANGE - AND RAPIDLY! WE MUST MAKE CHOICES AND DECISIONS IF WE ARE TO KEEP OUR EARTH! WE MUST

BE WILLING TO CHANGE OUR LIFE STYLES! WE MUST BE WILLING TO DO MANY THINGS IN A MANNER DIRECTLY OPPOSITE TO OUR TRADITIONS.

1. Stop squandering the treasures of the earth.
2. Stop thinking that man's supremity will automatically save him from ultimate destruction.

NEIGHBORS MUST BE WILLING TO COOPERATE AND PERHAPS EVEN SHARE LAND WHICH THEY OWN TO WORK FOR THE COMMON GOOD.

CITIES MUST WORK TOGETHER.

COUNTIES MUST WORK TOGETHER FOR THE COMMON GOOD.

STATES MUST WORK TOGETHER FOR THE COMMON GOOD.

INDIVIDUALS MUST FORGET THEMSELVES IN ORDER TO HELP OTHERS AND THUS SAVE THEIR OWN INVESTMENTS.

What good is it for an individual to live by a lake which is being polluted by his neighbor's and his own sewage, when a third neighbor who lives higher above the lake has an area that could be used to handle the drainage from all three homes and save the lake? People are not naturally that generous, but this must be a very necessary change!

WE MUST STOP READING THE NINTH AMENDMENT TO THE CONSTITUTION OF THE UNITED STATES AS SAYING

THAT ALL RIGHTS NOT SPECIFICALLY GIVEN TO THE GOVERNMENT BY THE CONSTITUTION ARE OURS.

WE MUST REMEMBER THAT THE CONSTITUTION ALSO STATES THAT NO CITIZEN MAY INFRINGE ON THE RIGHTS OF OTHER CITIZENS!

BE AWARE OF THE PROBLEMS. BEGIN TO LIVE A LIFE-STYLE THAT WILL HELP.

GO ONE STEP FURTHER!!! IF YOU CAN SEE YOUR NEIGHBOR HAS A PROBLEM (such as the one described above, offer to help him through the use of your land!) THAT ONLY YOU CAN HELP SOLVE, OFFER! SHOW PEOPLE THAT YOU TRUST THEM! YOU CAN BE FRIENDS EVEN THOUGH YOU MIGHT DISAGREE. PROBLEMS OF THE WORLD ARE MUCH LARGER THAN THE PROBLEMS OF INDIVIDUALS!!

THE ULTIMATE STATE OF THE WORLD LIES UPON THE EDUCATION OF EACH PERSON IN OUR COMMUNITY, COUNTY, STATE, NATION AND THE WORLD. THE ONLY WAY TO ACHIEVE RESPONSIBLE ACTION IS TO BE INFORMED, TO INFORM OTHERS, AND TO ACT ON YOUR INFORMATION. BE SURE YOUR INFORMATION IS ACCURATE!!!

Prepared and distributed by the Environmental Awareness Committee, Bemidji, Mn.
Mrs. William Britton, Chairman

BE A THOUGHTFUL HOUSEKEEPER

1. Don't let the water run indefinitely while brushing your teeth, washing your hair, washing dishes, etc.
2. If your toilet overflushes, put a brick in the tank so that it will use less water. A town of 10,000 people could save 30,000 gallons of water per day!!
3. Cut down shower time and/or tub-baths with the tub completely full of water. Even in this land of sky-blue water, water is at a premium. Bemidji, for instance, has seven deep wells for its water system. Even without the entire city on this system, all the pumps work 24 hours a day to supply water. In an emergency, there would be no reserve!

   Country-wide, under-ground water levels of pure water are diminishing, and there is no reason to believe that the new water entering these reservoirs is safe. In coastal areas, sea water is seeping into the emptying underground water reservoirs. Although the population increases, the basic amount of water remains the same, whether polluted or unpolluted!!!
4. Avoid food waste. Prepare enough just for one meal, or save leftovers and use immediately.
5. Baking soda and a non-chemical scouring pad are good cleaning agents.
6. Front loading washers use less detergent. So do suds-savers on washers.
7. Avoid aerosol containers. They not only pollute the air, they are hard to junk.
8. Don't use the toilet as a "trash" basket. Save your sewage treatment plant and yourself on costs for plumbing repairs. If you have a septic tank, fewer solids will collect.
9. Be sure your furnace is adjusted to burn the fuel completely. Be sure there is enough oxygen available for complete burning.
10. Use latex or water-based paints. Solvent-based paints contribute hydrocarbons to the smog.
11. Use wood in your fireplace - not coal. Be sure of a proper draft.
12. Don't use trash, leaves or garbage as fuel in your fireplace! Save trash and garbage for garden compost. (See page on gardening.)
13. Cut down on electricity. Power plants cause pollution. Turn out unused lights Avoid over-use of your air-conditioner. Don't use frivolous electric appliances. (Do you <u>really</u> need an electric toothbrush?)
14. Stop washday pollution. Shortly after WW II, hard detergents were the "savior" of the laundry room. Then came the sudsy foam into the waterways! A law was passed forbidding their use. Phosphate detergents and enzymes replaced them. The increased phosphates caused a tremendous increase in algal growth and many lakes and streams began to die off. Detergents cause 40-70% of the phosphate in the effluent from a sewage disposal plant. WHAT TO DO???
    a. Stop using pre-soaks which are even higher than detergents in phosphates.
    b. Find a low-phosphate detergent to use. (I find that running my clothes through the wash cycle twice before rinsing will make them **cleaner!**)
    c. Insist that the Federal Trade Commission require the listing of all ingredients on containers - not only on detergents, but all products! With allergies on the increase, it would be well to know the common names of some of the chemicals in "synthetic" products, like milk and cream substitutes. (Some of them have coconut oil in them, but the listing of chemicals does not show this. If you were allergic to coconut oil, it might save your life!!!)
    d. Don't use commercial, packaged water softeners.
    e. See back page of "START AT HOME" sheet, for listings of detergents, the % phosphate and the amount to use.
15. When clothing is too bedraggled for wearing, cut out the good parts, especially of wash and wear clothing to make pillow covers, or quilts, etc. Senior citizens groups might like some of these materials.

Prepared by the Environmental Awareness Committee, Mrs. Wm. Britton, Chairman
Bemidji, Mn. 56601

BE A THOUGHTFUL BUYER!!!

1. Don't use colored toilet tissue. The dyes do not decompose very readily. Many people say don't use any colored paper. Locally, we believe that the biodegradability of facial tissue, paper toweling, napkins, etc., is a moot question because they should be placed in solid wastes and not down the sewer. - Besides - all other products should be re-usable cloth!
2. To reiterate - buy returnable bottles.
3. Buy juices in concentrated form. Add the water at home. Save metal and paper.
4. Buy fewer pre-packaged foods, or as few as possible.
5. Tell store manager about over-packaged products, and why they should not be marketed by him.
6. Boycott products and services that are not working actively to cut down on pollution - and write letters to those that do -- but know your facts before you write; make sure that those considered to be polluters are <u>not</u> in the process of correcting their problem. Even though there have been laws on water pollution for 15 years, until recently there has not been enough public pressure to enforce them. Now some companies are really cooperating as soon as they get the technical knowledge. EACH PLANT USUALLY MUST TAKE A DIFFERENT POLLUTION CONTROL DEVICE, AND THEREFORE IT DOES TAKE TIME TO DESIGN CONTROLS THAT WILL BE ADEQUATE.
7. Teach your children to be thoughtful buyers. Show them that you care about the future of their environment!
8. BE INFORMED!!! Read labels carefully. Find out what preservatives and additives may be doing to your health. Nature gave us a wonderful body, but it can take only so much abuse.
9. Promote the boycotting of products that are manufactured to wear out before it is necessary, or are manufactured with the idea of style-change to make them out of date. For instance, light bulbs are no longer a long lasting product. They have a life of about three months. Some brands on the market will last longer.
10. Carry your own mesh shopping bag.
11. Try to do your purchasing for a week at one time, so that only one trip to the store must be made by auto. Automobiles pollute, too.
12. Buy shampoos, kitchen liquid soaps, lotions, etc., in glass bottles to recycle.
13. Avoid aerosol containers. They not only pollute the air, they are also hard to recycle.
14. Avoid buying household pesticides and garden pesticides that contain chlorinated hydrocarbons, such as, DDT, DDD, Aldrin, Chlordane, Dieldrin, Endrin, Heptachlor, Benzenehexachloride (BHC), Lindane, Toxaphene, Methoxychlor, as well as the herbicides such as: 2,4,D; 2,4,5,T; 2,4,5,TP; Malathion; Parathion; Sevin; Vapona; Amitrole; Dalapon; Dicamba; Diphenamid; Simazine; and Trifluralin.
    a. Look for the Dept. of Agriculture (USDA) registration number.
    b. Look for warning labels, such as, "POISON," "DANGER", "WARNING," "CAUTION," or skull and crossbones.
    c. Sort out the advertising claims from the warnings. Usually the claims are in large print, while the warnings are given in small type.
15. Don't buy that which you do not need, or will not expect to use in some way.
16. Don't throw away something that someone else might be able to use. Instead, either sell at a garage sale, or give to an organization that will repair and sell or repair and give away to someone who can use it.

DON'T BE A SUCKER FOR THE SOFT SELL. BE PREPARED TO KNOW WHETHER THE PRODUCT IS GOOD, OR WHETHER YOU REALLY NEED IT. IF YOU CAN DO WITHOUT, THE CHANCES ARE THAT IT WOULDN'T BE A GOOD BUY!

Prepared by the Environmental Awareness Committee, Mrs. Wm. Britton, Chairman,
Bemidji, Mn. 56601

WHAT YOU CAN DO IN YOUR GARDEN

Gardens are good for your disposition. They also return oxygen to the air. We can learn, once again, to garden with organic compounds, not chemicals. An organic gardener has a knowledge of how to place plants so that one plant might chase out an insect that might be a pest to another.

1. Place varieties of plants in your garden. Different plants encourage different pests and some are predatory to the others.
2. Don't try to grow plants not acclimated to your environment.
3. Use organic fertilizers (compost, cow manure, fish emulsion, etc.) but don't overfeed. Healthy plants can resist disease better than weak ones.
4. Water your garden only when needed but don't waste the water.
5. Used coffee grounds and tea leaves help condition the soil by retaining the water in sandy soil and by lightening the texture of heavy clay soil.
6. Cottonseed meal and bonemeal are good nitrogen sources! (Has anyone tried high phosphate content detergent as a garden fertilizer? It's not organic but it might be one way to dispose of any excess lying around the house.)
7. Bury your ½ gallon and gallon plastic containers - well-rinsed, of course, (bleach, liquid detergent, etc.) around a new planting after cutting several holes in the side of the bottle toward the planting. Fill with water and save on continuous watering.
8. Build your own compost heap. (See separate sheet)
9. Try non-poisonous insect control first. (See separate sheet)
   a. If you must, use a natural pesticide.
   b. Avoid synthethic pesticides.
   c. Don't use chlorinated hydrocarbons (listed in IV)
   d. Don't dispose of any of the above that you might have on hand by flushing down the toilet or pouring on the ground. They will eventually reach the waterways and poison!
10. Do not use products containing lead, mercury or arsenic. They are poison!
11. Support laws to ban sale and use of hard pesticides.
12. If you must spray, be extremely careful!!!
   a. Don't use a hose attachment spray. Too much is used in too little space.
   b. Study active ingredients on the label.
   c. Use too little spray, rather than too much.
   d. Clean all utensils used for measuring spray as well as the spraying equipment. Store in a safe place away from children and pets. Do not return any measuring equipment to the kitchen!!!!!
   e. Use a mask and spray when there is no wind so that the spray will not be blown from the area where it is needed.
13. When buying seeds, reject those that have been treated with pesticides, such as a fungicide.
14. Use a hand mower. Gas and electric ones pollute the air. Hand mowers give excellent exercise.
15. Don't put garden trash into plastic bags. The bags will prevent the organic material from decaying as rapidly as it should and will not allow it to return to the soil.
15. Talk to your neighbors about pollution and its control, not only by industry but by individual.
16. BE INFORMED. KNOW WHICH PLANTS WILL HELP CONTROL WHICH PESTS. PLAN YOUR GARDEN CAREFULLY SO THAT THE PLANTS WILL WORK TOGETHER TO DEFEND EACH OTHER AGAINST DESTROYERS.

Prepared by the Environmental Awareness Committee, Mrs. Wm. Britton, Chairman
Bemidji, Mn. 56601

HOW TO BUILD A COMPOST HEAP.

A well-constructed compost is a gardener's treasure. Leaves, twigs, trash can work for you in your garden. Make them into compost. It will help your garden grow! It lightens the soil, absorbs water, and adds food to your soil. How do you build one? First, select a place about 4 by 4 feet that will be fairly permanent. Then do the following:

1. Put anything on the pile that was once living material - weeds, hedge clippings, sawdust, coffee grounds, tea leaves, dead plants, pet deposics, fishbones, etc., but not other bones or meat scraps. Add a little lime or fertilizer, cover with a layer of manure and then with a layer of soil, and then soak it well. Turn about once a week, keeping it about as wet as a squeezed sponge. A few earthworms in it will help with the decomposition. It should be ready to use in about 12 weeks to 12 months, depending on outside temperature, and how wet it is kept.
2. Make the pile square or rectangular and in a place that is shielded from your home and your neighbor's home.
3. There should be drainage at the bottom of the pile, so that too much water will drain off.
4. Build two compost pits so that you can use the material from one, while the other is working.
5. Don't put any plants into the compost heap that look diseased or blighted.
6. A small compost bin may be made from an old garbage can with the bottom rusted out. Poke a few holes in its sides to allow for aeration.
7. When needed, and when ready, spade into the garden area for a better ground for working. A ton of compost - the amount that could be put into a 4 by 4 by 4 foot cube can save dollars and improve your garden.
8. To improve the nutrient value of your compost heap, add cottonseed meal and/or bonemeal. Wood ashes from your fireplace contain needed potassium.
9. Adding a little acid phosphate occasionally to help keep down the odor.

HOW TO CONTROL INSECTS WITHOUT CHEMICALS.

1. Water-blast aphids, leafhoppers, and spittle bugs off your plants. Do each day.
2. Buy ladybugs and lacewing larvae for aphids; praying mantis for aphids, whiteflies, spidermites; (check local botanist for local directions)
3. Use dormant oil spray on all deciduous trees except apricot. It smothers insects, eggs and larvae. Follow the exact proportions on the label.
4. Build martin houses, and provide for homes for tree swallows and barn swallows. They eat their weight - plus, in mosquitoes, and other small flying insects. Drain any dormant water, or spray with kerosene, if it is not a part of a water system.
5. Put stale beer in a shallow dish to attract slugs and snails during the night. In the morning, put them in a used coffee can, put the plastic lid on tight and place in the trash.
6. Plant garlic and chives around the rose bushes to ward off aphids.
7. Marigolds within a 3-foot radius of plants susceptible to nematodes will reduce their occurrance. Insects don't like the smell of marigolds either.
8. Encourage lizards, toads, snakes to live in your garden. They eat a lot of insects. They may be encouraged to stay by the placing of boards in the garden.
9. Basil, mint, rosemary, sage, savory and thyme are insect repelling plants.
10. Keep seed and water in your garden for birds in all seasons.
11. Don't try for completely perfect fruit and vegetables.
12. Pull or hoe weeds. Do not use a herbicide.
13. If an insecticide or herbicide is a must, consult your county agent for the name of a natural one.

Prepared by the Environmental Awareness Committee, Mrs. Wm. Britton, Chairman
Bemidji, Mn. 56601

BE A THOUGHTFUL CITIZEN

Be aware of the water that is used in your home. How much does it take to flush the toilet? How much water does it take to provide you with your daily newspaper? How much water does it take to make an automobile? - or a ton of steel? - or a pound of plastic?

How much water is there in the United States? An average of 30 inches rainfall. Subtract 1.2 trillion gallons from the 5 trillion gallons of rain for evaporation and transpiration losses. Divide by 200 million people and each person will have 6,000 gallons of water per day. Where does it go? You drink a half-gallon. The food you eat costs water to produce - in the neighborhood of 200 or 300 gallons. A daily ration of meat of 9.4 ounces adds about 1400 gallons to the total. Residential use calls for about 100 gallons of pure water per day. Industrial waste creates a load. Sewage creates a load, Livestock feedlots create a load. Thermal power plants now use about 1/10th of the average U.S. runoff, reducing the capacity of water to assimilate other wastes. Pesticides, acid mine drainage, oil spills, agricultural fertilizer runoff, and natural leaching of salts from soil adds to the burden of your 6,000 gallons of water. Other creatures must use it. BE AWARE OF HOW THE WATER IN YOUR COMMUNITY IS USED.

Promote recycling in your household. Much of this is covered in the pages on WHAT TO DO AT HOME, BE A THOUGHTFUL HOUSEKEEPER, BE A THOUGHTFUL BUYER, AND HOW TO CONTROL INSECTS WITHOUT CHEMICALS. In addition, take an inventory of what comes into your house. How many things are not essential or go through essentially unchanged or unused? How many disposable items do you use? The disposable world is closer than you may think. BUT WE DON'T HAVE TO LIVE IN THIS WASTEFUL WAY. CUT DOWN ON YOUR OWN USE OF DISPOSABLES.

Do something to stop junk mail. Send back the junk mail in a fresh envelope, postage due. Complain to the Post Office on the grounds that junk mail is "ecologically obscene". Collect a weeks junk mail and send it to your Congressman with an accompanying letter demanding an end to it. On first class mail where return postage is guaranteed, write "refused" and sign your name. Demand an end to the selling of mailing lists.

Carry a litter bag to dispose of your litter and encourage your friends to pick up their litter. Encourage libraries to have environmental displays and to buy books on ecology for children as well as adults.

Be willing to buy second-hand items. Fix broken toys, lamps, clocks, etc., instead of buying new ones.

Establish direct communication with other groups interested in conservation. Promote cooperation - the more people you have, the more influential you are.

Try to muffle household noises: power tools, motor bikes, snowmobiles, radios, stereos. Think of your neighbor and the hour when you use them. Noise pollution is increasing and people are losing their hearing at an earlier age. Loud noises can increase body tension, which affects blood pressure, heart, and nerves.

Start a tree-planting campaign. Trees return oxygen to the air.

Get together for a clean-up campaign in your neighborhood. Finish the day with a potluck supper, and a program put on by the youngsters. Make some friends at the same time, and have some fun!

Prepared by the Environmental Awareness Committee, Mrs. Wm. Britton, Chairman
Bemidji, Mn. 56601

BE A THOUGHTFUL USER OF THE AUTOMOBILE

The automobile produces 60 to 80% of the air pollutants in the United States.

THEREFORE: DON"T

1. Ride when you can walk or bicycle.
2. Ride alone when you can share.
3. Let your car idle excessively.

DO

1. Be aware that the automobile is destroying our communities, our land, our atmosphere, our very lives.
   a. 60,000 people die annually in automobile accidents.
   b. 170,000 more are permanently maimed.
   c. $3\frac{1}{4}$ million more are injured.
   d. Exhaust fumes enhance the chances of contracting respiratory diseases.
   e. Many trees and food plants are killed by auto pollutants.
   f. Buildings are damaged by auto fumes, as well as sulfur dioxide from stationary heating units.
   g. Extra paving for more highways permanently disrupt the ground water system.
   h. Noise from superhighways is deafening.
2. Promote the use of public transit.
   a. Know the ratio of pollution per person for each type of transit service.
      (1) Train would rank lowest at 12 grams of pollutant per 100 passenger miles. (in CO) emissions)
      (2) Bus would rate second at 27 grams
      (3) Jet airplane third at 160 grams
      (4) Automobile highest at 2,666 grams per 100 passenger miles.
   b. Know that each type emits different kinds of pollutants - some more damaging than others.
   c. Consider placing a tax on autos entering a city that are not filled with passengers.

3. Be aware of the fact that choices will <u>have</u> to be made.
   a. Are we willing to give up our special privileges of driving any place at any time in order to save our atmosphere so that we can actually breathe.
4. Get in the habit of environmental awareness
5. Be willing to change your life style to allow more time to get to your destination.
6. Be willing to put up with inconvenience.
7. Talk it up! If enough people change, the impact will be felt.
8. Buy unleaded gasoline when possible.
   a. Lead is a poison and can do you or your environment no good.
9. Keep your auto well-tuned. No emission control device can work adequately in a poorly running engine.
10. Agitate for laws requiring information to be <u>offered</u> to the buyer by the seller without his having to demand it.
    a. Ask your auto dealer, service garage or auto parts store for the particulars on pollution control systems.
11. Keep open to new ideas for automotive power other than internal combustion.
12. Know that the smaller car pollutes less.
13. Most cars have more power than they need.
14. Support the use of gasoline taxes for highway beautification, rapid transit, and pollution control research as well as improved highways.
15. Support a "JUNK CAR" collection tax.

Read "The User's Guide to the Protection of the Environment", Paul Swatek, Ballantine Press, $1.25 p. 245 ff. (Available Bookcraft, Bemidji,).

Prepared by the Environmental Awareness Committee, Mrs. Wm. Britton, Chairman
Bemidji, Minnesota 56601

HELP KEEP YOUR PART OF AMERICA BEAUTIFUL

1. Complain to advertisers and stores about their unsightly use of billboards. Write to your legislators about them.
2. Become acquainted with community ordinances and codes on pollution control, building quality, zoning beautification standards.
3. Encourage your community to set apart small nature preserves - places to communicate with nature; also neighborhood parks, green belts, regional parks.
4. Find out whether your community has programs for landscaping of highways, roadsides and shopping centers.
5. Identify blighted areas in your community - stream, lake, or junkyard - and begin bothering people responsible. Publicity is very effective - your local newspaper might do a feature series.
6. Encourage local businesses to plant and landscape their property.
7. When hiking, don't break branches or pick flowers and don't allow your children to do it either. Be satisfied to look, not destroy.
8. Get your neighbors involved.

START A COMMUNITY PROJECT

1. Form an environmental committee to study and then act on local environmental problems.
2. Join organizations where you feel you would be most effective in promoting your social and political concerns - League of Women Voters, PTA, Home-Owners Association, political parties, etc. Promote the environmental problem to these groups and get them to take action.
3. Encourage Boy Scouts and Girl Scouts to collect aluminum can, rags, bottles, glass, etc. as money-raising projects.
4. Present ecology displays in shopping centers, banks, etc.
5. Organize a collection of discard items such as egg cartons, plastic meat trays, spools, lumber scraps, greeting cards, cardboard, etc. to be given to such groups as Day Care Centers, Head-Start, and Senior Citizens.
6. Organize a clean-up to be conducted on a regular basis.
7. Encourage highway scenic improvement by cities and individuals.
   a. Could flowers be planted along the highways that are typical to your area, for instance, Illinois used to plant hibiscus along the highways to break the monotony of corn and soybean fields.
8. Encourage the city to make bright, attractive litter containers to be placed in various stations throughout the downtown area. Urge artist groups to keep them painted attractively.
9. Establish direct communication with other groups such as Isaak Walton League, that are interested in conservation. Promote conservation with your neighbors, co-workers, clubs, etc. Promote cooperation between the groups, the more people you have, the more influential you are.

Read, "Our Mistreated World, Case Histories of Man's Pillaging of Nature, " published by Dow-Jones Books, Princeton, New Jersey.

Prepared by the Environmental Awareness Committee, Mrs. Wm. Britton, Chairman
Bemidji, Minnesota, 56601

BE A THOUGHTFUL BOATER and SHORELAND OWNER

Boats now afloat discharge sewage equivalent to a city of 500,000 people.

1. Avoid excessive use of out-board motors.
   a. Approximately 2 gallons out of every 10 that are used in an out-board motor, goes into the lake without being burned.
   b. Exhaust fumes entering the water also cause pollution.
2. Keep the motor well-tuned, so that it will pollute as little as possible.
3. Buy an electric out-board motor.
4. Seriously consider buying a canoe.
   a. Added advantage of supreme quiet and the knowledge that the water is not being polluted.
5. Be sure that your large boat has a chemical toilet with a holding tank.
   a. Use a marina for cleaning it.
   b. Don't throw wastes overboard, especially pop bottles or beer cans or the tabs from the cans.
6. Support conservation practices and laws that will provide positive action for shoreline development. Make sure laws that <u>need funding</u>, <u>get funding</u>. Laws that cannot be enforced without funding, are just pieces of paper.
7. Study shoreline statutes that restrict the use of shoreline in your area.
   a. Make others aware of the restrictions.
   b. Make others aware of why there must be restrictions.
   c. Learn some of the ways to correct poor shoreland development and educate the people in your areas as to ways and means of accomplishing this.
   d. Show how several homeowners can work together to build an adequate septic tank and drainage field to protect lake or stream waters. (Additional information may be obtained from your County Agent.)
9. Listen to the opposition and face them with facts.

BECOME ACTIVE IN GOVERNMENT IN YOUR CITY, TOWNSHIP, COUNTY. <u>YOU ARE THE GOVERNMENT</u>! <u>ONLY YOU</u> CAN BE SURE THAT SOMETHING IS DONE. You can't depend on anyone else!!!!!!!

Be informed. Make sure that the information you have is correct. Present facts concisely. Pre-sent the alternatives to inaction succinctly. Present pollution control information through the various kinds of mass media, such as radio and TV.

GET TH E GRASS ROOTS AROUSED!!!

Prepared by the Environmental Awareness Committee, Mrs. Wm. Britton, Chairman
Bemidji, Mn. 56601

(COMMITTEE PRINT NO. 14)

COMMITTEE ON INTERIOR AND INSULAR AFFAIRS

House of Representatives

November 22, 1963.

THE LAND AND WATER CONSERVATION ACT OF 1963
(H.R. 3846)

OUTLINE OF MAJOR PROVISIONS

I. The Land and Water Conservation Fund

A Land and Water Conservation Fund is created from which appropriations will be made for the two purposes hereafter outlined. The life of the fund is limited to 25 years. Normally 60 percent of the appropriations will be for State purposes and 40 percent for Federal purposes, but these percentages may be varied in the annual appropriation acts. They may also be varied, in the absence of a contrary provision in the annual appropriation acts, by the President during the first 5 years of the program, but this variance may not exceed 15 points.

II. State Grants

MATCHING FUNDS

Appropriations from the Land and Water Conservation Fund for grants to the States will be available for three types of outdoor recreation projects:

(1) Statewide comprehensive planning
(2) Land acquisition
(3) Development.

Not more than 50 percent of the cost of any State project may be borne by the United States. In order to qualify, acquisition and development projects must be in accord with a comprehensive plan submitted by the applicant State and approved by the Secretary of the Interior. Funds may be transferred by a State to its political subdivisions for their projects if the latter are in accord with the State's approved plan, but the State must underwrite its political subdivisions' share of the costs. In most States emphasis during the first few years of the program will be on planning projects. As comprehensive planning is completed, land acquisition projects will take first place in importance.

AMOUNTS AVAILABLE

The amounts actually available for State assistance will depend on appropriations. It is estimated that the three principal sources of income to the Land and Water Conservation Fund (see Item IV of this outline), after the Fund is fully underway, will be sufficient to support appropriations for State purposes of $90 million annually.

ALLOTMENT OF FUNDS AMONG STATES

Two-fifths of all funds made available for State use will be allotted among the 50 States equally. The remaining three-fifths will be allotted on the basis of the States' needs, primary attention being given to their population, use of their outdoor recreation facilities by residents of other States, and the extent of Federal outdoor recreation programs within the State. Funds from the two-fifths apportionment which remain unused for 3 years will then become available for allotment under the three-fifths rule. No State may receive more than 7 percent of the total allotment to all States in any given year.

NONDUPLICATION OF FEDERAL SOURCES

A State may not receive assistance for the same project both from the Land and Water Conservation Fund and from another Federal source and may not receive assistance from the Land and Water Conservation Fund for the purchase of land from the Federal Government which is being sold to it for less than fair market value.

ACCOUNTING REQUIREMENTS

States are required to keep proper financial records of moneys received from the Land and Water Conservation Fund and to allow audit of their records by the General Accounting Office and the Secretary of the Interior. Diversion of property acquired and developed with Federal assistance for outdoor recreation purposes is forbidden except with proper permission and upon substitution of equivalent property for the same purpose.

III. Federal Outdoor Recreation Facilities

LAND ACQUISITION

Appropriations from the Land and Water Conservation Fund will also be available for land acquisition in connection with certain types of Federal projects:

(1) Units of the National Park System
(2) Authorized Federal outdoor recreation areas
(3) Wilderness, wild, and canoe areas of the National Forest System and other areas within that system which are primarily of value for outdoor recreation
(4) Authorized threatened fish and wildlife species areas
(5) Recreation land incident to Federal fish and wildlife areas.

No land may be acquired by a Federal agency with Land and Water Conservation Fund money unless the acquisition is otherwise authorized by law.

RESERVOIR PROJECTS

A portion of appropriations from the Fund will be paid into miscellaneous receipts of the Treasury as a partial offset for nonreimbursable allocations to recreation and to fish and wildlife enhancement made in connection with Federal water development projects.

ALLOTMENT OF FEDERAL FUNDS

Unless otherwise provided in the annual appropriation acts, allotments of appropriations among the various Federal purposes will be made in proportion to the number of paid visits to the various areas for which admission fees are charged.

IV. Sources of Revenue for Land and Water Conservation Fund

Funds will flow into the Land and Water Conservation Fund from three principal sources:

(1) Admission and user fees prescribed for certain Federal areas
(2) Net proceeds from the sale of Federal surplus real property
(3) Proceeds from Federal taxes on motorboat fuels.

Authority is also given for advance appropriations to the Fund for a period of 8 years. If made, the advance appropriations will be reimbursable from other sources of revenue to the Fund.

V. Admission and User Fees

GENERAL

Provision is made for the designation of federally administered areas at which admission and user fees will be charged and for prescribing such fees. The areas for which admission fees may be charged are those which are "administered primarily for scenic, scientific, historical, cultural, recreational or wildnerness purposes" and at which "recreational facilities or services are provided at Federal expense."

TYPES OF ADMISSION AND USER FEES

Two types of admission fee are provided for in H.R. 3846:

(1) A voluntary annual automobile sticker type of fee (maximum, $7 per year) which will admit to all areas covered by the fee system except those specifically excluded from its coverage
(2) Fees for individual or short-term visits payable by those who do not wish to purchase automobile stickers, by those who enter areas otherwise than by private noncommercial vehicles, and by those who enter areas not covered by the automobile sticker.

Provision is also made for fees for the use of certain types of recreational areas and services.

PROHIBITED FEES

Fees are not chargeable under H.R. 3846 for:

(1) Admission to areas not administered by a Federal agency
(2) Admission to areas at which the Federal Government does not provide recreational facilities or services
(3) Admission to areas for nonrecreational purposes
(4) Travel by noncommercial vehicles on national parkways or on primary, secondary, or interstate highways within areas otherwise covered
(5) Nonrecreational use of the waters of units of a Federal navigation system
(6) Use of roads by private noncommercial vehicle by persons owning property within a designated area.

If more than 50 percent of the land within an area has been donated to the United States by a State, notice that it is proposed to charge admission fees must be given to the Governor of the State concerned and his views must be taken into account before such fees are imposed. Consideration must also be given to all obligations of the United States, legal or otherwise, to the State concerned.

VI. Motorboat Fuel Taxes

H.R. 3846 does not impose any new taxes. It provides, however, that the taxes paid on gasoline and special motor fuels used in motorboats shall be covered into the Land and Water Conservation Fund. This does not affect present provisions of law permitting the purchaser to claim a refund of certain of these taxes.

VII. Surplus Property Sales

Net proceeds from the sale of Federal surplus real property and related personal property will be covered into the Land and Water Conservation Fund. H.R. 3846 does not affect existing provisions of law for transfer of property between Federal agencies and giving certain classes of non-Federal purchasers (hospitals, municipalities, etc.) rights to purchase at reduced prices.

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MULTIPLE-PURPOSE WATERSHED PROJECTS

Under Public Law 566

- LAND TREATMENT
- FLOOD PREVENTION
- AGRICULTURAL WATER MANAGEMENT
- MUNICIPAL AND INDUSTRIAL WATER SUPPLY
- RECREATION
- FISH AND WILDLIFE
- RURAL AREAS DEVELOPMENT

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service

PA–575
May 1963

Issued May 1963. Supersedes PA–392 "Small Watershed Projects Under the Watershed Protection and Flood Prevention Act."

MULTIPLE-PURPOSE WATERSHED PROJECTS

Under Public Law 566

By Watershed Planning Division, Soil Conservation Service

Experience in hundreds of localities demonstrates that multiple-purpose small watershed projects are an effective means for rural and urban communities to deal with land use and water problems.

Since 1954, when the Watershed Protection and Flood Prevention Act (Public Law 566) was enacted, many rural and urban communities have shown that they can halt unchecked soil erosion and excessive water runoff on rural land, stop destructive floods, improve drainage conditions on land in agricultural production, provide for more efficient irrigation, supply water for growing municipal needs, attract new industries, enhance fish and wildlife resources, and provide developments for recreation.

Small watershed projects have come to mean protecting, managing, improving, and developing the water and related land resources of a watershed up to 250,000 acres in size through a project-type undertaking.

- A project is planned and carried out jointly by local, State, and Federal agencies with the full understanding and support of a large majority of the landowners and citizens of the community.
- It can include many purposes: Flood prevention; agricultural water management; municipal and industrial water supply, both for present and future use; recreation and fish and wildlife development.
- It is based on (1) local initiative and responsibility, (2) Federal technical, cost-sharing, and credit assistance, and (3) State review and approval of local proposals and opportunity for State financial and other assistance.
- It is a combination of soil and water conservation measures on farm and ranch land, other rural land, and public land (land treatment) and structural measures (dams, levees, channels).
- It bridges the resource-development gap between the soil and water conservation work of indi-

vidual landowners and large Federal and State public-works projects for water resource development in major river valleys.

The U.S. Department of Agriculture's Soil Conservation Service (SCS) has the primary responsibility for carrying out the small watershed program.

Facts about multiple-purpose watershed projects—how they get started; how they are constructed, financed, operated, and maintained; what the Federal Government does; and what the local people do—are on the following pages.

GETTING STARTED

An application for Federal help in developing and carrying out a watershed project can be submitted by any local organization having authority for such activities under State law. The law requires that the project be limited to a watershed area no larger than 250,000 acres.

State agencies and qualified local organizations can *sponsor* or *cosponsor* an application. They include soil and water conservation districts; municipalities; counties; watershed, flood-control, conservancy, drainage, irrigation, or other special-purpose districts; and irrigation and reservoir companies, water users' associations, or similar organizations not operated for profit. Other organizations can *endorse* project applications.

The application includes (1) facts about the size and location of the watershed, (2) description of the land and water problems, (3) details about the work needed, and (4) information about the sponsoring organizations and their source of funds.

Application forms can be obtained from the State agency designated to approve applications for assistance (see list, p. 13), or from the Soil Conservation Service. Completed applications are sent to the designated State agency.

Technical specialists of the Soil Conservation Service, Forest Service, Fish and Wildlife Service, and other agencies may make a field examination of the watershed in company with representatives of the local organizations prior to approval of the application.

If the State agency disapproves the application, there is no further action. If it approves, it sends the application to the SCS State Conservationist. If he determines that it is legally valid, he sends it to the Washington office of the SCS. Receipt of the application is acknowledged by the Administrator of SCS. Further action is dependent upon the availability of planning help and the priority recommendations of the State agency.

When the SCS is able to furnish planning assistance, the State agency is requested to consider all unserviced applications in the State and to recommend those next in line for help. Each State agency has established criteria that must be met before an application is awarded a high priority rating. If an application meets the following conditions, it will satisfy the criteria of most States:

1. Sponsoring local organizations have the legal authority and will use it to meet their commitments for carrying out and maintaining the project.

2. Help is desired to achieve full multiple-purpose development of the water and related land resources of the watershed.

3. Material progress has been or is being made in applying soil and water conservation measures on individual farms and ranches.

4. The proposed project will benefit a substantial number of people.

5. Interest in and understanding and support of the project is prevalent throughout the watershed.

Certain States, however, may have special criteria. By working closely with their State agency, local organizations can find out what they must do to obtain a high priority rating.

When the State agency gives an application a high priority rating, the SCS conducts a preliminary investigation of the watershed to determine the physical and economic feasibility of developing a plan to meet the objectives of the sponsoring local organizations. If its findings are unfavorable, no further action is taken.

If favorable, the SCS State Conservationist prepares a work outline for planning the watershed. Sixty days prior to the time he will be able to furnish planning assistance, he requests the SCS Administrator to authorize such help. Ordinarily, planning help is authorized for a number of watersheds at 45-day intervals. Upon authorization, the SCS State Conservationist will make help available to start preparing a watershed work plan.

MAKING THE WORK PLAN

An SCS watershed planning staff composed of engineers, hydrologists, geologists, economists, and other needed specialists is assigned to work with the local SCS representative to help the sponsoring organization develop a watershed work plan. The Forest Service also assists. The Farmers Home Administration works with the local organization when it wishes to obtain a watershed loan. The Fish and Wildlife Service makes studies relating to the impact of the proposed project on fish and wildlife resources. The Bureau of Outdoor Recreation may help in connection with recreation developments. Other Federal and State agencies

are notified by the SCS of initiation of the studies and are invited to participate.

Findings are reviewed with the local organizations at progressive stages of planning. Then a draft plan is prepared that sets forth (1) the proposed land and water resource protection and development measures, (2) the cost of the proposed measures, (3) the benefits, and (4) the cost-sharing and other arrangements for installing and maintaining the measures in the plan.

What the Plan Can Include

Land Treatment

Land-treatment measures are basic to any watershed project. Structural measures cannot be fully effective unless these soil and water conservation measures are applied on individual farms and ranches, other rural land, and the public land of the watershed.

For this reason, either the law or Department of Agriculture policy requires as a condition to providing assistance for structural measures that:

1. One-half of the land above floodwater retarding dams and retention reservoirs *must* be under basic conservation plans.

2. Not less than 75 percent of the effective land-treatment measures must be installed or their installation provided for on those sediment-source areas that are a serious hazard to the design, operation, or maintenance of any structural measure.

3. Installation is assured of on-farm practices needed to realize benefits from any structural measure for drainage or irrigation.

The basic conservation plans are the same kind that farmers and ranchers make with technical help through soil and water conservation districts.

Flood Prevention

Flood prevention measures in watershed projects include land-stabilization measures to prevent the destruction of land and thereby to reduce the movement of damaging amounts of sediment to stream channels and lower land. Large gullies and severely eroding land may be brought under control with vegetation or structures. Road banks and fills may be protected. Waterways crossing two or more farms may be improved by shaping and planting. Trees and other vegetation needed to keep the soil tied down may be protected from fire.

Flood prevention also includes waterflow and sediment control to prevent flood damage to groups of landowners, communities, and the general public.

When exceptionally heavy rainstorms sweep across a watershed, runoff may be great even from conservation-treated farm and ranch land. This is especially true if the soil is already saturated or is frozen. The damage from this surplus water can be controlled by dams to retard floodwater; stream-channel clearing, straightening, and enlarging; levees and dikes; desilting basins; floodways; floodwater diversions; and special water-holding or water-diverting terraces and dikes.

Structures for flood prevention are located and planned to—

1. Protect the largest possible area of land subject to flooding.

2. Encroach as little as possible on highly productive land.

3. Provide enough protection to land now subject to overflow so that owners can make full and continuous agricultural use of it, although they may have occasional damage from major storms.

4. Provide greater protection from major storms where human life or high nonfarm investments are subject to flood hazards.

Agricultural Water Management

Agricultural water-management measures that can be included in watershed projects are those for (1) irrigation, (2) drainage, and (3) supply and distribution of water for other agricultural uses.

The irrigation measures may include water-supply reservoirs, diversion dams, pumping plants, sluiceways, canal headworks, canal laterals, and main distribution pipelines to carry water to the farm boundary. They also may include lining canals and sealing storage reservoirs, and measures needed to conserve and use water supplies efficiently and to carry water to individual farms with the least practical loss.

The drainage measures must provide for more efficient land use on existing farms and ranches. Present drainage systems may be improved. Or new drainage systems may be provided for areas now used for crops or grazing. The measures include all parts of a group drainage system, such as open ditch or tile, drops, checks, flumes, control gates, manholes, and pumping plants.

Drainage or irrigation of land not previously or currently used for agricultural production must be incidental to, not a primary purpose of, the measures for which help is provided.

Help may be given to provide a more uniform supply and distribution of water for agricultural use to two or more landowners if the measures are part of the watershed plan. These measures will be designed to make annual streamflow more stable, to increase the recharge of ground-water reservoirs, to distribute on a community-wide basis water for livestock and other agricultural purposes.

Public Recreation Development

Developments that create or improve facilities for the enjoyment of outdoor recreation based on the use of or proximity to water in reservoirs, lakes, natural streams, or along shorelines may be included in watershed projects. Such recreation uses include fishing, hunting, swimming, boating, water skiing, picnicking, camping, and related activities.

A watershed recreational development can include (1) a single reservoir, a single lake, a single reach of shoreline, or a well-defined reach of a single perennial stream (but not the entire stream system of the watershed); (2) land required for public access and public use; and (3) minimum basic facilities such as roads and trails, parking lots, public water supply, sanitary facilities, power facilities, beach development, boat docks and ramps, plantings and other shoreline or area improvements, and picnic tables and fireplaces.

Public Fish and Wildlife Development

Water-based developments to improve the fish and wildlife habitat can also be included in watershed projects. These may involve added storage capacity in reservoirs to regulate streamflow, modification of reservoir structures for releasing cold water, stream-channel improvement, and marshes and pits to provide breeding and nesting areas for migratory waterfowl and aquatic mammals.

Municipal or Industrial Water Supply

Developments to supply water for municipal or industrial use can be included in watershed projects. Storage capacity in reservoirs may be planned for present or future use. Pipelines conveying water from a reservoir or stream to a filter plant or distribution system may be included.

Other Measures

Watershed projects occasionally include other nonagricultural water-management measures such as storage in reservoirs for pollution abatement by streamflow regulation or saline-water-intrusion control.

WORK PLAN APPROVAL

The draft work plan (p. 14) is reviewed by the SCS Engineering and Watershed Planning Unit and the SCS Washington office. When it is approved, the sponsoring local organizations and SCS jointly conduct an informal field review with representatives of the field offices of interested Federal and State agencies. The final plan is then prepared and signed by all the sponsoring local organizations.

If the plan does not include any single structure exceeding 2,500 acre-feet of capacity and does not involve a Federal contribution to construction costs in excess of $250,000, the SCS State Conservationist approves the plan for the SCS. If funds are available, the Federal assistance proposed may be furnished immediately.

If, however, the plan contains provisions that exceed either of the above limitations, it must be submitted to the SCS Washington office for the following action:

1. Submittal to the Governor of the State and to the U.S. Department of the Army, Department of the Interior, and Department of Health, Education, and Welfare, for review and comment during a 30-day review period.

2. Approval of the SCS Administrator.

3. Transmittal to the Bureau of the Budget by the Secretary of Agriculture.

4. Transmittal to the Congress by the Bureau of the Budget.

5. Approval by the Committee on Agriculture and Forestry of the U.S. Senate and by the Committee on Agriculture of the House of Representatives or by the Committees on Public Works in both the Senate and House of Representatives. These committees may hold hearings on the plan and may request testimony from representatives of the local organizations.

6. Authorization by the SCS Administrator to furnish the Federal assistance specified in the plan when funds are available.

FINANCING THE PROJECT

The SCS Administrator allocates funds for watershed projects from money appropriated each year by the Congress. Priority is given to the allocation of funds for technical assistance and engineering services. Funds for construction are allocated according to the readiness of local organizations to contract for construction.

Cost Sharing

Non-Federal Costs

Non-Federal costs include:

1. Installing land treatment measures on non-Federal land.

2. Acquiring all land rights except for public recreation or fish and wildlife development. These costs include removal, relocation, or replacement of bridges, roads, pipelines, buidings, fences or wells, whether done by the local organization or by the owners.

3. At least 50 percent of acquiring land rights for public recreation or fish and wildlife development.

4. Acquiring water rights.

5. Administering contracts on non-Federal land.

6. All construction not allocated to (a) flood prevention (b) agricultural water management, and (c) public recreation or fish and wildlife development.

7. At least 50 percent of construction allocated to (a) agricultural water management, and (b) public recreation or fish and wildlife development.

8. Engineering and other installation services not allocated to (a) flood prevention, (b) agricultural water management, and (c) public recreation or fish and wildlife development.

9. At least 50 percent of the engineering and other installation services required for minimum basic facilities for public recreation or for fish and wildlife development.

10. Operating and maintaining works of improvement on non-Federal land.

11. An equitable share of operating and maintaining works of improvement on Federal land in consideration of the benefits that accrue to non-Federal land.

Federal Costs

The Federal Government pays the following costs:

1. Technical assistance for planning and applying land treatment measures on non-Federal land.

2. A part of the cost, not to exceed the rate provided under other agricultural programs, for certain land-treatment measures when specifically authorized by the SCS Administrator.

3. Installation of land-treatment measures on Federal land.

4. All construction allocated to flood prevention.

5. Engineering and other services (including engineering services associated with the administration of contracts) allocated to (a) flood prevention, (b) agricultural water management, and (c) public recreation or fish and wildlife development.

6. Not more than 50 percent of the construction allocated to (a) agricultural water management, and (b) public recreation or fish and wildlife development.

7. Not more than 50 percent of the engineering and other installation services required for minimum basic facilities for public recreation or fish and wildlife development.

8. Not more than 50 percent of land rights required for public recreation or fish and wildlife development.

9. Administering contracts on Federal land when awarded by a Federal agency for works of improvement for flood prevention.

Recreation Development Limitations

Recreation developments eligible for cost sharing must be open to the public. They are limited to one in a project of less than 75,000 acres, to two in a project of 75,000 to 150,000 acres, and to three in a project larger than 150,000 acres.

Advances

After a work plan is approved, the SCS may "advance" funds to the sponsoring organizations to preserve sites for future construction. Such advances must be repaid with interest before construction. They will be processed by FHA, obligated and disbursed by SCS, and repaid to FHA.

The SCS may also advance funds to develop water supply for future municipal or industrial use up to 30 percent of the cost of any multiple-purpose reservoir. Repayment may be deferred up to 10 years without interest. Local organizations must furnish assurance that such water supply will be used and must agree to a schedule of repayment before construction.

Loans

To help the local organization pay its share of the project cost the Farmers Home Administration may make loans to the sponsoring local organization. A maximum loan of $5 million may be made to one project for a period up to 50 years at the Federal long-term borrowing rate.

CARRYING OUT THE PROJECT

There's a job for everyone in carrying out a watershed project—the sponsoring local organizations; individual landowners; citizens of the community; local, State, and Federal agencies; and community public and private organizations and groups.

Responsibilities of the Local Organizations

The major responsibilities of the local organizations are to:

1. Acquire land, easements, and rights-of-way needed for structures or other improvements on private land. The local organization may acquire them by purchase or gift. Included are removal, relocation, or replacement of bridges, roads, railroads, pipelines, buildings, fences, or wells, whether done by the local organization or by the owners.

2. Construct, or let contracts for construction, on private property.

The local organization and the SCS enter into an agreement covering each contract for construction (or for land rights for recreation or fish and wildlife development). This agreement is the basis for obligating Federal funds.

3. Obtain agreements from farmers and ranchers to plan and apply soil and water conservation measures and provide assurance of the application of a high percentage of these land-treatment measures.

4. Comply with State laws governing watershed improvements, water rights, or specifications for structures.

Information and Education

To carry out the project, all people in the watershed must be fully informed about what is being done and why and what each group's responsibilities are. This calls for a continuing program of information and education.

Technical Assistance for Land Treatment

The Soil Conservation Service gives technical assistance to landowners who plan and apply soil and water conservation measures on their farms and ranches or other rural land. Landowners receive this assistance through soil and water conservation districts. Additional technical assistance may be given from funds appropriated under Public Law 566 only as they are required to complete land-treatment measures within the agreed-upon period for project installation.

SCS technical assistance includes:

1. Making a soil survey from which the land can be classified according to its capability for use and needs for treatment.

2. Helping landowners to plan the use and treatment of their land in accordance with this classification.

3. Aiding landowners to plan and apply soil and water conservation practices such as:

- Terraces, dams, diversions, waterways, contour farming, strip-cropping, and the growing of green-manure cover crops and other vegetation needed to protect the soil from wind and water erosion and to restore, improve, and maintain soil productivity.
- Irrigation, chiseling, subsoiling and pitting, contour furrowing, water spreading, drainage, wells, ponds, and other improvements to provide and conserve water for crops, livestock, fish and wildlife, and forage production.
- Stocking rates, reseeding, erosion control, and other practices necessary to restore and improve range and permanent pastures not in national forests or managed in conjunction with national forests.
- Woodland-conservation practices that can be applied with general technical help.

The Forest Service provides the specialized technical assistance that landowners need to apply the more difficult forestry practices. This assistance usually will be made available through the State forestry agency. It includes forest protection, distribution of planting stock, and other specialized technical aid in forest management.

The Forest Service gives necessary technical help with conservation measures needed to restore or improve privately owned rangeland within national forests. The Forest Service also gives this assistance on rangeland adjoining national forests and administered in conjunction with the forests under formal agreement with the owners or lessees.

Engineering Help With Structures

The local organization has the option of using non-Federal professional engineers or Soil Conservation Service engineers.

If the local organization requests, SCS can provide the engineering services for structural measures. These services include surveys, site investigations, layout, design, preparation of specifications, and supervision of construction of structures.

If the local organization uses non-Federal engineers satisfactory to SCS, it may be reimbursed by SCS for the cost allocated to flood prevention, agricultural water management, and recreation or fish and wildlife development. SCS may require the local organization to provide or employ professional engineers for municipal or industrial water-supply development.

Other Available Help

In addition to assistance under Public Law 566, aid is available from other Federal, Federal-State, and State programs dealing with land, water, plants, recreation, and fish and wildlife.

The Soil Conservation Service uses, and encourages other agencies to use, all help available under other Federal legislation to speed the completion of watershed projects.

This help includes—

1. Educational assistance from the cooperative Federal-State Extension Service.

2. Agricultural Conservation Program cost sharing.

3. Credit from the Farmers Home Administration.

4. Farm-forestry assistance under the Cooperative Forest Management Act.

5. Protection of forest areas from fire, insects, and diseases under cooperative programs authorized by the Clarke-McNary Act, Forest Pest Control Act, and White Pine Blister Rust Protection Act.

6. Cost sharing under the Great Plains Conservation Program (Public Law 1021).

7. Assistance in recreation and fish and wildlife development from the Fish and Wildlife Service, the Bureau of Outdoor Recreation, and State recreation and fish and game agencies.

8. Technical, cost-sharing, and credit assistance from the U.S. Department of Agriculture authorized by the Agricultural Act of 1962 for income-producing recreation developments on rural land, the Cropland Retirement Program, Resource Conservation and Development projects, and the Rural Renewal Program.

9. Protection and treatment of Federal land in the watershed by land-managing agencies.

10. Collection of basic data by research agencies.

Public Land Improvements

The agency administering Federal land within the watershed is responsible for installing on this land the land-treatment and structural measures provided for in the watershed plan.

The State is responsible for structures and other improvements that may be needed on State-owned land within the watershed.

MAINTAINING THE PROJECT

Sponsoring local organizations are responsible for operating and maintaining all structures and developments on private land. A written agreement on maintenance is required before Federal funds are made available for any part of the construction cost.

Structures and soil and water conservation measures on Federal land are maintained by the agency administering the land.

Soil and water conservation measures on individual farms and ranches or other rural land are maintained by the owners and operators under agreements with their local soil and water conservation district. If the watershed is outside a soil and water conservation district, the local organization must make maintenance arrangements satisfactory to SCS for fulfilling this responsibility.

Recreation Fees

The local organization may charge fees for public recreation provided such fees do not produce revenues in excess of the local organization's requirements to amortize its initial investment and provide adequate operation and maintenance.

The local organization is required to establish a schedule of maximum admission or use fees that may be charged by private concessionaires.

State Agencies Designated To Approve Applications for Assistance Under Public Law 566

ALABAMA	State Soil Conservation Committee
ALASKA	The Governor
ARIZONA	The Governor
ARKANSAS	State Geological and Conservation Commission
CALIFORNIA	State Soil Conservation Commission
COLORADO	State Soil Conservation Board
CONNECTICUT	State Soil Conservation Advisory Committee
DELAWARE	The Governor
FLORIDA	State Soil Conservation Board
GEORGIA	State Soil and Water Conservation Committee
HAWAII	The Board of Land and Natural Resources
IDAHO	State Department of Reclamation
ILLINOIS	The Governor
INDIANA	State Flood Control and Water Resources Commission
IOWA	State Soil Conservation Committee
KANSAS	Watershed Review Committee
KENTUCKY	Division of Flood Control and Water Usage
LOUISIANA	State Soil Conservation Committee
MAINE	State Soil Conservation Committee
MARYLAND	State Soil Conservation Committee
MASSACHUSETTS	Water Resources Commission
MICHIGAN	State Soil Conservation Committee
MINNESOTA	State Soil Conservation Committee
MISSISSIPPI	State Soil Conservation Committee
MISSOURI	The Governor
MONTANA	State Soil Conservation Committee
NEBRASKA	State Soil and Water Conservation Commission
NEVADA	State Department of Conservation and Natural Resources
NEW HAMPSHIRE	State Soil Conservation Committee
NEW JERSEY	State Department of Conservation and Economic Development
NEW MEXICO	State Engineer
NEW YORK	Water Resources Commission
NORTH CAROLINA	State Soil and Water Conservation Committee
NORTH DAKOTA	State Soil Conservation Committee
OHIO	State Department of Natural Resources
OKLAHOMA	State Soil Conservation Board
OREGON	State Engineer
PENNSYLVANIA	State Soil Conservation Commission
RHODE ISLAND	State Development Council
SOUTH CAROLINA	State Department of Agriculture
SOUTH DAKOTA	State Water Resources Commission
TENNESSEE	State Soil Conservation Committee
TEXAS	State Soil Conservation Board
UTAH	State Department of Agriculture
VERMONT	State Water Resources Department
VIRGINIA	State Soil Conservation Committee
WASHINGTON	State Department of Conservation
WEST VIRGINIA	State Soil Conservation Committee
WISCONSIN	State Soil Conservation Committee
WYOMING	State Soil and Water Conservation Committee
PUERTO RICO	Commonwealth Department of Agriculture

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STATE OF MINNESOTA
WATER POLLUTION CONTROL COMMISSION

A

Proposal For

CLASSIFICATION AND STANDARDS FOR THE MINNESOTA RIVER AND TRIBUTARY WATERS FROM CARVER RAPIDS TO THE OUTLET OF REILLY CREEK AND GRASS LAKE BELOW SHAKOPEE

The classification for use and the standards of quality and purity as hereinafter set forth are hereby adopted and established for that portion of the Minnesota River from below the Carver Rapids, approximately at the eastward extension of the Carver Village south boundary lying between sections 30 and 31, Louisville Township, Scott County, to immediately below the outlet of Reilly (Terrell) Creek and Grass Lake below Shakopee, approximately at the northward extension of the boundary between sections 4 and 5, Eagle Creek Township, Scott County, and waters tributary thereto except Reilly (Terrell), Bluff, Chaska (East), Chaska (West), Spring, Carver, and Sand Creeks and waters tributary thereto.

Section 1. Classification for Use

(a) The present or potential primary uses of the waters requiring maintenance of water quality in accordance with the standards hereinafter prescribed are fishing, recreational boating, esthetic enjoyment, irrigation, stock watering, wildlife, and disposal of treated sewage and waste effluents.

(b) The waters also may be used for navigation or general industrial purposes or any other beneficial uses for which the waters may be suitable.

Section 2 Related Conditions

The waters are suitable for the aforesaid primary uses and for maintenance of game fish of species commonly inhabiting waters of the vicinity under natural conditions, but not as a source of drinking water or special quality industrial process water, or for bathing or swimming, subject to such restrictions on any such uses which involve close, frequent, or prolonged contact with the water as may be necessary for protection of public health.

Section 3. Standards

(a) No untreated sewage shall be discharged into the waters. No treated sewage, industrial waste, or other wastes containing viable pathogenic organisms, shall be discharged into the waters without effective disinfection. Effective disinfection of any discharges, including combined flows of sewage and storm water may be required to protect the aforesaid uses of the waters. Effective disinfection is defined herein as a process which will provide disinfection equivalent to that provided by chlorination of a treated sewage effluent to maintain a chlorine residual of at least 0.5 mg/l after a chlorine contact period of at least 15 minutes.

(b) Existing discharges of untreated sewage, and untreated industrial waste or other wastes, shall be abated or treated and controlled so as to comply with these standards.

(c) No treated sewage, and no industrial waste or other wastes shall be discharged into the waters so as to cause any nuisance conditions, such as the presence of floating solids, scum, oil slicks, suspended solids, material discoloration, obnoxious odors, visible gassing, sludge deposits, slimes or fungus growths, or other offensive effects.

(d) No treated sewage, and no industrial wastes or other wastes shall be discharged into the waters so as to cause any material increase in constituents or characteristics which may impair the quality of the water so as to render it objectionable or unsuitable for fish or wildlife or as a source of water for general industrial use or agricultural purposes, including irrigation.

(e) The discharge of oxygen demanding sewage or waste effluents shall be restricted so that after reasonable opportunity for mixing and dilution thereof with the receiving waters the dissolved oxygen content of such waters will be maintained at not less than 4 milligrams per liter during April and May, based on the monthly average flow which is exceeded by 90 per cent of the monthly flows of record for the month of April or May, whichever is lower, and so that a level of not less than 3 milligrams per liter will be maintained during August and February, based on the minimum daily flow which is exceeded by 90 per cent of the minimum daily flows of record for the month of August or February, whichever is lower.

(f) In addition to the aforesaid requirements, the highest levels of dissolved oxygen which are attainable by continuous operation of all the units of the treatment works discharging into this reach of the river at their maximum capability consistent with practical limitations of such works shall be maintained in the waters, in order to improve conditions for fish and for other uses of the waters.

(g) The discharge of industrial waste or other wastes shall be controlled so that the heat content of such discharges, after reasonable opportunity for mixing and dilution thereof with the receiving waters, does not raise the temperature of such waters above 93° F, based on the average natural water temperature in the month of August and the August monthly average flow which is exceeded by 90 per cent of the monthly average flows of record for August.

(h) The discharge of treated sewage, industrial wastes, or other wastes shall be restricted so that, on the basis of the monthly average flow specified in paragraph (e), the limits hereinafter specified will not be exceeded in the waters by reason of such discharges, after reasonable opportunity for mixing and dilution:

Ammonia	2 milligrams per liter (as Nitrogen)
Chlorides	50 milligrams per liter (as Chloride ion)
Chromium	1 milligram per liter (as Chromium)
Copper	0.2 milligram per liter (as Copper)
Cyanides	0.02 milligram per liter (as Cyanide ion)
Oil	10 milligrams per liter
pH range	6.0 - 9.5

Phenolic materials	0.01 milligram per liter (as Phenol)
Radioactive materials	Not to exceed the lowest concentrations permitted to be discharged to an uncontrolled environment as prescribed by the appropriate federal authority or by the State Board of Health.

(i) Means for expediting mixing and dispersion of sewage, industrial waste, or other wastes in the receiving waters shall be provided so far as practicable whenever deemed necessary by the Commission to maintain the quality of the receiving waters in accordance with applicable standards.

(j) Liquid substances which could constitute a pollution hazard shall be stored in accordance with Regulation WPCC 4. Other wastes as defined by law or other substances which could constitute a pollution hazard shall not be deposited in any manner such that the same may be likely to gain entry into these waters in excess of or contrary to the standards herein adopted, or cause pollution as defined by law.

(k) No treated sewage, and no industrial waste or other wastes, shall be discharged into the waters in such quantity or in such manner alone or in combination with other substances as to cause pollution thereof as defined by law.

(l) In any case where, upon application of the responsible person or persons, the Commission finds after a hearing thereon that by reason of exceptional circumstances the strict enforcement of a provision of these standards would cause undue hardship and would be unreasonable, that disposal of the sewage, industrial waste, or other wastes involved is necessary for public health, safety, and welfare, and that no means for such disposal in strict conformity with the standards is reasonably available, the Commission, in its discretion, may permit a variance therefrom upon such conditions as it may prescribe for prevention, control, or abatement of pollution and in harmony with the general purpose and intent of the standards.

Adopted _____

STATE OF MINNESOTA
WATER POLLUTION CONTROL COMMISSION

Proposal for

CLASSIFICATION AND STANDARDS FOR NINE MILE CREEK AND THE CREDIT RIVER AND TRIBUTARY WATERS

The classification for use and the standards of quality and purity as hereinafter set forth are hereby adopted and established for the waters of the Nine Mile Creek and the Credit River and waters tributary thereto in Hennepin, Dakota, and Scott Counties, from the source to the junction with the Minnesota River in sections 27, 28, and 29 in Bloomington, Hennepin County, and in section 31, Savage, Scott County, respectively.

Section 1. Classification for Use

(a) The present or potential primary uses of the waters requiring maintenance of water quality in accordance with the standards hereinafter prescribed are fishing, swimming, esthetic enjoyment, and other recreational uses, subject to such restrictions on any such uses which involve close, frequent, or prolonged contact with the water as may be necessary for protection of public health.

(b) The waters also may be used for general industrial purposes, agriculture, and other beneficial uses for which the waters may be suitable and which do not conflict with the stated primary uses.

Section 2. Related Conditions

The waters are suitable for the aforesaid primary uses and for growth and propagation of game fish of species commonly inhabiting waters of the vicinity under natural conditions, but not as a source of drinking water or special quality industrial process water.

Section 3. Standards

(a) No untreated sewage, and no untreated industrial waste or other wastes containing viable pathogenic organisms or any substances which may cause disease, endanger the public health, or otherwise impair the quality of the receiving waters for the stated uses, shall be discharged into the waters.

(b) No major quantities of treated sewage from any source originating after the taking effect hereof shall be discharged into the waters. No treated sewage, and no treated industrial waste or other wastes containing viable pathogenic organisms, shall be discharged into the waters without effective disinfection. Effective disinfection of any discharges, including combined flows of sewage and storm water, may be required to protect the aforesaid uses of the water. Effective disinfection is defined herein as a process which will provide disinfection equivalent to that provided by chlorination of a treated sewage effluent to maintain a chlorine residual of at least 0.5 mg/l after a chlorine contact period of at least 15 minutes.

(c) Existing discharges of major quantities of sewage, industrial wastes, or other wastes, treated or untreated, shall be abated, or diverted out of the watershed, or otherwise controlled so as to comply with these standards.

(d) No sewage, industrial waste, or other wastes shall be discharged into the waters so as to cause any nuisance conditions, such as the presence of floating solids, scum, oil slicks, suspended solids, material discoloration, obnoxious odors, visible gassing, sludge deposits, slimes or fungus growths, or other offensive effects.

(e) No sewage, industrial waste, or other wastes shall be discharged into the waters so as to cause any material increase in any constituents or characteristics which may impair the quality of the water so as to render it objectionable or unsuitable for fish and wildlife or as a source of water for general industrial use or agricultural purposes, including irrigation.

(f) The discharge of oxygen demanding sewage or waste effluents shall be restricted so that after reasonable opportunity for mixing and dilution thereof with the receiving waters the dissolved oxygen content of such waters will be maintained at not less than 5 milligrams per liter during April and May, based on the monthly average flow which is exceeded by 90 per cent of the monthly flows of record for the month of April or May, whichever is lower, and so that a level of not less than 3 milligrams per liter will be maintained during August and February, based on the minimum daily flow which is exceeded by 90 per cent of the minimum daily flows of record for the month of August or February, whichever is lower. Where flow records are not available, the indicated flows may be estimated on the basis of available information on the watershed characteristics, precipitation, run-off and other pertinent data.

(g) In addition to the aforesaid requirements, the highest levels of dissolved oxygen which are attainable by continuous operation of all the units of the treatment works discharging into these creeks or rivers at their maximum capability consistent with practical limitations of such works shall be maintained in the waters in order to maintain conditions suitable for fish and for other uses of the waters.

(h) The discharge of industrial waste or other wastes shall be controlled so that the heat content of such discharges, after reasonable opportunity for mixing and dilution thereof with the receiving waters, does not raise the temperature of such waters above 93°F, based on the average natural water temperature in the month of August and the August minimum daily flow specified in paragraph (f), and during the months of December through May does not raise the temperature of such waters above 73°F, based on the applicable monthly average water temperature and the applicable monthly average flow which is exceeded by 90 per cent of such flows of record.

(i) The discharge of sewage, industrial wastes, or other wastes shall be restricted so that, on the basis of the minimum daily flow specified in paragraph (f), the limits hereinafter specified will not be exceeded in the waters by reason of such discharges, after reasonable opportunity for mixing and dilution:

Ammonia	2 milligrams per liter (as Nitrogen)
Chlorides	50 milligrams per liter (as Chloride ion)
Chromium	1 milligram per liter (as Chromium)
Copper	0.2 milligram per liter (as Copper)
Cyanides	0.02 milligram per liter (as Cyanide ion)
Oil	Not to exceed a trace
pH Range	6.5 - 9.0
Phenolic materials	0.01 milligram per liter (as Phenol)
Radioactive materials	Not to exceed the lowest concentrations permitted to be discharged to an uncontrolled environment as prescribed by the appropriate federal authority or by the State Board of Health.

(j) Means for expediting, mixing and dispersion of sewage, industrial waste, or other wastes in the receiving waters shall be provided so far as practicable whenever deemed necessary by the Commission to maintain the quality of the receiving waters in accordance with applicable standards.

(k) Liquid substances which could constitute a pollution hazard shall be stored in accordance with Regulation WPCC 4. Other wastes as defined by law or other substances which could constitute a pollution hazard shall not be deposited in any manner such that the same may be likely to gain entry into these waters in excess of or contrary to the standards herein adopted, or cause pollution as defined by law.

(l) In any instance where it is found that it may not be feasible to provide for effective mixing or dispersion of an effluent, or if at the applicable stream flows mentioned in the preceding sections on standards of water quality and purity, it is evident that the stream flow may be less than the effluent flow at any time, the aforesaid standards may be interpreted as effluent standards for control purposes, where applicable. In addition, the following effluent standards may be applied in special situations where it is found necessary to protect the waters for the stated uses:

Turbidity value	25
Total phosphorus	1 milligram per liter (as phosphorus)
Biochemical oxygen demand	20 milligrams per liter (as 5-day demand)
Total suspended solids	20 milligrams per liter

(m) No sewage, industrial waste, or other wastes shall be discharged into the waters in such quantity or in such manner alone or in combination with other substances as to cause pollution thereof as defined by law.

(n) In any case where, upon application of the responsible person or persons, the Commission finds after a hearing thereon that by reason of exceptional circumstances the strict enforcement of a provision of these standards would cause undue hardship and would be unreasonable, that disposal of the sewage, industrial waste, or other wastes involved is necessary for public health, safety, and welfare, and that no means for such disposal in strict conformity with the standards is reasonably available, the Commission, in its discretion, may permit a variance therefrom upon such conditions as it may prescribe for prevention, control, or abatement of pollution and in harmony with the general purpose and intent of the standards.

Adopted: _____

STATE OF MINNESOTA
WATER POLLUTION CONTROL COMMISSION

Proposal For

CLASSIFICATION AND STANDARDS FOR EAGLE CREEK AND PURGATORY CREEK AND TRIBUTARY WATERS

The classification for use and the standards of quality and purity as hereinafter set forth are hereby adopted and established for the waters of Eagle Creek and Purgatory Creek and waters tributary thereto in Scott, Dakota, Hennepin, and Carver Counties, from the source to the junction with the Minnesota River in section 7, Glendale Township, Scott County, and in section 36, Eden Prairie, Hennepin County, respectively.

Section 1. Classification for Use

(a) The present and potential primary uses of the waters requiring maintenance of water quality in accordance with the standards hereinafter prescribed are fishing, swimming, esthetic enjoyment, and other recreational use.

(b) The waters also may be used for general industrial purposes, agriculture, and other beneficial uses for which the waters may be suitable and which do not conflict with the stated primary uses.

Section 2. Related Conditions

The waters are suitable for the aforesaid primary uses and for growth and propagation of game fish, including trout, and other species commonly inhabiting waters of the vicinity under natural conditions, but not as a source of drinking water or special quality industrial process water.

Section 3. Standards

(a) No untreated sewage, and no untreated industrial waste or other wastes containing viable pathogenic organisms or any substances which may cause disease, endanger the public health, or otherwise impair the quality of the receiving waters for the stated uses, shall be discharged into the waters.

(b) No treated sewage effluent originating after the taking effect hereof, shall be discharged into the waters. No treated sewage, and no treated industrial waste or other wastes containing viable pathogenic organisms, shall be discharged into the waters without effective disinfection. Effective disinfection of any discharges, including mixtures of sewage with storm water, may be required to protect the aforesaid uses of the waters. Effective disinfection is defined herein as a process which will provide disinfection equivalent to that provided by chlorination of a treated sewage effluent to maintain a chlorine residual of at least 0.5 mg/l after a chlorine contact period of at least 15 minutes.

(c) Existing discharges of sewage, industrial wastes or other wastes, treated or untreated shall be abated, or diverted out of the watershed, or otherwise controlled so as to comply with these standards.

(d) No sewage, industrial waste, or other wastes shall be discharged into the waters so as to cause any nuisance conditions, such as the presence of visible floating solids, scum, foam, oil slicks, suspended solids, material discoloration, obnoxious odors, gas ebullition, sludge deposits, slimes or fungus growths, or any other offensive effects attributable to such discharges.

(e) No sewage, industrial waste, or other wastes shall be discharged into the waters so as to cause any material increase in any constituents or characteristics which may impair the quality of the water so as to render it objectionable or unsuitable for the growth and propagation of fish and wildlife or as a source of water for general industrial use or agricultural purposes, including irrigation.

(f) The discharge of oxygen demanding sewage or waste effluents shall be restricted so that after reasonable opportunity for mixing and dilution thereof with the receiving waters the dissolved oxygen content of such waters will be maintained at not less than 7 milligrams per liter during April and May, based on the monthly average flow which is exceeded by 95 per cent of the monthly flows of record for the month of April or May, whichever is lower, and so that a level of not less than 5 milligrams per liter will be maintained during August and February, based on the minimum daily flow which is exceeded by 95 per cent of the minimum daily flows of record for the month of August or February, whichever is lower. Where flow records are not available the indicated flows may be estimated on the basis of available information on the watershed characteristics, precipitation, run-off and other pertinent data.

(g) In addition to the aforesaid requirements, the highest levels of dissolved oxygen which are attainable by continuous operation of all the units of the treatment works discharging into these creeks at their maximum capability consistent with practical limitations of such works shall be maintained in the waters, in order to maintain conditions suitable for fish and for other uses of the waters.

(h) The discharge of sewage, industrial waste or other wastes shall be controlled so that the heat content of such discharges does not materially raise the temperature of these waters above naturally prevailing levels at any time.

(i) The discharge of sewage, industrial wastes, or other wastes shall be restricted so that, on the basis of the minimum daily flow specified in paragraph (f), the limits hereinafter specified will not be exceeded in the waters by reason of such discharges, after reasonable opportunity for mixing and dilution:

Ammonia	Not to exceed a trace (as Nitrogen)
Chlorides	50 milligrams per liter (as Chloride ion)
Chromium	Not to exceed a trace (as Chromium)
Copper	Not to exceed a trace (as Copper)
Cyanides	Not to exceed a trace (as Cyanide ion)
Oil	Not to exceed a trace
pH range	6.5 - 8.5
Phenolic materials	Not to exceed a trace (as Phenol)
Radioactive materials	Not to exceed the lowest concentrations permitted to be discharged to an uncontrolled environment as prescribed by the appropriate federal authority or by the State Board of Health.

(j) Means for expediting mixing and dispersion of sewage, industrial waste, or other wastes in the receiving waters shall be provided so far as practicable whenever deemed necessary by the Commission to maintain the quality of the receiving waters in accordance with applicable standards.

(k) Liquid substances which could constitute a pollution hazard shall be stored in accordance with Regulation WPCC 4. Other wastes as defined by law or other substances which could constitute a pollution hazard shall not be deposited in any manner such that the same may be likely to gain entry into these waters in excess of or contrary to the standards herein adopted, or cause pollution as defined by law.

(l) In any instance where it is found that it may not be feasible to provide for effective mixing or dispersion of an effluent, or if at the applicable stream flows mentioned in the preceding sections on standards of water quality and purity it is evident that the stream flow may be less than the effluent flow at any time, the aforesaid standards may be interpreted as effluent standards for control purposes, where applicable. In addition, the following effluent standards may be applied in special situations where it is found necessary to protect the waters for the stated uses:

Turbidity value	10
Total phosphorus	1 milligram per liter (as Phosphorus)
Biochemical oxygen demand	10 milligrams per liter (as 5-day demand)
Total suspended solids	10 milligrams per liter

(m) No sewage, industrial waste, or other wastes shall be discharged into the waters in such quantity or in such manner alone or in combination with other substances as to cause pollution thereof as defined by law.

(n) In any case where, upon application of the responsible person or persons, the Commission finds after a hearing thereon that by reason of exceptional circumstances the strict enforcement of a provision of these standards would cause undue hardship and would be unreasonable, that disposal of the sewage, industrial waste, or other wastes involved is necessary for public health, safety, and welfare, and that no means for such disposal in strict conformity with the standards is reasonably available, the Commission, in its discretion, may permit a variance therefrom upon such conditions as it may prescribe for prevention, control, or abatement of pollution and in harmony with the general purpose and intent of the standards.

Adopted:_____

STATE OF MINNESOTA
WATER POLLUTION CONTROL COMMISSION

Proposal For

CLASSIFICATION AND STANDARDS FOR THE MINNESOTA RIVER AND TRIBUTARY WATERS FROM THE OUTLET OF REILLY (TERRELL) CREEK AND GRASS LAKE BELOW SHAKOPEE TO THE JUNCTION WITH THE MISSISSIPPI RIVER AT FORT SNELLING

The classification for use and the standards of quality and purity as hereinafter set forth are hereby adopted and established for that portion of the Minnesota River from a point immediately below the outlet of Reilly Creek and Grass Lake below Shakopee, approximately at the northward extension of the boundary between sections 4 and 5, Eagle Creek Township, Scott County, to immediately above the junctions with the Mississippi River at Fort Snelling, approximately at the due southward extension of Edgecumbe Road from the intersection with West Seventh Street, and the due southward extension of Lexington Parkway from the intersection with West Seventh Street, in sections 21 and 22, St. Paul, and waters tributary thereto except Nine Mile Creek, the Credit River, Eagle Creek, Purgatory Creek and waters tributary thereto.

Section 1. Classification for Use

(a) The present or potential primary uses of the waters requiring maintenance of water quality in accordance with the standards hereinafter prescribed are pleasure boating, water skiing, fishing, swimming, and other recreational uses, subject to such restrictions on any such uses which involve close, frequent, or prolonged contact with the water as may be necessary for protection of public health.

(b) The waters also may be used for navigation, general industrial purposes, agriculture, and other beneficial uses for which the waters may be suitable and which do not conflict with the primary uses stated above.

Section 2. Related Conditions

The waters are suitable for the aforesaid primary uses and for maintenance of game fish of species commonly inhabiting waters of the vicinity under natural conditions, but not as a source of drinking water or special quality industrial process water.

Section 3. Standards

(a) No untreated sewage, and no untreated industrial waste or other wastes containing viable pathogenic organisms or any substances which may cause disease, endanger the public health, or otherwise impair the quality of the receiving waters for the stated uses, shall be discharged into the waters.

(b) No major quantities of treated sewage from any source originating after the taking effect hereof shall be discharged into the waters. No treated sewage, and no untreated industrial waste or other wastes containing viable pathogenic organisms, shall be discharged into the waters without effective disinfection. Effective disinfection of any discharges, including combined flows of sewage and storm water, may be required to protect the aforesaid uses of the waters. Effective disinfection is defined herein as a process which will provide disinfection equivalent to that provided by chlorination of a treated sewage effluent to maintain a chlorine residual of a least 0.5 mg/l after a chlorine contact period of at least 15 minutes.

(c) Existing discharges of major quantities of sewage, industrial wastes, or other wastes, treated or untreated, shall be abated, or diverted out of the watershed, or otherwise controlled so as to comply with these standards.

(d) No sewage, industrial waste, or other wastes shall be discharged into the waters so as to cause any nuisance conditions, such as the presence of floating solids, scum, oil slicks, suspended solids, material discoloration, obnoxious odors, visible gassing, sludge deposits, slimes or fungus growths, or other offensive effects.

(e) No sewage, industrial waste, or other wastes shall be discharged into the waters so as to cause any material increase in any constituents or characteristics which may impair the quality of the water so as to render it objectionable or unsuitable for fish and wildlife or as a source of water for general industrial use or agricultural purposes, including irrigation.

(f) The discharge of oxygen demanding sewage or waste effluents shall be restricted so that after reasonable opportunity for mixing and dilution thereof with the receiving waters the dissolved oxygen content of such waters will be maintained at not less than 4 milligrams per liter during April and May, based on the monthly average flow which is exceeded by 90 per cent of the monthly flows of record for the month of April or May, whichever is lower, and so that a level of not less than 3 milligrams per liter will be maintained during August and February, based on the minimum daily flow which is exceeded by 90 per cent of the minimum daily flows of record for the month of August or February, whichever is lower.

(g) In addition to the aforesaid requirements, the highest levels of dissolved oxygen which are attainable by continuous operation of all the units of the treatment works discharging into this reach of the river at their maximum capability consistent with practical limitations of such works shall be maintained in the waters, in order to improve conditions for fish and for other uses of the waters.

(h) The discharge of industrial waste or other wastes shall be controlled so that the heat content of such discharges, after reasonable opportunity for mixing and dilution thereof with the receiving waters, does not raise the temperature of such waters above 93° F, based on the average natural water temperature in the month of August and the August monthly average flow which is exceeded by 90 per cent of the monthly average flows of record for August.

(i) The discharge of sewage, industrial wastes, or other wastes shall be restricted so that, on the basis of the monthly average flow specified in paragraph (f), the limits hereinafter specified will not be exceeded in the waters by reason of such discharges, after reasonable opportunity for mixing and dilution:

Ammonia	2 milligrams per liter (as Nitrogen)
Chlorides	50 milligrams per liter (as Chloride ion)
Chromium	1 milligram per liter (as Chromium)
Copper	0.2 milligram per liter (as Copper)
Cyanides	0.02 milligram per liter (as Cyanide ion)
Oil	10 milligrams per liter
pH range	6.0 - 9.5
Phenolic materials	0.01 milligram per liter (as Phenol)
Radioactive materials	Not to exceed the lowest concentrations permitted to be discharged to an uncontrolled environment as prescribed by the appropriate federal authority or by the State Board of Health.

(j) Means for expediting mixing and dispersion of sewage, industrial waste, or other wastes in the receiving waters shall be provided so far as practicable whenever deemed necessary by the Commission to maintain the quality of the receiving waters in accordance with applicable standards.

(k) Liquid substances which could constitute a pollution hazard shall be stored in accordance with Regulation WPCC 4. Other wastes as defined by law or other substances which could constitute a pollution hazard shall not be deposited in any manner such that the same may be likely to gain entry into these waters in excess of or contrary to the standards herein adopted, or cause pollution as defined by law.

(l) No sewage, industrial waste, or other wastes shall be discharged into the waters in such quantity or in such manner alone or in combination with other substances as to cause pollution thereof as defined by law.

(m) In any case where, upon application of the responsible person or persons, the Commission finds after a hearing thereon that by reason of exceptional circumstances the strict enforcement of a provision of these standards would cause undue hardship and would be unreasonable, that disposal of

the sewage, industrial waste, or other wastes involved is necessary for public health, safety, and welfare, and that no means for such disposal in strict conformity with the standards is reasonably available, the Commission, in its discretion, may permit a variance therefrom upon such conditions as it may prescribe for prevention, control, or abatement of pollution and in harmony with the general purpose and intent of the standards.

Adopted:_____

STATE OF MINNESOTA
WATER POLLUTION CONTROL COMMISSION

Proposal for

CLASSIFICATION AND STANDARDS FOR REILLY (TERRELL) CREEK, BLUFF CREEK, THE CHASKA CREEKS, SPRING CREEK, CARVER CREEK AND SAND CREEK AND TRIBUTARY WATERS

The classification for use and the standards of quality and purity as hereinafter set forth are hereby adopted and established for the waters of Reilly (Terrell) Creek, Bluff Creek, Chaska Creek (East), Chaska Creek (West), Spring Creek, Carver Creek and Sand Creek, and waters tributary thereto in Carver, Hennepin, Scott, Le Sueur, and Rice Counties, from the source to the junction with the Minnesota River in sections 32 and 33, Eden Prairie, Hennepin County, and sections 31 and 32, Eden Prairie, Hennepin County, in section 4, Chaska, Carver County, in section 9, Chaska, Carver County, in section 20, Carver, Carver County, in section 20, Carver, Carver County, in section 20, Louisville Township, Scott County, respectively.

Section 1. Classification for Use

(a) The present or potential primary uses of the waters requiring maintenance of water quality in accordance with the standards hereinafter prescribed are fishing, swimming, esthetic enjoyment and other recreational uses, subject to such restrictions on any such uses which involve close, frequent or prolonged contact with the water as may be necessary for protection of public health.

(b) The waters also may be used for general industrial purposes, agriculture, and other beneficial uses for which the waters may be suitable and which do not conflict with the stated primary uses.

Section 2. Related Conditions

The waters are suitable for the aforesaid primary uses and for growth and propogation of game fish of species commonly inhabiting waters of the vicinity under natural conditions, but not as a source of drinking water or special quality industrial process water, and for disposal of treated sewage and industrial waste effluents for which no other means of disposal is available.

Section 3. Standards

(a) No untreated sewage, and no untreated industrial waste or other wastes containing viable pathogenic organisms or any substances which may cause disease, endanger the public health, or otherwise impair the quality of the receiving waters for the stated uses, shall be discharged into the waters.

(b) No treated sewage, industrial waste or other wastes containing viable pathogenic organisms, shall be discharged into the waters without effective disinfection. Effective disinfection of any discharges, including combined flows of sewage and storm water, may be required to protect the aforesaid uses of the waters. Effective disinfection is defined herein as a process which will provide disinfection equivalent to that provided by chlorination of a treated sewage effluent to maintain a chlorine residual of at least 0.5 mg/l after a chlorine contact period of at least 15 minutes.

(c) Existing discharges of untreated sewage, and untreated industrial wastes or other wastes, shall be abated, or treated, or otherwise controlled so as to comply with these standards.

(d) No treated sewage, and no industrial waste or other wastes, shall be discharged into the waters so as to cause any nuisance conditions, such as the presence of floating solids, scum, oil slicks, suspended solids, material discoloration, obnoxious odors, visible gassing, sludge deposits, slimes or fungus growths, or other offensive effects.

(e) No treated sewage, and no industrial waste or other wastes, shall be discharged into the waters so as to cause any material increase in any constituents or characteristics which may impair the quality of the water so as to render it objectionable or unsuitable for fish and wildlife or as a source of water for general industrial use or agricultural purposes, including irrigation.

(f) The discharge of oxygen demanding sewage or waste effluents shall be restricted so that after reasonable opportunity for mixing and dilution thereof with the receiving waters the dissolved oxygen content of such waters will be maintained at not less than 5 milligrams per liter during April and May, based on the monthly average flow which is exceeded by 90 per cent of the monthly flows of record for the month of April or May, whichever is lower, and so that a level of not less than 3 milligrams per liter will be maintained during August and February, based on the minimum daily flow which is exceeded by 90 per cent of the minimum daily flows of record for the month of August or February, whichever is lower. Where flow records are not available, the indicated flows may be estimated on the basis of available information on the watershed characteristics, precipitation, run-off and other pertinent data.

(g) In addition to the aforesaid requirements, the highest levels of dissolved oxygen which are attainable by continuous operation of all the units of the treatment works discharging into these creeks at their maximum capability consistent with practical limitations of such works shall be maintained in the waters, in order to improve conditions for fish and other uses of the waters.

(h) The discharge of industrial waste or other wastes shall be controlled so that the heat content of such discharges, after reasonable opportunity for mixing and dilution thereof with the receiving waters, does not raise the temperature of such waters above 93°F, based on the average natural water temperature in the month of August and the August minimum daily flow specified in paragraph (f), and during the months of December through May does not raise the temperature of such waters above 73°F, based on the applicable monthly average water temperature and the applicable monthly average flow which is exceeded by 90 per cent of such flows of record.

(i) The discharge of treated sewage, industrial wastes, or other wastes shall be restricted so that, on the basis of the minimum daily flow specified in paragraph (f), the limits hereinafter specified will not be exceeded in the waters by reason of such discharges, after reasonable opportunity for mixing and dilution:

Ammonia	2 milligrams per liter (as Nitrogen)
Chlorides	50 milligrams per liter (as Chloride ion)
Chromium	1 milligram per liter (as Chromium)
Copper	0.2 milligram per liter (as Copper)
Cyanides	0.02 milligram per liter (as Cyanide ion)
Oil	Not to exceed a trace
pH range	6.5 - 9.0
Phenolic materials	0.01 milligram per liter (as Phenol)
Radioactive materials	Not to exceed the lowest concentrations permitted to be discharged to an uncontrolled environment as prescribed by the appropriate federal authority or by the State Board of Health.

(j) Means for expediting, mixing and dispersion of sewage, industrial waste, or other wastes in the receiving waters shall be provided so far as practicable whenever deemed necessary by the Commission to maintain the quality of the receiving waters in accordance with applicable standards.

(k) Liquid substances which could constitute a pollution hazard shall be stored in accordance with Regulation WPCC 4. Other wastes as defined by law or other substances which could constitute a pollution hazard shall not be deposited in any manner such that the same may be likely to gain entry into these waters in excess of or contrary to the standards herein adopted, or cause pollution as defined by law.

(l) In any instance where it is found that it may not be feasible to provide for effective mixing or dispersion of an effluent, or if at the applicable stream flows mentioned in the preceding sections on standards of water quality and purity, it is evident that the stream flow may be less than the effluent flow at any time, the aforesaid standards may be interpreted as effluent standards for control purposes, where applicable. In addition, the following effluent standards may be applied in special situations where it is found necessary to protect the waters for the stated uses:

Turbidity value	25
Total Phosphorus	1 milligram per liter (as Phosphorus)
Biochemical oxygen demand	20 milligrams per liter (as 5-day Demand)
Total suspended solids	20 milligrams per liter

(m) No treated sewage, and no industrial waste or other wastes, shall be discharged into the waters in such quantity or in such manner alone or in combination with other substances as to cause pollution thereof as defined by law.

(n) In any case where, upon application of the responsible person or persons, the Commission finds after a hearing thereon that by reason of exceptional circumstances the strict enforcement of a provision of these standards would cause undue hardship and would be unreasonable, that disposal of the sewage, industrial waste, or other wastes involved is necessary for public health, safety, and welfare, and that no means for such disposal in strict conformity with the standards is reasonably available, the Commission, in its discretion, may permit a variance therefrom upon such conditions as it may prescribe for prevention, control, or abatement of pollution and in harmony with the general purpose and intent of the standards.

Adopted: _____

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MINNESOTA FARM & HOME SCIENCE

SPECIAL ISSUE: *Minnesota's Water Resources*

Published by the University of Minnesota Agricultural Experiment Station

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Dean of the Institute of Agriculture—Sherwood O. Berg

About a year ago the Agricultural Experiment Station appointed a Water Resources Committee to study the Station's research on water resource problems. The Committee reviewed past and current studies, defined problems of interest, and investigated proposals for future water-related research.

Their report lists nearly 170 Experiment Station research projects concerning water resources which have been completed, are underway, or are proposed for the immediate future.

Because few persons are more keenly concerned with Minnesota's water than farmers and those who process food and fiber, we asked the Committee to prepare this issue of *Minnesota Farm and Home Science*. We hope you'll find it a valuable source of information on Minnesota's water resources.

The introductory article on the opposite page was prepared by the Experiment Station's Water Resources Committee: Donald G. Baker, assistant professor, Department of Soil Science; Donald P. Duncan, professor and assistant director, School of Forestry; Philip W. Manson, professor, Department of Agricultural Engineering; Joseph C. Olson, Jr., professor, Department of Dairy Industries; Lloyd L. Smith, professor, Department of Entomology, Fisheries, and Wildlife; and Darrell F. Fienup, professor, Department of Agricultural Economics, chairman. These men also served as a special editorial committee for this issue of *Minnesota Farm and Home Science*.

At Branch Experiment Station field days during July you'll see new and recommended varieties of small grains, forage crops, and soybeans; the results of chemical and cultural weed control methods; crop rotation projects; and soil fertility studies.

Livestock projects will be displayed at some stations. There will be noontime speakers. Lunches will be available—or bring your picnic hampers. July dates and places are: 2, Lamberton; 7, Waseca; 8, Rosemount; 9, Morris; 14, Crookston; 23, Grand Rapids; and 24, Duluth.

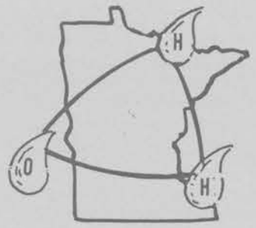
Assuming that this is a 200-acre farm in southern Minnesota and that it supports 6 persons, 75 dairy cattle, and 200 hogs, this is its annual water need:

The crops will consume through evaporation and transpiration nearly 120 million gallons. The livestock will drink about 700,000 gallons. And the family will use about 110,000 gallons. That amounts to a water layer approximately 22 inches deep over the entire 200 acres.

Water is basic to all forms of life. Plants, animals, and humans cannot exist without it. Yet too often water is taken for granted; we become concerned only when it becomes scarce, polluted, or destructive.

As population and incomes grow, increased demands are placed on existing water supplies for municipal, industrial, and recreational use. Water needs and problems tend to be greatest in urban areas where heaviest population and industrial growth has occurred. Water use for air conditioning and cooling systems, automatic dishwashers, washing machines, and lawn watering are examples of increased home uses of water resulting from higher incomes. Even more important is the increase in leisure time which many people like to use for water-based outdoor recreation activities. But polluted lakes and streams do not mix well with swimming, fishing, and water skiing. The trend is not only toward increased competition in use of our water resources but toward conflicts between incompatible uses.

As agricultural technology continues to be developed, water increasingly becomes the limiting factor to further expansion in production. More water will be used for irrigation, which is today the greatest single use for fresh water in the United States. At the same time, growing industrial and domestic uses of water will cause increased competition for irrigation water. Conservation, development, and control of water will be necessary to insure adequate supplies for all future needs.



Conservation and Development of Minnesota's Water Resources

Precipitation which falls on agricultural and forest land is the basic source of all water. Therefore, land use and cropping and forestry practices are vital determinants of water quantity and quality available for other uses. More knowledge is needed of how water interacts with its environment, is stored, and is lost through evaporation and transpiration. Economical ways to increase the efficiency of water use must be determined.

Water can also be destructive in time of flooding for both cities and agricultural land. Control of runoff through proper land management and watershed planning not only provides flood control but may benefit forest and crop production and assist in recreational development. On the other hand, drainage is a problem on some agricultural lands when precipitation is excessive.

Minnesota's Water Resources

Minnesota is richly endowed with water resources, but problems of quality, conflicting uses, and actual shortage in local areas do exist. Average precipitation is about 25 inches and varies from about 19 inches in the corner of the Red River Valley in the northwest to about 32 inches in the southeast corner of the state. Over half of the total precipitation occurs in the 4 months of the growing season. Low winter temperatures and relatively high humidity in summer reduces the rate of evaporation.

Surface waters are abundant in many areas of the state. Our many lakes are primarily an important recreational asset, but they also serve as reservoirs to restrain flood waters. In some cases they are a source of water for agricultural, industrial, or municipal uses. Optimum recreational use of lakes requires control of pollution, sedimentation, and fluctuation in the water level. More public accesses must be developed and maintained. Control of lake levels as a measure of flood control and water use for agricultural and other purposes may not be consistent with optimum recreational use and development. Conflicts from multiple uses must be recognized and resolved.

Most of Minnesota's water originates within the state. Surface water is carried away by streams into three major drainage basins: The Hudson Bay, the Mississippi, and the St. Lawrence or Lake Superior basins. Over two-thirds of the state, including most of the agricultural area, is in the Mississippi River drainage basin. The Red River Valley drains into Hudson Bay.

The fact that Minnesota is principally a headwater area has important implications for the development and control of its water resources. If the streams are polluted or if flooding occurs, it is largely because Minnesotans are responsible. It is within our power to remedy these problems and to develop the water resources for the benefit of all.

Streams present a dual problem of rapid runoff in the spring or in times of high precipitation, and low waterflow in drought periods, which usually occur in late summer and fall or midwinter. Conservation of water in the headwater areas and watersheds will reduce runoff in times of excess moisture and increase streamflow in periods of drought. Watershed planning and development, improved land and forestry practices, wetlands preservation, and control of lake water levels will help to stabilize streamflow.

Ground water supply varies primarily in relation to local geologic conditions but is also related to climatic factors such as precipitation and evaporation. In general, the central area of Minnesota from north to south and the southeast have abundant ground water supplies. In northeastern Minnesota the bedrock does not yield

ground water, though the glacial drift contains some water. The Iron Range is already experiencing water supply problems. Lower precipitation in western Minnesota, a relatively high evaporation rate, variability in the location of permeable aquifers, and frequent ground water quality problems preclude this as an area of water abundance.

There is a need for more geological surveys and intensive study of the occurrence of water in the state. More observation wells are needed to record fluctuations in the water table. Over 500 million gallons of ground water were used for irrigation in 1960. This is a highly consumptive use which will likely increase in the future. Increasing competition for the use of ground water between agricultural, industrial, and municipal users can be expected to develop.

Research Needs

Past and current research on water resource problems conducted by the Minnesota Agricultural Experiment Station has emphasized the interaction of water with its agricultural and forest environment, and how the water resource can be developed, altered, conserved, or controlled for man's benefit. This issue of *Minnesota Farm and Home Science* is devoted to a report on part of that research, classified into six major areas:

Hydrology, meteorology, and climatology;
Water supply and quality;
Water management and hydraulics;
Water, soil, plant, and animal relationships;
Recreation, fisheries, and wildlife;
Economic and institutional aspects.

Following is a brief description of research conducted in each area by the Minnesota Agricultural Experiment Station, and future research needs.

Hydrology, meteorology, and climatology—This work is basic to the understanding and control of water relationships in the environment. The source, availability, and natural quality of Minnesota's water supply is integrally related to its agricultural and forest lands. Studies have been made of precipitation and temperature probabilities and trends, transpiration and evapotranspiration from various vegetative and forest covers, and waterholding capacities and drainage characteristics of various soils. More studies are needed to determine where and in what proportion water is stored, consumed, and lost and in what ways the agents of dispersal may be controlled or altered to man's benefit.

Water supply and quality—Some of Minnesota's most important water problems fall in the area of water supply and quality. A comprehensive water use program for the state cannot be developed until a detailed quantitative and qualitative inventory of surface and ground waters is completed. Agricultural, industrial, and recreational development often depends on abundant and high quality water supplies. Studies of natural water quality for irrigation, rural use, and food processing have been emphasized in past research. More work should be undertaken on rural and industrial water needs and waste disposal to prevent pollution of our lakes and streams. The effect of soil and water conservation practices on supply and quality of surface and ground water needs further study.

Water management and hydraulics—Most economical development of our water resources depends on the watershed approach to proper water management. For sound watershed planning more knowledge is needed of the relationship of agricultural drainage, irrigation, and soils to wetlands, recreation, wildlife, erosion, floods, ponds, water structures, and channel improvement. The hydraulics of water flow require further research if proper design criteria are to be applied to open ditch and tile drainage or to flood prevention structures. Current and past research in this area has concentrated on the effect of various structures and land management practices on soil and water control.

Water, soil, plant, and animal relationships—These studies are mainly directed toward the efficiency of plant and animal production in Minnesota's economy. They also contribute to improved understanding of how management of soils, plants, and animals affects the quality and regimen of water. Past research has included the effects of drainage on crops and forest growth, methods of cover treatment to conserve moisture, and the effects of plant and soil variables upon water infiltration and soil erosion. Future work should involve study of soil characteristics affecting water infiltration, permeability, irrigation, and drainage; the effects of plant cover on interception, soil moisture depletion, frost formation, runoff, and erosion; assessment of factors affecting plant or animal efficiency in utilizing water; and determination of various plant tolerances to water deficiencies and excesses at various seasons.

Recreation, fisheries, and wildlife—Development of outdoor recreation, fisheries, and wildlife has tremendous potential in Minnesota. Water is closely linked to all of these. This potential will only be realized through sound planning based on expanded research.

Most research has emphasized the improvement of commercial and sport fishery production. Water quality as it influences survival of stream organisms and rates of photosynthesis has also been a major area of study. Future work should concentrate on the recreational potential of state water areas, relation of pesticides and pollution on fish production, and public attitudes regarding development of water recreation facilities.

Economic and institutional aspects—Economic and institutional aspects of water resource development deal with the relationships between water supplies and needs, the pricing and allocation of water to different uses, and resolution of conflicts of interest between current and potential water users.

Past research has emphasized farmers' use of supplemental irrigation, the changing status of water rights in Minnesota, and the regulation of water use. Future work should emphasize supply and demand analyses to determine trends and factors influencing agricultural and recreational uses of water. Studies of water rights, water use, and water control are necessary to resolve conflicts of interest between agricultural, industrial, and public users.

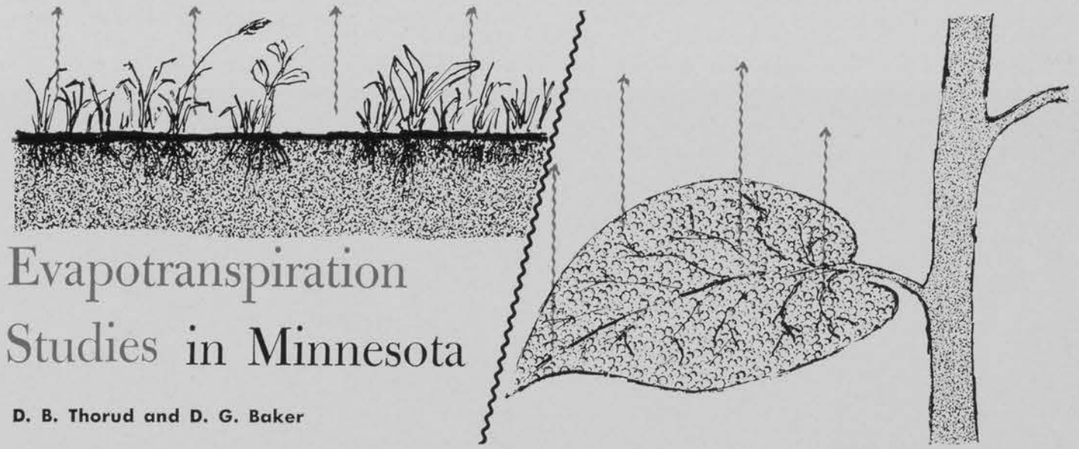
Summary

Agriculture's stake in and its importance relative to the water resources of an area have been emphasized in past and current research carried on by the Minnesota Agricultural Experiment Station. Almost all precipitation falls initially on agricultural and forest land. Depending on the cover and condition of the soil, the precipitation is either lost almost immediately or is conserved for future local use. Water quality for nonagricultural users is also affected. Viewing water as an unlimited resource in Minnesota is an illusory concept which will become increasingly evident in the years ahead. A far-sighted water research program must take into account the mutual interdependence of water needs and use by agriculture, industry, and the general public.

Minnesota has a great unrealized potential in its natural endowment of water resources. Future economic development of the state will depend to a major degree upon the foresight and planning used to promote and facilitate optimum recreational, agricultural, and industrial uses of water. This will be possible only through a greatly expanded water resource research program.

On a national basis the Senate Select Committee on National Water Resources considered "the provision and management of water supplies for waste dilution, irrigation of arid lands, outdoor recreation and the conservation of fish and wildlife to pose the most serious water problems."[1] In Minnesota it appears that increased emphasis should be placed on development and management of our water supplies, particularly with respect to problems of pollution and natural quality, recreational development, and fish and wildlife conservation. Water must not be taken for granted if Minnesota is to realize its economic development potential. ■

[1] *Report of the Select Committee on National Water Resources*, U.S. Senate Report No. 29, January 1961, p. 14.



Evapotranspiration Studies in Minnesota

D. B. Thorud and D. G. Baker

Average annual precipitation in Minnesota is about 25 inches, approximately 5 inches less than the national average. About 3 inches flows from the state via streams and rivers; the remaining 22 inches are lost to the atmosphere through evaporation.

Winter evaporation losses are slight, but during the growing season a constant stream of invisible vapor flows from the earth's surface to the atmosphere. Because this flow is not visible the loss may seem inconsequential, even though it ranges from 75 percent of the total annual precipitation in southeastern Minnesota to nearly 100 percent in northwestern Minnesota.

The overall physical process responsible for this loss is evaporation. But a special form of evaporation called "transpiration" contributes to these losses. Transpiration refers to the movement of water originally obtained by plant roots to small openings in the leaves, termed "stomates," where the water is then subject to evaporation. When soil moisture is not limiting, stomates expose moist evaporating surfaces to the atmosphere even when the soil surface may be quite dry. Where plants are growing, both evaporation and transpiration contribute moisture to the atmosphere. The total moisture loss resulting from these two processes is termed "evapotranspiration."

Evapotranspiration measurements have shown little if any real difference in water consumption by different agricultural crops over equal time periods if soil moisture is adequate and if plants are of equal density in the field (see table, page 6).

In Minnesota, with optimum or near optimum soil moisture conditions, the average evapotranspiration loss in inches of water regardless of crop is about as follows:

April, 0.03 in./day; **May,** 0.09 in./day; **June,** 0.15 in./day; **July,** 0.17 in./day; **August,** 0.14 in./day; **September,** 0.09 in./day; and **October,** 0.05 in./day.

Research has also shown that the total evapotranspiration loss is essentially a function of weather. Thus if certain meteorological factors are known the evapotranspiration loss can be calculated with little error.

Another important finding indicates that the total water loss from a corn field can be divided about equally between soil surface evaporation and plant surface transpiration. Protective covering on the soil between rows has beneficially conserved soil moisture by greatly reducing soil surface evaporation.

D. B. Thorud is an instructor in the School of Forestry; D. G. Baker is an assistant professor in the Department of Soil Science.

Evapotranspiration losses under four crops

Alfalfa			Corn			Soybeans			Sugar beets		
	Water use			Water use			Water use			Water use	
Period	Total	Daily	Period	Total	Daily	Period	Total	Daily	Period	Total	Daily
	inches			inches			inches			inches	
6/1-6/30	4.65	0.16	6/1-6/27	4.15	0.15	6/1-7/2	4.51	0.15	5/31-6/30	4.55	0.15
7/1-7/31	5.46	0.18	6/28-7/29	5.92	0.19	7/3-7/31	5.58	0.19	7/1-7/31	6.05	0.19
8/1-8/30	4.55	0.15	7/30-8/29	4.65	0.15	8/1-8/30	3.58	0.12	8/1-8/30	2.98	0.10
9/1-10/1	2.85	0.09	8/30-10/19	2.42	0.05	8/31-10/1	2.39	0.07	8/31-10/1	2.84	0.09
	17.51*			17.29*			16.06*			16.42*	

* A soil moisture sampling at an earlier date would result in total seasonal losses of about 18 to 22 inches for all species except alfalfa which would have somewhat greater losses due to a longer growing season.
Data courtesy of O. Soine, Northwest Experiment Station, Crookston, and W. Nelson, Southwest Experiment Station, Lamberton.

Much more is known about evapotranspiration from cropped than from forested lands. Certain known principles will certainly hold true for forested lands but important details are lacking. For example, do conifers or deciduous trees consume more water? And how much more water is lost by evapotranspiration from forested than from agricultural lands?

Since Minnesota is nearly 40 percent forested and since about one-half of our water supply passes through forests, the ways in which tree cover affects water supplies are being investigated.

Previous investigations indicate that rainfall and snowfall which is intercepted by vegetational surfaces and then lost directly to the atmosphere by evaporation without entering the soil, may equal 15 to 25 percent of the total annual precipitation (see photo). For example, if rain gauges placed in the open record 20 inches of rainfall, only 16 inches may reach the ground in a neighboring forest. However, the type of forest cover is an important variable affecting these processes.

Snow interception in a dense spruce forest. Much of the snow retained on branches is eventually evaporated back into the atmosphere.

As an illustration, consider hardwoods which are leafless in winter. These trees intercept comparatively small amounts of snowfall. The resulting accumulations on the ground may provide a greater potential water supply for spring and summer streamflow than do lesser amounts of snow found under conifers. But snowpacks under hardwoods are essentially unshaded from the sun and consequently may melt more rapidly than snowpacks under dense conifers. Hydrologically, then, conifers may be more desirable than hardwoods in areas where springtime flooding is serious even though hardwoods may yield a greater total snow-water supply.

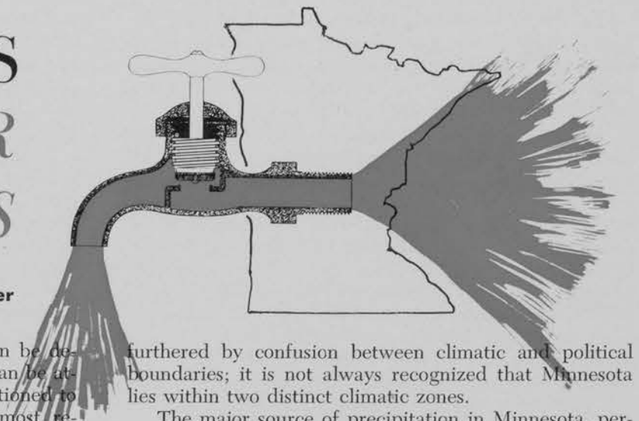
The litter of leaves and branches on the forest floor also intercepts and holds back significant quantities of rainfall from the soil and streams. Much of the moisture in the litter is lost directly to the atmosphere by evaporation with little apparent benefit to man, although the transpiration demand upon surrounding vegetation may be somewhat reduced as a result of higher humidity. On an annual basis litter interception losses can amount to 1 to 3 inches of rainfall.

The details and timing of these and other forest hydrology processes require further study in the form of complete evapotranspiration investigations. In these studies all hydrologic components of the environment should be studied simultaneously in several common forest types. Precipitation interception by trees, shrubs, herbs, and litter layers; snow melting and evaporation; and soil moisture depletion and recharge are some of the most important variables requiring attention. Deficiencies in our current knowledge of these and other hydrologic factors and their impact on one another could lead to serious errors. For example, if measurements indicate greater amounts of precipitation reaching the forest floor in a forest of low tree density than one of high density, an immediate conclusion might be that the low density forest would yield more water for streamflow and soil moisture replenishment. However, greater sunshine penetration into the low density forest may cause larger evapotranspiration losses, thus drying the litter and soil, and possibly faster snowmelt runoff which could be undesirable.

Existing knowledge indicates that woodland and forest effects on interception and other evapotranspiration losses are varied and dependent to a large degree on species composition and density. This variability provides an opportunity for the forest manager to alter the timing and quantity of water yields because species composition and stand density can be manipulated with relative ease for different objectives. If the objective is increased water yield the manager would minimize evapotranspiration losses; if flood control is the objective these two losses would be maximized. However, any method of forest management put into practice should be compatible with other simultaneous management objectives including timber and wildlife production and recreational programs.

But before forests can be manipulated for particular watershed objectives much more must be known about the physical processes involved. Environmental factors subject to manipulation should be thoroughly understood so that wise choices can be made between alternative management possibilities. Certainly management programs should not be instituted if an economic return in terms of water supply or some other benefit cannot be reasonably assured. Continued hydrologic research on Minnesota forest and crop lands will help provide the knowledge necessary for making these decisions. ■

MINNESOTA'S *WATER RESOURCES*



D. G. Baker

Today our use of water is so great that it can be described only as "luxury" consumption. This can be attributed to two things: (1) we have been conditioned to a life of abundance, and (2) water, unlike most resources, is returned through a natural process which often leads to the supposition that water is unlimited. Furthermore, Minnesota's many lakes present the deceiving illusion of an area abundant in water. This illusion is furthered by confusion between climatic and political boundaries; it is not always recognized that Minnesota lies within two distinct climatic zones.

The major source of precipitation in Minnesota, perhaps 90 to 95 percent, is the Gulf of Mexico. The remainder is obtained from air masses originating over the Pacific Ocean.

Lakes and rivers within Minnesota do not supply moisture to the state; even their temperature influence is effective only a few miles around them. Lake Superior,

D. G. Baker is an assistant professor in the Department of Soil Science.

though approaching the size where it is of minor influence in certain areas, is not a moisture source for Minnesota due to prevailing westerly winds.

As a result of the long, tortuous, and often unpredictable path taken by the humid air masses before reaching Minnesota, there is no guarantee of receiving necessary precipitation. For example, during the 127 years of record the total annual precipitation at St. Paul has varied between a maximum of 40.44 inches to a minimum of 10.21 inches.

Except for the extreme northeast, Minnesota may not reach into adjoining areas for extra water. By international agreement water cannot be withdrawn from the Great Lakes beyond the confines of their drainage basin. Therefore, only the area immediately adjoining Lake Superior is permitted use of its waters. Thus our supply of water rests solely upon that received by precipitation. This is what we must budget ourselves to, regardless of how inadequate or variable precipitation may be.

Some parts of the hydrologic cycle are, or may be in the future, subject to manipulation. Sucess, however, is by no means assured. One recent suggestion relative to climatic control is the diversion of ocean currents. Supposedly arid areas would then be "watered" by air masses made humid as a result of the shift in direction of the currents. Admitting the possibility of this scheme actually working, it must be discarded as a solution for the present needs. In fact, precipitation in Minnesota might be reduced as a result. Any scheme that can result in such a wholesale disruption of natural systems is both awesome and potentially more hazardous than anything yet conceived.

A second means of climatic control, though as yet on an extremely localized scale, is that of cloud seeding. Here the objective is to promote precipitation by seeding clouds with dry ice or silver iodide. When introduced about 15 years ago, this method met with great interest; to date it has not lived up to expectations. In a survey of results the Council of the American Meteorological Society concluded that cloud seeding was particularly effective only when conditions were such that it might have rained anyway. It was also concluded that seeding was notably ineffective over flat country.

In addition to man-induced climatic control or climatic change there are also natural climatic changes. All life, including man and his pursuits, is geared to a natural and regular climatic rhythm. We are so closely tied to climate that any alteration in what we conceive to be normal creates serious problems. The subnormal precipitation of the early 1930's is an example. A phenomenon presently occurring (at least up through 1960) complicates water consumption estimates and will make any long-range plans difficult. It is apparent from temperature records and other pertinent evidence that the northern hemisphere especially is warming up. For several long-term weather stations in Minnesota the increase in winter temperature, the season which has shown the greatest rise, amounted to 3.7° F. in 59 years. Since the cause has not yet been established there is no means of predicting whether this warming will continue or not. Of immediate concern is the fact that a warmer atmosphere causes more water to be evaporated from soil, plant, and water sources. Thus, even though total precipitation may remain the same, available water is more readily consumed.

Of the precipitation Minnesota receives, a major portion enters the soil where it is then lost to the atmosphere through the natural processes of evaporation from the soil surface and by plant transpiration. (Since these two losses, *evaporation* and *transpiration*, occur together and are caused by the same factors the coined word *evapotranspiration* is often used when referring to them). The remainder either percolates through the soil to become ground water reserves or is lost immediately as runoff to be carried away by streams and rivers. Even a portion of the so-called ground water reserves is lost by springs and flowage to rivers and lakes.

Two extreme examples may be cited to give some idea as to the portions involved in each category. In southeastern Minnesota, at Winona, the average (1926-55) annual total precipitation was 30.56 inches. Of this total the evapotranspiration losses were calculated to average 25.40 inches per year, leaving 5.16 inches as surplus. Strictly speaking this was not a true surplus; some of this may have been needed by plants. But due to precipitation distribution it was not available for plant use. Part of the 5.16 inches was lost immediately as runoff and a part, depending upon precipitation intensity and distribution, entered the ground water system. Due to thick unconsolidated glacial deposits, as well as the character of the underlying bedrock, a relatively large proportion probably entered ground water reserves.

At the other extreme is Hallock in the northwestern corner of the state. Here during the same period precipitation averaged 19.76 inches of which 19.06 inches was consumed through evapotranspiration. The value for surplus, 0.70 inches, may appear to be too small. However, an additional amount of water within the streams and rivers of the Red River Valley comes from underground drainage of the lakes and ground water of the higher land immediately to the east.

Ground water reserves in all parts of the state are affected by urban growth and any surface obstruction such as a highway, since the water is unable to enter the soil and is almost immediately channeled into drainage systems. Thus the surplus water has no opportunity to enter ground water sources.

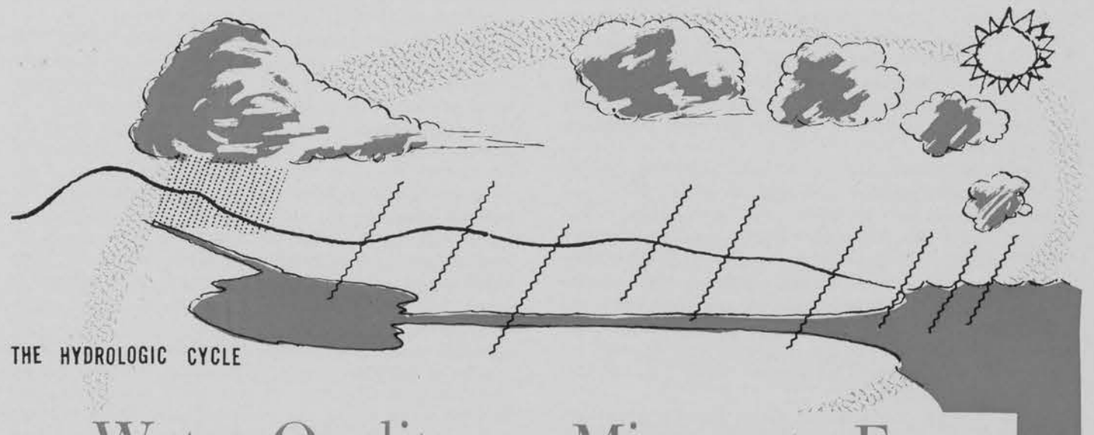
It therefore appears that little short of stringent conservation practices must be adopted, especially by the great urban and industrial consumers of water. This would involve both the reuse of water, necessitating increased purification practices, greater use of surplus waters such as river water, and decreasing runoff through various reservoir systems.

Recent innovations may be of some aid in the immediate future. Evapotranspiration, for example, can be reduced by laying plastic sheets between widely spaced crops such as corn. To date this is used commercially only with the very high value row crops. Lake and reservoir evaporation can be reduced by spreading a monomolecular film of organic material on the surface.

To permit the greatest and most efficient use of our waters, more than just conservation of them is needed. For the required assessment and scheduling it is necessary to know both when and how much precipitation might be expected. To answer these questions both meteorology and climatology may be used. Quite accurate meteorological forecasts of up to about 72 hours in advance can be made; but knowledge of the physics of the atmosphere is still too limited to permit meteorological forecasts of a longer period. For the longer period forecast it is necessary to turn to climatology. Based upon climatological records, some of which now exceed 50 years in duration, it is possible to determine the probability that a particular event may be expected to occur.

Among the climatological events for which probabilities have been determined is the amount of precipitation to be expected within certain time periods at various Minnesota stations.

Another climatological event of great importance for which probabilities have been determined is the occurrence of drought. Drought is a complicated climatological feature; it is not simply a matter of lack of precipitation but depends upon the rooting depth of the plant, the water-holding capacity of the soil, precipitation frequency and amount, and certain meteorological factors which affect evapotranspiration rates. These difficult calculations were made for a number of stations in the state. ■



THE HYDROLOGIC CYCLE

Water Quality on Minnesota Farms

E. R. Allred

Snow and rainfall are considered primary sources of water for mankind, because at this particular point in the hydrologic cycle water contains the fewest impurities. Water is never pure in nature; between the time when it is converted to vapor at the ocean's surface and when it strikes the earth in the form of rain or snow it absorbs atmospheric gases and picks up dust particles and other substances. After striking the earth, water begins to dissolve and carry in solution various minerals with which it comes in contact. The more soluble minerals are usually found in greatest abundance.

Impurities in water, such as minerals and atmospheric gases, may or may not create problems depending upon the intended use. For example, some waters may contain sufficient amounts of acids to be corrosive when in contact with metals. Waters containing large amounts of sodium cannot be used for irrigation. Certain industrial firms must also know if any particular constituents in an intended water supply would become objectionable if used in their manufacturing processes.

E. R. Allred is a professor in the Department of Agricultural Engineering.

Water Softening

The average homemaker is most frequently concerned about the hardness and the iron content of water. A water is "hard" if it contains excessive amounts of dissolved minerals—principally calcium and magnesium. Such water has low cleansing ability and requires the addition of large amounts of soap or other chemicals when used for laundry purposes. Hard water also has a tendency to form deposits when the minerals precipitate out of solution, causing clogging of pipes and fixtures.

When a city or town softens large quantities of water, they use chemicals to precipitate the minerals out of solution. They can then be removed by filtration. Zeolite softeners, in which calcium and magnesium ions in the water are exchanged for sodium ions in the zeolite, are most suitable for individual family use.

The degree of hardness at which water softening becomes necessary differs with individuals and uses. But softening for domestic purposes is usually warranted if a water supply contains from 8 to 10 grains (of hardness forming minerals) per gallon. Water pumped from a given formation is usually of uniform hardness. Pump-

ing from other formations at other depths may yield water of quite different hardness, depending upon the type of minerals found in each formation. Lakes, streams, and other surface waters of Minnesota are of relatively low hardness—usually from 5 to 10 grains per gallon. Most Minnesota well waters, on the other hand, are moderately to very hard, containing from 12 to 40 grains per gallon.

Iron Removal From Water

Compared to calcium and magnesium, the amount of iron contained in the waters of Minnesota is usually very small.

Unfortunately even small quantities of iron may create difficult problems. Iron contents up to 0.3 parts per million (p.p.m.) usually present no problem. However, above 0.3 p.p.m. reddish-brown stains appear on plumbing fixtures and laundered clothes. Water samples taken from some Minnesota wells show iron contents approaching 8 p.p.m. Such waters are disagreeable in taste, impart off-flavors to cooked foods, and severely stain everything they contact.

Zeolite water softeners can remove small amounts of iron along with calcium and magnesium. But if the iron content exceeds 3 p.p.m. attempts to use the softener are usually unsuccessful because the iron precipitate (rust) tends to clog flow through the zeolite material. Under certain conditions where a zeolite softener alone cannot be used to correct an iron problem, polyphosphates are sometimes added to the water in an effort to temporarily prevent the oxidation of the dissolved iron. In such instances the iron remains in solution rather than appearing as a rust precipitate.

Waters with iron contents above about 3 p.p.m. require special treatment. It is usually necessary to install an oxidizing filter ahead of the softener. A filter assists in two ways: (1) by oxidizing the iron out of solution and into a rust precipitate, and (2) by removing the rust through its filtering action. Small remaining quantities of iron can usually be handled safely by the zeolite softener.

Another problem commonly associated with waters which have a high content of iron is the formation of a bacterial growth called crenothrix. When a well or other water supply system has conditions favorable to crenothrix growth, pipes become partially clogged with a slimy rust residue.

If crenothrix growth occurs, clorination is the most practical and least costly method of correction. One part of ordinary laundry bleach (or other sodium hypochlorite solution) mixed with 12 parts of water can be used effectively to control crenothrix. The solution is poured into the well and the pump allowed to operate until the smell or taste of chlorine can be detected at each faucet. The entire system is left idle for at least 2 hours (preferably overnight), and then flushed until all traces of chlorine have been removed.

Since the iron content of a given water supply depends upon the nature of the soil or rock formation through which the water moves, it may be possible to obtain a different iron analysis by increasing or decreasing the well depth. But deepening a well with the hopes of improving the iron or hardness qualities of a water supply should not be attempted without some assurance that conditions will not become worse.

Biological Pollution

Ever-increasing pressures for greater efficiency in agriculture have created a trend toward higher concentrations of livestock (or poultry) on fewer acres of land. Other economic factors, such as transportation costs, result in many "high density" livestock and poultry housing systems located near population centers. Few people are aware of the magnitude and the increasing problems of rural waste disposal, since until recent years a large proportion of the population of Minnesota lived on small farms. Under such conditions waste disposal was not a serious problem as most wastes were utilized by spreading them on the land as fertilizer, or buried.

With the encroachment of residential developments into suburban areas and the gradual shift of large concentrations of livestock and poultry toward the populated centers, new approaches toward the disposal of farm wastes must be found. Domestic wastes from the farm residence and the manure wastes from livestock or poultry are the most serious disposal problems.

A well-designed farm waste disposal system must (a) prevent pollution of existing surface or underground water supplies; (b) prevent conditions that would attract or permit the breeding of flies, rodents, etc.; (c) eliminate, or provide for the dispersion of objectionable odors; (d) be efficient in use of labor; (e) avoid excessive capital investments.

Disposal of farm wastes, either domestic or animal, creates a potential source of pollution for both surface and underground water supplies. Such wastes may pollute the water chemically or biologically. Other types of pollution may impart undesirable taste, color, turbidity, or odors to the water.

Should any doubt exist as to the suitability of a given water supply for human consumption, laboratory tests should be made. Such tests for the presence of coliform bacteria, detergents, or excessive nitrates, indicate whether or not a given water supply is suitable for drinking. Wastes from farm residences or areas where large quantities of chemicals are used—detergents, commercial fertilizers, etc.—may cause chemical rather than biological pollution. The presence of chemical pollutants may be caused by current conditions or as the result of residual buildup of such substances within the soil due to past waste disposal practices.

Nature greatly assists our efforts to prevent the biological pollution of water supplies. Many pathogenic organisms cannot survive outside the warm temperatures in the bodies of animals. Others die when exposed to either sunlight or air. The processes of storage, sedimentation, and dilution also tend to provide for natural biological purification of surface waters.

Natural removal of bacteria from ground waters occurs by filtration through the soil. Research data indicate that when water carrying organic forms of bacteria is allowed to percolate through a fine-grained soil the resulting pollution will be confined to a localized area at or near the point of disposal. Bacteria are removed from polluted water during its percolation through the soil by attachment to the soil particles.

Tests indicate that under some conditions as little as 10 feet of fine sand is sufficient to obtain complete removal of bacteria from a given waste water. On the other hand, percolation through coarse-textured soils or through fissured rock formations, even over great distances, may not result in the complete removal of bacteria because of the low absorptive capacity of such formations.

The cool temperatures found at the level of the ground table also help to restrict bacterial growth. Because most disease-causing bacteria die rapidly after their entry into a ground water body, all traces of such pollution usually disappear soon after the source of pollution is removed.

As in cases where iron bacteria are present, the most practical method of disinfecting a new or polluted well is by chlorination. Laundry bleach-water solutions, mixed in the 1 to 12 proportions described earlier, may be used to disinfect against harmful bacteria. The chlorine solution is poured into the top of the well casing in such a way as to wash down the outside of the drop pipe(s) and the inside of the casing itself. The sanitary seal of most wells is equipped with a removable plug to provide entry into the well casing.

Where biological pollution is suspected or known to exist, leave the disinfectant in the well for about 12 hours. Following this period, pump water from the well into the pressure tank and through the distribution system. To be certain that all parts of the distribution system are in contact with the chlorinated solution, open each faucet until the odor of chlorine is apparent. Leave the disinfectant within the piping system for 2 hours, then discharge into waste until all traces of chlorine have been removed.

Chemical Pollution

Of the many chemical pollutants found in water supplies, nitrates appear to be most hazardous to health. If the test analysis of a water sample indicates the presence of nitrates in excess of about 45 p.p.m., the water should be considered hazardous for consumption by infants. Over 100 cases of methemoglobinemia (nitrate cyanosis), including 14 deaths, resulting from nitrate poisoning were reported among infants in Minnesota from 1947 to 1950. Although infants are more susceptible to the harmful effects of nitrates, adults and animals can also be affected at high concentrations.

Decomposing organic matter is the most common source of excess nitrates. Water percolating through soils where organic decomposition is taking place carries nitrates with it. Unlike bacteria, which decompose rapidly with time and can be absorbed by percolation through the soil mass, nitrates are carried and remain indefinitely in the ground water supply. Consequently, when nitrates are admitted into a water supply harmful concentrations may build up unless sufficient dilution is provided.

Water from shallow wells (less than 50 feet) is more apt to have high concentrations of nitrates than is water from deep wells. But deep wells are not immune, especially if the well is not properly sealed to prevent water from draining downward from the ground surface along the outside of the casing. Although little is known about variations which may occur in the concentration of nitrates within a given well, studies indicate higher concentrations occur at or near the top of the water table surface. In some instances simply lowering the casing within a well has resulted in obtaining a water much lower in nitrates.

Situations where pollution by chemicals—such as nitrates—becomes a problem can be alleviated by dilution and/or by removal of the pollutant by pumping. The source of the pollutant must first be eliminated in either case. In some areas the subsoils are already heavily laden with nitrates built up over many years as a result of faulty waste disposal practices. Even though the conditions creating the problem are eliminated, many years may be required in order to restore tolerable levels of nitrates through dilution and pumping.

Water Testing

Water purity can be determined by sending a 1-quart sample to a commercial testing laboratory for analysis. Such laboratories are listed in the yellow pages of your telephone directory under the heading "Laboratories—analytical" or "Laboratories—testing." You may wish to get an estimate of the cost before sending your sample.

If the water in question is being used in a home where there is a child below the age of 6 months or where there is an expectant mother, the Minnesota Department of Health will make a nitrate analysis without charge. Send a 1-pint sample to:

Section of Engineering Laboratories
Minnesota Department of Health
University of Minnesota
Minneapolis, Minnesota 55114

Precautionary Measures for Improved Water Quality

Basic rules to consider in the location and construction of a new water well to reduce chances for biological or chemical pollution, are:

(a) Locate well on ground high enough to prevent surface drainage from entering the well. Extending the casing above the natural ground surface and building an earth mound around the casing provide protection against surface water. A sloping concrete platform should be poured over the mound and around the casing.

(b) Locate well at least 75 to 100 feet from sources of pollution. Greater distances are recommended in coarse-grained or gravelly subsoils.

(c) Install a sanitary well seal between any pipes extending downward in the well and the well casing for protection against entrance of rodents, insects, and other foreign materials.

(d) Provide a grout seal around the outside of the casing to protect against low-quality water present in the upper horizons draining downward into an aquifer of more desirable water.

(e) Disinfect the water and all parts of the equipment with which the water comes in contact by pouring a chlorine solution into the well.

(f) Fill and cover all abandoned wells in the immediate vicinity to prevent direct entrance of pollutants from ground surface. ■

SURFACE WATER OF MINNESOTA

Curtis L. Larson

Because of Minnesota's many lakes, it might appear that we have an overabundance of water. We have more than 14,000 lakes over 10 acres in size, giving us a water area of more than 5,000 square miles, the largest of any state in the nation.

In terms of water available for consumption, however, Minnesota ranks below about three-fourths of the states. The state's annual precipitation averages 25.5 inches, and only 5 inches of this is left over after evaporation and transpiration. Thus our relatively large water area is not due to high rainfall or runoff, but to such factors as the generally flat topography, the action of receding glaciers, and a relatively cool climate.

Water area is important from the standpoint of recreation, a *nonconsumptive* use. Nonconsumptive uses also include water power, cooling, navigation, and any use in which all the water used is left in place or returned. Withdrawal of water without returning it is *consumptive* use. Irrigation is a good example, but is not a major water use in Minnesota. Municipal and industrial uses are generally considered consumptive, although about 90 percent of the water withdrawn for these purposes is returned to the streams. Therefore, surface water can be used over and over again if its quality is maintained.

Measuring Streamflow

Streamflow records have many uses. They indicate the amount of water available for use each year; sufficient length of record is necessary to determine the average annual amount available and to determine the variation from year to year. Distribution of flow within the year is also important. Streamflow records, including peak flows, are needed for predicting probable peak flows in the future. This is the first step in designing any channel, culvert, gully control structure, or any structure handling runoff water.

Curtis L. Larson is an associate professor in the Department of Agricultural Engineering.

Streamflow is measured by the U. S. Geological Survey, with assistance from the state, at 104 locations in Minnesota. At each location a recording instrument is used to obtain a continuous record of the water level, which is translated into the rate of flow. Average daily flows are calculated for each day of the year and published along with peak flows, monthly and annual totals, etc. In addition, peak flows only are measured at 134 locations on highway bridges and culverts.

Annual runoff amounts at the various stream gaging stations are given in terms of inches of water over the watershed, so as to be comparable to annual rainfall. Runoff amounts for an average year have been compiled for the state and are shown in the outline map. These are roughly the amounts of water one has to work with in any water storage or water utilization project.

These are generalized values for an average year and for a watershed ranging to several hundred square miles —the average area represented by a gaging station— typical of that section of the state. Local areas may have considerably more or less runoff than indicated here, depending on the soils and geology of the area.

Note from the runoff map that the amount of runoff varies greatly throughout Minnesota. It is extremely small in the west increasing considerably to the east, though still small in comparison to eastern states. This very pronounced difference across the state is due largely to two climatic factors:

Average annual runoff in Minnesota.

1. The annual rainfall increases from west to east, from a minimum of less than 20 inches in the northwest corner of the state to about 33 inches in the southeast.

2. Evaporation and transpiration rates decrease steadily though not as rapidly from southwest to northeast, being influenced by temperature and humidity. Since the difference between rainfall and evapotranspiration becomes runoff, the net result is as shown on the map.

This picture changes drastically from one year to the next with the amount of rainfall. In a year of subnormal rainfall there is generally little or no runoff except during the spring thaw. So in such years lake and ground water levels inevitably decline, especially in the western part of the state. In the year or years that follow, a part of the surplus goes to restore these levels. Likewise, there are occasional years of above-normal rainfall and much greater than normal runoff.

Is Our Runoff Data Adequate?

If 20 years or more of streamflow data are available for the site of a proposed water project, one can do a comprehensive job of planning the project. Unfortunately, this amount of data is rarely available.

In Minnesota the average stream gaging station represents an area of about 800 square miles. Only about 1 in 10 of our regular gaging stations is located on watersheds of less than 100 square miles. Since the small watersheds far outnumber the large, we have fairly good data on large streams but little data on small watersheds.

Although the large watersheds are still important, much development work is now being done on the small ones. Take for example the USDA small watershed program started in 1954 to provide protection from flood and sediment damage and since modified to include development for municipal, industrial, and recreational water supply. Only rarely do USDA hydrologists find that the watershed under consideration has the streamflow data they need. Likewise, highway department hydrologists are faced with a dearth of data whenever they set out to plan culverts and bridges for our new highways.

Although the network of stream gaging stations is being increased steadily, we can never hope to measure the flow from every small watershed in the country. We are giving serious thought to sampling approaches of various types to provide the small watershed data we need. One possibility is the use of correlation techniques to relate the flow at base stations with long continuous records to several nearby "satellite" stations, which would be moved in a few years to other small streams.

Increasing efforts are being made to relate runoff to rainfall, since rainfall data is more generally available, cheaper to collect, and generally less variable than runoff. This requires a good knowledge of the many processes that take place between rainfall and runoff, as well as statistical techniques. Recent developments in this field of *synthetic hydrology* show considerable promise for the future.

As we attempt to expand our basic data on surface water resources, we should also expand our studies on how various watershed factors affect streamflow. For example, we need the ability to predict how conservation practices and other changes in land use will affect future runoff.

Minnesota is fortunate to have a great natural resource in its surface waters, both its lakes and its streams. These waters are essential to municipal and industrial water supply as well as to our large recreational industry. Fullest use of this great resource requires sound management and depends on increased efforts to obtain adequate hydrologic data and a better knowledge of hydrologic processes. ■

References:
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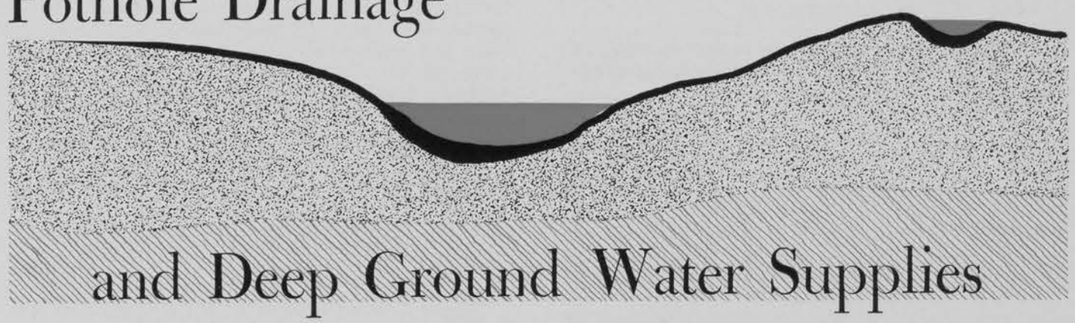


Pothole Drainage and Deep Ground Water Supplies

George M. Schwartz and Philip W. Manson

Draining potholes for agricultural and other purposes is often said to deprive the ground water of an important water source. Yet, as far as we can learn, there is little evidence to substantiate any definite conclusions as to the effect of pothole drainage upon ground water resources.

In 1962 the Minnesota State Soil Conservation Committee made funds available to the Department of Agricultural Engineering to start a basic research study of the hydrology of potholes in Minnesota. The specific purpose of our study is to determine the effect of pothole drainage upon deep ground water supplies. Potholes in this study are considered open bodies of water not exceeding 10 acres in size. The trends and conclusions presented in this article are based on 1-year observations.

George M. Schwartz is professor emeritus, (Geology); Philip W. Manson is a professor in the Department of Agricultural Engineering.

The Theoretical Relations of Potholes to the Water Table

Some concept of the possible relations of water in ponds and lakes to the water table is desirable in approaching the pothole problem. We generally assume that in moist regions there is a saturated zone below the ground surface, the surface of which is called the water table. Actually, if the soil is very low in permeability or if rocks, such as granite, exist at or near the surface the water table may be discontinuous or nonexistent.

Some lake levels coincide with the water table. Others, particularly small lakes and ponds, may be perched above the main water table and perhaps coincide with a *perched water table*—a local saturated zone held above the regional water table by an impervious layer. With these concepts as a starting point, we considered the various situations in which potholes occur in the complicated glacial deposits of Minnesota.

From our experience it seemed that the situations were more complicated than indicated by just a twofold classification. If a pond or lake exists in highly permeable surficial deposits, such as well-graded coarse sand, the open water surface must necessarily coincide rather closely with the water table. But if the soil or bottom sediments in the pond are relatively impermeable, different possibilities arise.

A study of the many topographic maps available for Minnesota revealed a striking lack of water-level adjustment of potholes and of many lakes to anything resembling the topography of a regional water table. Moreover, it was well known from soils and glacial sediments that a wide range of materials were involved. In this aspect of the problem, consideration of the different glacial deposits was essential.

Taking into account the many variables involved, we classified five types of situations. More subdivisions might be envisioned, but we wanted to keep the classification as simple as practicable.

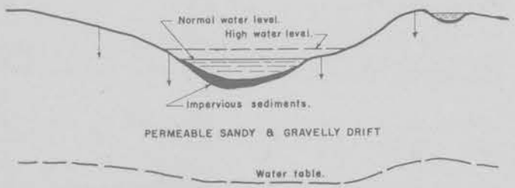


Figure 1. Pothole perched above the regional water table and sealed in by impervious sediments deposited in the pothole.

Most potholes in glacial deposits were probably formed by melting blocks of ice buried in debris deposited by the glacier. In places the glacial debris may be made up of sand, gravel, and boulders, and is highly permeable. However, it seems probable that the glacial drift, at first unprotected by vegetation, would often be subject to rapid sheet erosion which would result in deposition of fine-grained sediments in the low spots. This deposition would deter seepage and start the pond formation. It is also possible that an organic sediment deposited in the water would act as a seal.

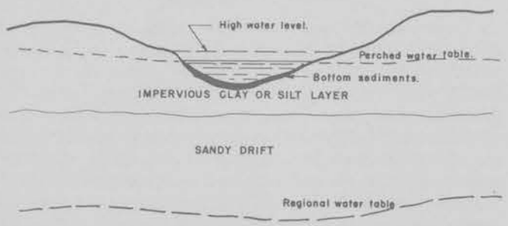


Figure 2. Potholes with perched water held in by an impervious layer high above the regional water table.

Glacial sediments are often stratified. Large areas in Minnesota have glacial sediments from the last glacial invasion overlying earlier deposits, which are derived from sources to the northeast and are sandy and gravelly, whereas later deposits have a high content of clay and silt. Thus impervious clay layers do overlie sandy drift. In this situation the perched water table may be more extensive than is the case in the situation discussed under figure 1.

Figure 3. Potholes at different elevations in highly impervious silt and clay.

Sediments deposited on the bottom of potholes need not be impervious. Under this condition the water table is uncertain because of the impervious clay and silt.

This situation may be expected to exist rather widely over the prairie areas of western Minnesota. Where the gray drift deposited by the Des Moines lobe of the late Wisconsin age is widespread the drift has a high clay content and percolation of water downward is slow or perhaps entirely absent in areas of great thicknesses of clay and silt. The existence of a deep water table may be problematical, as wells have been drilled several hundred feet in such areas without encountering water. In this situation ponds and lakes exist independent of each other and often at widely differing elevations. This condition has been observed in the older deposit where a moderate amount of fine material seems to lower the permeability drastically.

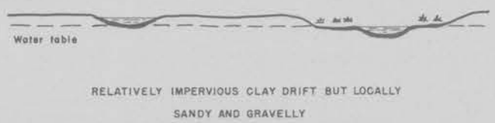


Figure 4. Water table in a relatively level area characteristic of large areas of prairie in southwestern Minnesota.

Over much of the prairie the soil has a high content of clay and silt. In this situation the significance of a shallow water table and potholes at nearly the same level is uncertain. Are they so because the country is level or do they represent the emergence of the water table at the surface? A study of the relation of potholes to drainage ditches may give the answer. Does a series of ditches designed to lower the ground water level necessarily drain a pothole, or are auxiliary ditches or tile necessary? This fourth type presents the most difficult problem involved in the project.

The condition illustrated in figure 5 is probably responsible for many lakes and potholes in the area of the Anoka Sand Plain which covers much of Anoka County; a small area in northern Ramsey County; and large adjacent areas in Chisago, Isanti, and Sherburne Counties. Somewhat similar long and narrow areas occur along the Mississippi River north of Minneapolis. The soil is very

Figure 5. Potholes determined by the regional water table in a relatively level sandy flood plain or terrace.

sandy, and generally highly permeable. The areas are usually nearly level but low with respect to the drainageways.

The water table of the Anoka Sand Plain is known to be close to the surface, and in the absence of ditches large areas were originally occupied by the so-called "wire-grass marshes. Topographic maps show the numerous lakes and ponds at closely similar elevations and, presumably, closely adjusted to the shallow water table. An intensive study of this type of occurrence will be particularly valuable for comparison with the areas of less permeable soil.

Our Present Research Program

Investigation of the validity of the five situations described above involves several differing types of work.

1. Perhaps foremost is an accurate record of the water levels in a considerable number of widely distributed potholes in as many different situations as possible. These observations must be at short intervals during the period of high evapotranspiration and this data must be correlated with the rainfall as far as possible. Observations over several seasons would be desirable. Observation of water and ice levels during the winter should be particularly desirable.

2. It is necessary to determine by test holes the position of the water level in the ground near the lake or pothole and to observe this level over a period of time. The ground water level, or lack of it, at the time test holes are dug is not necessarily the stable level. Slow percolation of water into the hole takes time.

3. A sampling of the deposits in the bottom of the ponds and lakes is essential. These sediments are twofold in nature: Organic deposits may be present in layers approaching many feet in thickness in practically all bodies of water which have existed for a considerable time. Below the organic sediments will be either the original deposits left by the melting ice or a deposit of fine sediment washed in before a cover of vegetation was established over the land to limit erosion. Also, recent sediments may be the result of erosion from cultivated fields. The proper sampling of the bottom sediment is the most difficult aspect of the necessary program. Tests must be made to furnish information on the size classification of the sediments and to determine relative and absolute permeability characteristics.

4. It is desirable to obtain some idea of the relative permeability of undisturbed surficial material near the water by infiltration tests in the test holes. Preliminary investigations indicate wide variation in the permeability of material adjacent to potholes compared to relative uniformity in the bottom sediments.

5. Finally, use of harmless chemicals, radioisotopes, and other means of "tagging" specified waters is being considered for tracing the movement of ground waters in the vicinity of the potholes. The chemical quality of the deep ground water supplies under or near the pothole will be compared with the water quality of the pothole to try and develop a quick and reliable correlation of the flow relationship between the two water sources.

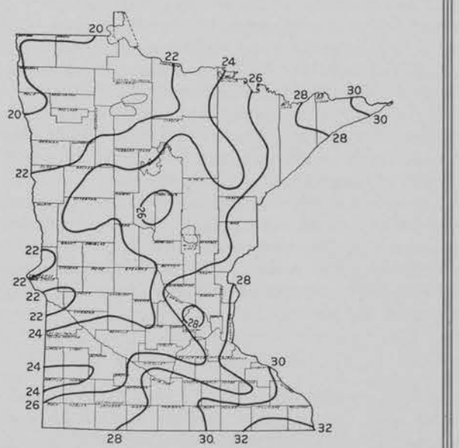
Presently some 100 potholes and lakes well distributed over the major geological environments of Minnesota are under observation.

Conclusions

Because of the limited data now available we cannot give definite conclusions in this article. Available data indicates that the common pothole lined with a highly impervious sediment or the common pothole surrounded by a highly impervious silt or clay soil contributes little water to the deep ground water supply. Where the pothole is not sealed, as is common in the sandy flood plain, the surface elevation of the pothole is generally an expression of the elevation of the ground water table.

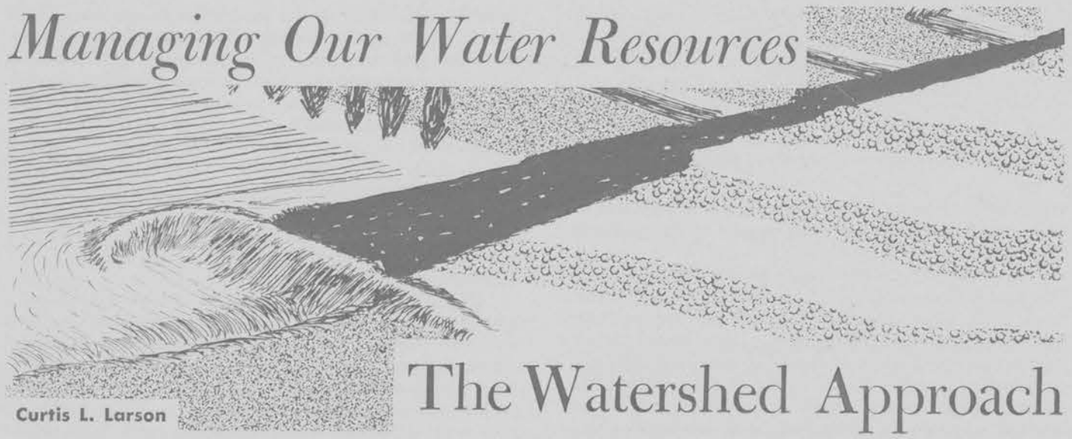
The changing water surface elevation of most potholes can be closely correlated to rainfall, run-in, and calculated evapotranspiration losses. Water movement through the highly impervious layer underlying most potholes seems so small and insignificant that water losses through soil seepage apparently does not appreciably affect the water elevations of most potholes.

If these early observations are substantiated by the completed research program, the drainage of potholes situated in highly impervious surroundings will be known to have little or no effect upon the deep ground water reservoir. ■



Average annual precipitation, in inches, for Minnesota

Managing Our Water Resources



The Watershed Approach

Curtis L. Larson

Today Minnesota has an ample supply of water. But demands for water use are growing rapidly; careful water planning or management is necessary to assure future generations of Minnesotans an adequate supply.

Good water management means that we can use and enjoy our water resources, but that we must use them wisely. We must see that our annual water use does not exceed the annual supply. We must avoid waste and pollution. We should recognize that water has many uses and proceed to develop and use our water supplies for the greatest common good.

It is now apparent that these goals can be accomplished only by using the *watershed approach* to our water problems. By this approach various water problems are considered jointly and a watershed is considered as the problem area, rather than a township, a suburb, or a small area where a single problem exists.

Combining the watershed approach with principles of sound water management, we find three main phases or steps in solving the water problems of a given area. They are (1) determining the water resources and water problems of the watershed, (2) determining the water needs and possibilities for water development in the watershed, and (3) preparing a watershed plan of development which provides the greatest continuing benefit to the people of the area and of the state.

Separate articles on our surface water resources and various aspects of water planning are found elsewhere in this issue of *Minnesota Farm and Home Science*. This article describes some of the water problems existing in Minnesota, and engineering phases of watershed management and planning.

Our Water Problems

In Minnesota, streamflow comes from four sources: snow melt, storm runoff, surface storage, and ground water. As snow melts some water infiltrates into the soil and some runs off. The relative amounts of infiltration and runoff are highly variable, depending on frost conditions and rate of melting, as well as other factors. If the snow has accumulated to a considerable depth and melting is rapid, spring floods are likely to occur on our medium- and large-size streams, such as the Red, Minnesota, and Mississippi Rivers. Floods are not common in Minnesota but, to anyone affected, flooding is a serious problem.

In many streams, especially the smaller ones, large flows are more often the result of spring or summer rainstorms. Storm runoff is greatly influenced by the moisture content of the soil. If the soil is dry and if the rainfall rate is low or moderate, only a small portion of even a large rain runs off. Following the spring thaw, however, the soil retains ample moisture for some time, since temperatures are still low and crops are at an early stage. Thunderstorms and heavy rains generally begin in May. Thus floods caused by storm runoff are most likely during May and June. Combining this with runoff from snow melt, we find that 50 to 80 percent of the annual runoff of Minnesota streams usually occurs in a 3-month period beginning in March or April.

Much of our state has rather flat topography. As a result excess water runs off very slowly, leaving the soil saturated for weeks at a time. About 45 percent of the land area of the state is or was too wet for satisfactory crop growth and efficient farm operations. In the good soil areas of southern Minnesota and in the Red River Valley a great deal of drainage work has been done to ease this problem, but many wet areas remain. The practice of agricultural drainage will undoubtedly continue, since the individual farmer must increase his efficiency to maintain a satisfactory income.

During the late summer, fall, and winter, our streamflow is derived mainly from ground water or from storage in our many lakes. Occasionally rainy periods may add to this. If the year is relatively dry, ground water levels and lake levels recede and by midsummer, many small streams cease to flow.

Several types of outdoor recreation are growing by leaps and bounds, and most are associated with water areas. Despite our many lakes we may soon find ourselves short of space for the many people interested in fishing, boating, water skiing, camping, and canoeing. Eliminating pollution and increasing the summer flow of our streams could make them useful for these purposes. To do so, however, we would have to operate some of our larger lakes as storage reservoirs, releasing more water during the summer months.

In general, rural areas and small towns must rely on wells for their water supplies, since well water does not require extensive treatment. The availability of ground water depends to a large extent on the geology of the area. In southeast Minnesota and other small areas the supply is generous; the north-central part of the state has a good supply for shallow wells. In some areas of western Minnesota both surface and ground water supplies are very limited; this is a limiting factor in attracting industries to certain communities.

We must also be concerned with water quality as well as water quantity. We still have far to go in eliminating water pollution to make our waters suitable for all types of use. We must also continue to improve our land use to cut down on soil erosion, the main source of most sediment in our streams. Muddy streams and lakes are of little use. Sediment laden runoff steadily reduces the capacity of streams and lakes and, when a flood occurs, greatly increases the total damage.

We have seen that many of our water problems stem from the uneven distribution of water in nature, both in place and in time. These problems are found, to a greater or lesser degree, throughout the country. If and when we are willing to accept the cost and perhaps some inconvenience, we can usually find a method of redistributing the available water from areas of surplus to areas of shortage, or from time of surplus to time of shortage.

Storing Water

Since much of our total runoff occurs during short periods of heavy flow, the obvious remedy is storage in reservoirs. Thus the construction and operation of reservoirs can be an important method of water management. Reservoirs can be made to serve many purposes—flood control, water supply, various forms of recreation, etc. However, they are sometimes costly and difficult to justify economically. Furthermore, we may find conflicts between various uses.

If our only object is flood control we build a reservoir and keep it empty, ready to receive a flood at any time. When a major storm occurs, water fills the reservoir and is released at a reduced rate so as to cause no flooding downstream until the reservoir is empty. Such a reservoir is called a *detention reservoir* and flood control is its only purpose. Major flood reductions are possible for some distance downstream of a detention reservoir, but not in areas far downstream.

If we are interested in water supply for any purpose we build a reservoir and attempt to keep it full rather than empty. We release water only when needed, whether to maintain a minimum flow in the stream below, to supply a town with water, or some other use. Thus the operation of a *storage reservoir* is contrary to that of a detention reservoir.

If both flood control and water supply storage are desired, it may be possible to make the reservoir large enough for both. The dam and spillway are constructed in such a way that the lower part of the reservoir becomes the storage reservoir, and is kept full if possible, and the upper part is reserved for flood storage and kept empty. This causes wider fluctuations in water levels, which may be a disadvantage. The only alternative is to build separate reservoirs for each purpose, at a considerably higher total cost.

Other methods of flood control can be used instead of or with detention reservoirs; most common of these is *channel improvement*. This includes deepening, widening, and straightening of the main channel to increase its capacity. It is often an effective and economical method of reducing flooding in the local area, but does nothing to help areas further downstream. On many projects a combination of upstream reservoirs plus some downstream channel improvement proves to be the best solution. Levees are occasionally used but are best suited for protecting small, high-value areas such as towns or farmsteads.

In planning any type of reservoir one must find a suitable site. Some parts of Minnesota are so flat that there are no reservoir sites. An ideal site is one in which a dam of moderate height will produce a reservoir covering a considerable area, thus producing a large volume of storage.

In steeply rolling topography there are many possible sites for small dams, but many of these require a relatively high dam to obtain a moderate amount of storage. Better results would be obtained with one or two larger dams in the main valley, except that this may mean flooding valuable farmland, a farmstead, a major highway, or a railroad. There are other requirements to consider, such as the ability of the subsoil at the dam site to support the weight of a dam, seepage losses, and the location of the reservoir in relation to the area to be served or protected.

Another important question in planning a water storage project is "Will the runoff into the reservoir be adequate to maintain the desired water level?" This is most likely to be a problem in western Minnesota, where annual runoff is only an inch or two. Evaporation and seepage are the principal losses. In northeast Minnesota and along the Wisconsin border evaporation from a lake or reservoir is normally less than precipitation on the water area, so is not a problem. In the rest of the state, however, there is a net loss, increasing from northeast to southwest to a maximum of 12 inches per year in the southwest corner of the state. So in western Minnesota a reservoir or lake must have a relatively large watershed to offset evaporation and seepage losses. Fortunately, seepage loss is not high in this area, but is very difficult to estimate. In parts of southeast Minnesota storage reservoirs are not feasible because of high seepage losses through cracks and holes in the underlying limestone.

To avoid filling with sediment, the watershed above a reservoir must be well protected from erosion. This is or should be a requirement before proceeding with any type of reservoir project. Therefore, the cooperation of all people in the watershed is necessary for success.

How Does Land Treatment Affect Runoff?

Land treatment refers to the application of soil conservation practices or vegetative cover to the land. The principal purposes are to protect the land from soil erosion and to keep sediment out of our streams, lakes, and reservoirs. Land treatment also tends to reduce storm

Curtis L. Larson is an associate professor in the Department of Agricultural Engineering.

Reduction in storm runoff amounts by plant cover at Fenimore, Wisconsin, and Edwardsville, Illinois

Storms occurring, on the average, once in:	Reduction in storm runoff	
	Fenimore, Wisconsin (3 watersheds)	Edwardsville, Illinois (1 watershed)
2 years	42%	10%
5 years	28%	8%
10 years	24%	8%
25 years	22%	7%
50 years	21%	6%
Percent cultivated		
Before:	47%	96%
After:	17%	0%

runoff. The important questions are, "How much?" "Is it enough to be important?" "And does it affect the total flow for the year?"

To answer these questions we need years of data from carefully controlled research watersheds. These must be side-by-side watersheds similar in all respects except the amount of land treatment. We have no studies of this type in Minnesota, but several such experiments have been carried out elsewhere in the country on both agricultural and forest land.

The nearest of these studies was conducted in southern Wisconsin and northern Illinois by the Agricultural Research Service. At Fenimore, Wisconsin, three watersheds up to 330 acres in size were established in 1938 in an area having moderately permeable soils similar to those in southeast Minnesota. During the period since 1938 various changes in plant cover were made. For the four watersheds, the average area in cultivation was reduced from 47 percent to 17 percent. We see in table 1 that for storms occurring about once in 2 years runoff was reduced by 42 percent, a considerable reduction. For a storm occurring once in 50 years, the average reduction was much less (21 percent).

For these soils then, we can conclude that land treatment can have an important effect on flood runoff if applied to a substantial portion of the watershed. We must conclude also that the greatest benefit is for the moderate size storms rather than for the large storms which cause major floods.

The Illinois watersheds were in a soil area having an impermeable layer or claypan 10 to 20 inches deep. These soils were therefore well below average in permeability. Although different in origin and character, these Illinois soils are somewhat similar to those of south-central Minnesota in terms of permeability and infiltration capacity. On one of these watersheds the cultivated area was reduced from 96 percent to zero, or 100-percent alfalfa, as shown in table 1. Despite the virtually complete change from cultivated land to cover crops, the reduction in storm runoff was only 6 to 10 percent, much less than for the Wisconsin watersheds. The conclusion is that for soils of low permeability, land treatment has only a minor effect in reducing flood runoff.

This and similar studies show that there is no simple answer to the question of how plant cover affects flood runoff, since it depends also on the nature of the soils. It does show that, in any area, we cannot hope to stop floods by land treatment alone. In certain areas we may be able to eliminate many of the smaller floods in this way, but certainly not the large ones.

Effects of similar magnitude are obtained with soil conservation practices, such as contour cultivation, contour strip cropping, and graded terraces. They may reduce small floods considerably, but have a limited effect on large floods. However, these practices are well worthwhile for erosion and sediment control alone, so that the flood reduction they provide, though limited, can be considered an extra benefit.

How about the effect of land treatment on annual runoff, and on streamflow during dry periods? There is little data with which to answer these questions, since

Detention reservoirs and soil conservation practices are combined to protect land from erosion and to prevent flood and sediment damage. Note terraces on fields in the foreground.

most of the experimental watersheds are necessarily small in size and often have no ground water flow. If extra water infiltrates into the soil during storm periods due to land treatment, what happens to it?

Land treatment usually involves more vegetative cover with higher transpiration losses. The increases may or may not be great, depending on the type of vegetation, the extent of the change, the soil, and the climate. The net effect may be either positive or negative, depending on which is greater, the extra infiltration due to more vegetation or the extra transpiration. In any case, we cannot afford to remove vegetation as a method of attempting to increase streamflow if there is an erosion hazard or a flood hazard, or if we are dealing with productive land. Neither should we hesitate to use land treatment because of possible adverse effects on annual runoff. When and if water becomes scarce and expensive in our area we will give this problem more consideration.

Some additional techniques for conserving water which we might use in the future are now being developed. Evaporation from small experimental reservoirs has been reduced about 30 percent by a thin layer of certain harmless chemicals. But no practical way of maintaining such a layer against wind action on a large body of water has been found.

Experiments are being conducted on reduction of transpiration by plants. Plastic films can be used to reduce soil evaporation, if the cost can be justified, or to increase runoff, if desired. In the Los Angeles area water spreading is a common practice—shallow ponds are built along streams and water is diverted into them. Infiltration from the ponds adds to ground water supplies. To be practical, this method requires very permeable soils. Undoubtedly practices like these will be more highly developed and more commonly used as the cost of water increases.

Watershed Programs

In Minnesota, a multipurpose watershed project can be carried out through a state or federal program, or both.

In 1954 Congress passed the Watershed Flood Prevention Act (Public Law 566) which gave the U. S. Department of Agriculture the responsibility for flood control on watersheds under 250,000 acres. This program is intended to relieve flood damage in upstream areas, but will not greatly reduce floods on major streams. Larger projects will continue to be carried out by the Corps of Engineers.

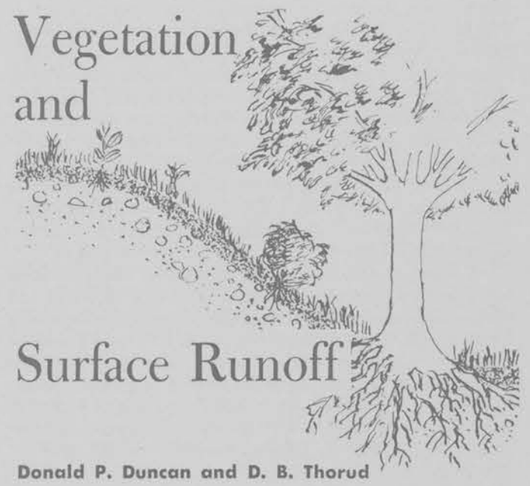
The main purpose of the USDA program, carried out by the Soil Conservation Service, is to prevent flood and sediment change. However, such a project may also provide for drainage or irrigation development, or for municipal, industrial, or recreational water supply. Recent changes by Congress authorize the installation of recreational facilities under this program.

State action on watershed projects is being carried out through the Minnesota Watershed District Act of 1955, amended in 1959. Watershed districts can be organized along watershed lines, thereby using the watershed approach. Districts can take action on any or all types of watershed problems and obtain needed funds by special assessment.

The watershed district and federal programs have proved to be complementary rather than competing programs. Fourteen watershed districts have been organized so far. Some of these have been organized to provide the local cooperation and local financing for PL 566 or Corps of Engineering projects; others are doing their own planning and construction. In all cases the district manages the affairs of the watershed when the project is complete, and often decides to make added improvements.

Thus we have the legal means for organizing and carrying out any type of watershed project. We have sufficient knowledge to proceed, though continued research will no doubt improve our planning and present new opportunities. However, because many people and various interests are involved in water projects, the greatest needs are a spirit of cooperation and a willingness to share the costs. ■

Vegetation and Surface Runoff



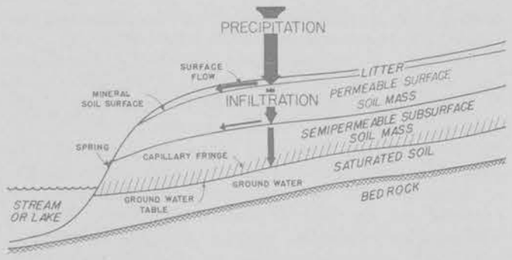
Donald P. Duncan and D. B. Thorud

Water originating as rain or snow may flow over land surfaces into streams and lakes or it may move through the soil (see diagram). Two distinct advantages accrue from movement through the soil rather than over its surface. One advantage is the delayed arrival of rainfall at streams which results from greater resistance to flow within the soil. Streamflow flood peaks on small watersheds can be materially reduced by maximizing entrance into the soil and minimizing surface runoff. The second advantage is greatly reduced erosion. Surface runoff often has a high erosion potential and frequently transports soil particles from the land to lakes, streams, and reservoirs. Flow beneath the surface normally does not have this effect.

Many factors influence how water reaches streams and lakes—whether it arrives as surface runoff or as flow through the soil. Soil structure, texture, and moisture content; rate of precipitation; and other variables have an important effect. But the vegetative cover on the land also has a primary influence.

Vegetation affects infiltration (the entrance of water into the soil surface) in a number of ways. Over a period

Donald P. Duncan is professor and assistant director, School of Forestry; and D. B. Thorud is an instructor in the School of Forestry.



Possible distribution of precipitation as seen in a cross section through a hillside. Width of arrows indicates proportion of precipitation.

of years it provides a surface accumulation of decaying organic matter. Through the activity of micro-organisms, earthworms, burrowing mammals, and other forms of life, this litter and humus gradually becomes incorporated into the surface mineral soil. There it helps to create a loose, porous medium through which water moves readily. Organic matter also tends to stabilize soil aggregates against breakdown, thereby preserving soil porosity.

A thick organic blanket which frequently can be found overlaying the soil in forests has a second beneficial effect: by offering physical resistance to flow it retards surface runoff rates. Thus water that might otherwise be channeled into destructive surface flow is detained and at least partially absorbed by the soil.

A third, and perhaps most important, effect of litter and humus layers stems from their ability to shield soil surface aggregates from the highly destructive impact of beating raindrops. Where organic matter is burned or otherwise disturbed the exposed soil often becomes sealed during rainstorms as a result of aggregate breakdown and plugging of pores. Local flooding and erosion may become a problem with these impermeable soil conditions which lead to increased surface runoff rates.

Effect of Vegetation on Frost

Vegetation also affects soil frost formation. During the spring snowmelt period, deep hard frost in the soil may cause surface runoff in large amounts. On the other hand, a soil only partially frozen or with a porous type of frost permits much of the melt water to enter the soil.

School of Forestry research in an old oak stand on land owned by the St. Paul Water Department indicates that frost depth and duration are materially affected by snow cover, by litter, and by soil compaction. Snow cover may be reduced considerably under a dense evergreen forest where foliage retains a substantial proportion of the annual snowfall. Such interception increases the depth of penetration of soil frost. On the other hand, in a deciduous forest, such as oak, the crowns hold little snow.

For 1963, in the oak stand under study the maximum winter frost penetration occurred in late February. At this time, natural undisturbed plots had an average frost depth of only 34 inches. On plots where snow had been removed all winter the maximum frost depth was 47 inches. This 13-inch increase over natural conditions developed in the absence of snow cover, which seldom exceeded 5 inches of depth in undisturbed areas of the oak stand.

Like snow, litter formation under forest cover also insulates the soil and thereby reduces frost penetration. Litter removal increased maximum frost depth by 5 inches in the stand studied. Thus snow appeared to be the most effective insulator. Compaction of the soil increased frost penetration by about 2 inches compared to undisturbed soil. The most severe treatment of combined compaction and snow removal had a maximum frost penetration of 52 inches, representing an 18-inch increase over natural conditions.

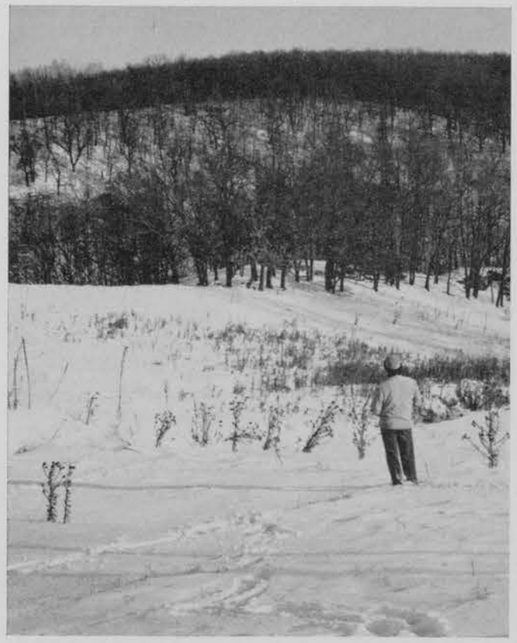
Frost disappearance in the spring was postponed by about 10 days in the combined compaction-snow removal plots and also in plots where only snow was removed. Under certain conditions this delayed softening of the soil may increase spring runoff.

Research in the Whitewater River Valley

The interaction of vegetation, topography, and land management can also materially affect the runoff properties of a region. In the Whitewater River Valley of southeast Minnesota this interaction is important. Here and in other valleys in that section of the state spring floods are the rule. The ridge tops and uplands above the valleys are generally cultivated, as are some of the bottom lands, but many of the slopes are still clothed with natural vegetation.

To study the effect of cover type, aspect (direction in which the slope faces), and degree of slope, as well as to define the effect of grazing upon surface runoff, a series of plots has been installed on slopes in the Whitewater area (see photo). All are one-hundredth acre in size (10.0 feet wide by 43.6 feet long). Each is bounded by water-repelling barriers, except at the bottom where a surface runoff collection trough spans the plot. Standard rain gauges are installed near all plots and two recording rain gauges have been included in the experiment for rainfall intensity studies. Precipitation interception by tree cover is also being measured.

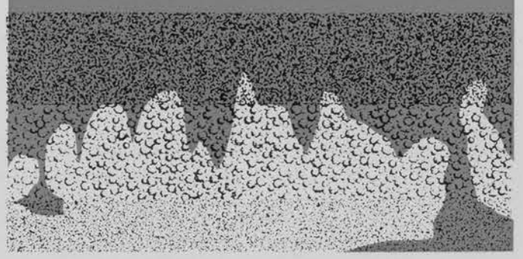
Runoff plots at the Whitewater are located in open areas (foreground), in woodland (background), on various aspects or exposures, and on grazed and ungrazed slopes.



Thus far, most effort has been devoted to instrumentation perfection. However, preliminary data indicate that little surface runoff occurs on undisturbed woodland and dry southwest-facing slopes while even light grazing increases surface runoff. Although southwest slopes are not heavily vegetated and have thin soils, the underlying limestone rock is permeable and appears to accept water readily.

The forester managing noncultivated land, whether he be a timber producer, a pasture or range specialist, a wildlife habitat manager, or one concerned with the provision of outdoor recreation, must give some attention to watershed values. One portion of the hydrologic cycle where his intervention may be most effective is that which determines whether precipitation shall enter the stream as surface runoff or more slowly as subsurface or ground water flow. But he first needs to know what results various types of management will provide. Current School of Forestry research is directed to this end. ■

Infiltration Rates



How Fast the Soil Absorbs Water

Richard H. Rust

Knowledge of the rate and the amount of water which can enter the soil is essential to the efficient use of both soil and water. Water infiltration and soil permeability values are necessary to evaluate possible erosion losses, water conservation, and the design of dams and other surface drainage structures required in watershed planning.

Since more than 96 percent of Minnesota's land area is agricultural or forested, the soil obviously plays a major part in both the use and conservation of precipitation which falls upon it. Data presently available are too few on which to base adequate water conservation practices for Minnesota soils.

Our current research on this problem is developed around methods of simulating rainfall, applying the "rainfall" to various soils under a variety of cropping and tillage practices, and measuring the rate at which water runs off measured plot areas. The total amount of water applied minus the amount which runs off is equal to the absorbed, or "infiltrated" water. This is usually expressed in time intervals, such as inches per hour.

If we establish a rate in inches per hour for a given soil and crop and we measure the natural rainfall intensity in inches per hour, we can predict the probable occurrence and amount of runoff or ponding that might occur. In predicting runoff we must, of course, take into account water added from adjoining land.

In the 12 North-Central States, where intensity of rainfall is especially variable, a current research project is attempting to establish infiltration rates on some 35 to 40 extensive soils. In Minnesota we are presently concerned with the Webster, Kenyon, Port Byron, and Barnes soils, all of which occur in our corn and grain production areas.

Two crop conditions, continuous—in the crop 3 or more years—corn and continuous bromegrass, are being studied uniformly throughout the region. These crops were selected on the probability that with the usual tillage, infiltration rates would be significantly higher on bromegrass than on corn.

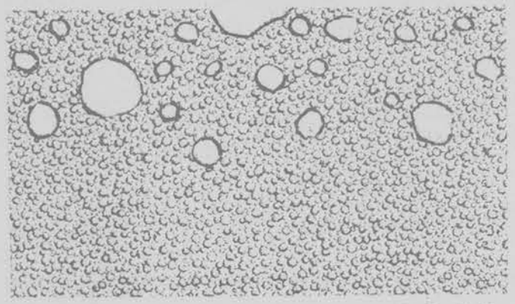
Preliminary data from 2 years of field testing show the following:

1. Infiltration rates when water is applied at a simulated rainfall rate of about 4.5 inches per hour on generally medium-textured soils under corn range from about 0.25 to 1.10 inches per hour; on bromegrass, from about 0.50 to 1.60 inches per hour.
2. Infiltration rates on soils under bromegrass are generally 50 to 75 percent higher than on soils under corn.
3. On soils with dry rooting zones (absence of rainfall for about 2 weeks) infiltration rates are commonly double the rate on wetted rooting zones. Rates up to 2.5 inches per hour have been sustained for more than an hour in dry soils. Eventually, of course, the profile is "filled up" with water and the infiltration rates lower. However, many medium-textured soils require 8 to 10 inches of water to be filled to a depth of 5 feet.

We are continuing this research in attempts to evaluate the effect of such practices as minimum tillage, mulching, and use of surface soil conditioners on infiltration rates. ■

Richard H. Rust is an associate professor in the Department of Soil Science.

Water in the Soil



G. R. Blake

A large part of our precipitation, perhaps 90 percent, enters the soil. This amount is highly variable, of course, depending on the slope, soil type, and crop that is growing. Once in the soil most of it is available to plants for their use. The principal loss thereafter, seepage into the ground water, is a small percentage.

Soil moisture surveys by the Department of Soil Science cooperating with branch experiment stations and the Soil Conservation Service show that water equivalent to about 7 inches of rainfall is stored in the root zone of our soils at the beginning of the growing season. Since plant and evaporation requirements usually exceed precipitation in part of June and all of July and August, this stored water is vital to crops in midsummer.

Minnesota soils contain about 10 times as much water in early June as flows in the Mississippi River past Minneapolis in the course of a year. Because about 70 percent of the earth's land surface is in the northern hemisphere, the world's oceans are shallower by three-quarters of an inch in June than in September due to this reservoir in farmland.

Storage of Water in Soils

The amount of water an individual soil can retain and give up to crops as needed depends first on its texture. Silt and clay soils hold more than sands. But often loamy soils can store more than either sandy or very fine clay soils. Examples of the storage capacities of some representative soils are shown in the table.

Plant-available water than can be stored in representative soils

Soil type	County	Inches of rain that can be stored to the depth shown	
		1 foot	4 feet
Barnes loam	Otter Tail	2.0	8.6
Bearden silt loam	Wilkin	2.1	11.8
Dickinson sandy loam	Redwood	1.3	3.5
Fargo silt loam	Wilkin	2.5	11.2
Fayette silt loam	Wabasha	2.9	11.6
Kranzburg silt loam	Pipestone	2.9	14.6
Mora silt loam	Mille Lacs	.....	7.6
Nicollet clay loam	Watonwan	2.0	9.0

G. R. Blake is a professor in the Department of Soil Science.

The amount of water plants can obtain depends not only on the soil storage capacity, but also on their ability to go after it. Deep-rooted crops can obtain more than shallow-rooted crops because they exploit more of the soil. Alfalfa can remove water to greater depths than can potatoes.

The limits of stored water available to plants are defined by the field capacity and the wilting percentage. After excess water drains through wet soils, losses greatly decrease and the soil is said to be at its *field capacity*. Except for evaporation from the surface few inches, the soil will stay relatively moist for several weeks unless plants remove the moisture.

A crop that covers the surface withdraws from storage every 6 days in warm July weather water equivalent to an inch of rain. When stored water is largely removed, wilting occurs because plant roots can't remove water from competing soil particles fast enough to supply their needs. At this point some water remains in soils, but is very slowly available. This moisture content is commonly called the *wilting percentage*. Available water, then, is that held between field capacity and the wilting percentage.

Drought Resistance of Crops

Drought resistance is not necessarily related to the ability of plants to get water from dry soils. There are three principal reasons for drought resistance:

1. Some plants are able to store water in their tissues; cacti are noted for this. When water is no longer available in the soil the stomatal ports, through which water escapes, tend to remain closed and stored water in fleshy plant parts is used in the necessary functions.

2. Some crops by nature can root deeply and tap deep water reserves. Alfalfa is noted for this. Individual roots have been followed to great depths. Many vegetable plants such as onions, radishes, or lettuce are shallow rooting and are sensitive to water deficiency for that reason.

3. Some plants are able to make a recovery when water again becomes available. Most lawn grasses can become dormant; the aboveground parts die, yet recover very quickly when water is applied.

The daily use of water is virtually the same for all crops that cover the soil surface. The sum of evaporation and transpiration is dependent on the heat energy available. To change water from liquid to vapor requires nearly six times as much heat as to warm the same quantity of water from 32° F. to boiling temperature. More evapotranspiration occurs on sunny than on cloudy days because more heat is available.

Yet it is well known that alfalfa lowers the soil moisture reserves more than does corn, for example. This is not because alfalfa uses more per day, but because it grows actively for a longer season. There is the secondary factor that alfalfa roots tap deeper reserves. With deep water as a principal source, roots in the upper soil horizons continue to lower the soil moisture often well below the wilting point. The moisture deficit in the upper 2 feet of soil may thus be greater under alfalfa than under corn. Unless supplied by fall and spring rains, moisture reserves for the following year are lower under the long-season alfalfa.

Movement of Water in Soils

Water moves rapidly in saturated soils. After drainage to field capacity the rate of movement is greatly reduced. Still, water will flow to the soil surface to supply evaporation for several hours on a summer day. When the soil surface dries, water flow rate again declines greatly and evaporation is slowed. The dry soil surface is an effective "dust mulch." Cultivating at this stage does not improve this barrier to evaporation. In fact cultivating at this stage only turns up more moist soil from which additional water is lost.

Water will move up from a water table to plant roots, but only 3 or 4 feet. Beyond this depth the rate of water movement is too low to be practical. Since most water tables in field soils are fairly deep—15 to 25 feet—we cannot depend on more than a trace of water ever reaching the upper soil layers. Cultivating will not bring water to the crop. However, breaking a surface crust may allow the roots a better supply of oxygen and permit them to go deeper after the stored water.

The question of whether a soil left rough on the surface will lose more or less water by evaporation than if it is worked down is a complicated one. Evaporation from a packed soil is likely to be greater while the soil surface is wet. When the soil surface is dry, evaporation is likely to be greater in loose soil. But even then there is a complicating factor. Loose soil, from which greater losses by evaporation might be expected in the summer, has a much higher infiltration rate than firmed or packed soil. The retention by the loose soil of an inch of water from intense showers that might be lost by runoff from a firmed soil, could easily compensate for and overcome the greater evaporation losses. This is why leaving plowed soil rough depends so much on time of year and nature and distribution of the precipitation.

A consequence of the very slow movement of water into dry soils is that precipitation is not distributed evenly through the soil profile. An inch of water may wet the dry surface 6 to 8 inches while the soil below remains dry. A second rain drives the wet front lower into the soil. For this reason it is unreliable to conclude that soil moisture reserves are good just because the surface soil is wet. It is normal in the early spring to find wet soil to a depth of 2 or 3 feet and dry soil below. But only if deep probings are made can one say whether reserves for use in midsummer are present. Similarly, it is a mistake to assume that just because the surface is dry the soil beneath is dry enough to till. Though the soil is wet underneath, the surface may dry quickly, especially after a heavy midsummer rain. Under these conditions packing from the force of machinery will occur. The wise farmer must look deep into his soil—preferably 3 or 4 feet—to be sure of moisture conditions in the soil profile. ■

WATER in Animal Life

P. B. Hammond

The earliest forms of life on our planet were unicellular organisms dwelling in the seas and lakes. These evolved into more complex structures composed of many cells and specialized parts. The envelope of water surrounding each cell was retained as the architecture of the body became more complex and as various forms of life emerged from the aquatic environment to dwell on the land. All forms of animal life, whether they live on the desert or in the water, are still aggregates of cells surrounded by water and are largely composed of water.

The wateriness of animals is no mere accident of nature; it is an essential condition of life. Much of the body's machinery is designed to assure constancy of the watery environment within.

Dr. P. B. Hammond is a professor in the Department of Veterinary Physiology and Pharmacology, College of Veterinary Medicine.

The watery envelope surrounding body cells is in a state of flux. It is constantly being lost to the environment and replenished from the environment. The constant traffic inward and outward must be carefully balanced, since a net loss of as little as 10 percent of the total body water can be fatal. By contrast, practically all of the body fat and more than half of the body protein can be spared without fatal consequences.

The Functions of Water in the Body

Water is so abundant that its unique properties often go unappreciated. For example, it has greater heat-storing capacity than any other liquid or solid. The advantages are obvious in a cold climate. Water also is the best liquid for cooling systems. The evaporation of 1 pound

of water has a greater cooling effect than does the evaporation of a like amount of any other liquid. It is also an excellent solvent, with the capacity to convey a great variety of substances such as gases, salts, and sugars to the remotest points in the body.

Only a liquid system could serve the complicated transportation problems of animals. The nutritive demands and waste disposal needs of animal cells require a versatile carrier system able to transport a great variety of substances quickly and in the smallest units possible; that is, as individual molecules in solution. It is small wonder indeed that water should occupy such a key role in the life processes as we know them.

The Requirements of Water by the Body

The water requirements of an animal or of a man vary greatly with the temperature of the environment and with the metabolic activity of the individual. Physical exercise, growth, and lactation all increase water requirements.

The need for water rises sharply when the environmental temperature exceeds 80° F. As the air temperature rises the rate of evaporation of water from the surface of the body increases. This is by design rather than by accident. Rather than try to cut down evaporative loss of water, the body actually encourages it by such mechanisms as sweating and panting. This is done to take full advantage of the cooling effects of water vaporization.

The same principle is utilized in the design of air conditioners for the home. If animals did not have this built-in air conditioning system they could not survive even the moderate heat of our Minnesota summers, much less that of the desert regions. It is interesting to note, in this connection, that desert animals are lankier and have more surface area in proportion to their weight than do their counterparts living in more temperate regions. The desert hare, for example, is angular and has long, broad ears whereas the arctic hare is squat and blocky, and has small ears. One type is designed for heat dissipation while the other is designed for heat conservation.

Disturbances of Water Balance in the Body

Disturbances of water balance in animals have two general causes. The first is external and applies almost exclusively to animals living in hot, dry climates. Excessive water loss by evaporation combined with limited intake can and does result in death or severe illness. This is not a common problem in Minnesota. The second general cause is abnormal body function. When the ability of an animal to conserve water is compromised by disease it may die in spite of an unlimited external water supply.

Three examples of common diseases in Minnesota which illustrate disturbance of water balance through abnormal body function are:

1. Severe persistent diarrhea, particularly in young animals, which may be fatal. The cause of death is circulatory failure. Shrinkage of the blood volume, due to abnormal loss of water from diarrhea, reduces to a critical degree the rate at which tissues are nourished.

2. Upper bowel obstruction is a less generally recognized cause of severe water loss (generally referred to as dehydration). When the small bowel of simple-stomached species, such as man or the dog, is obstructed, persistent vomiting with a consequent loss of body water results. Essential minerals are lost with the water. Consequently, the cause of illness or death in this situation is multiple, but the loss of water is a major factor.

Because of its relatively frequent occurrence, we have recently investigated the effects of upper bowel obstruction in cattle. We still don't fully understand the cause of obstruction in all cases. Frequently the acid-secreting compartment of the stomach (abomasum) becomes twisted. Sometimes a segment of intestine will telescope into the adjacent segment, causing obstruction. We also suspect that, in many instances, the obstruction is due to paralysis of the abomasum induced by nerve damage.

Regardless of the cause, the animals always appear extremely dehydrated. There is one outstanding difference between ruminant animals such as the cow or sheep and simple-stomached animals which stimulated our interest in the problem. Ruminant animals rarely vomit. So it was difficult to understand how they could lose fluids when obstructed.

A clue to this seeming paradox was provided by research conducted over 30 years ago. Researchers found that the rabbit, also a nonvomiting species, became greatly dehydrated when its upper bowel was experimentally obstructed; this caused a passage of water and minerals from the body tissues into the stomach. Our own investigations of experimental upper bowel obstruction in cattle demonstrated the same phenomenon; the animals literally dehydrated within themselves. Total body weight did not change, yet as much as one-fourth of the tissue water shifted into the stomachs. It is still not clear why this shift takes place. Further investigation of the problem is needed to clarify its more fundamental aspects.

3. A condition of cattle commonly known as engorgement toxemia, or grain founder, is another example of this peculiar type of internal dehydration. Most stockmen are familiar with this disease; it is the result of sudden, massive consumption of grain. When given the opportunity, cattle literally engorge themselves with grain. This huge accumulation of grain in the rumen is rapidly broken down to lactic acid by the bacterial flora of the rumen. Large amounts of water are drawn into the rumen from the tissues to dilute the acid. The effects on the animal are often fatal. As in the case of obstruction, the rapid movement of water from the tissues is not the sole critical event. The acid moves the other way, into the tissues, resulting in harmful effects on body function.

The problem of engorgement toxemia has been studied by veterinary scientists at many research stations. Studies at the Minnesota Station by Dr. R. H. Dunlop several years ago did much to clarify the relative importance of the water movement as compared to the acid movement in the other direction. Dr. Dunlop demonstrated that if a similar amount of mannitol, an inert, nonacidic material, was placed in the rumen in place of the lactic acid liberated in grain founder, a similar degree of tissue dehydration with fatal consequences resulted. Thus, the dehydration alone was shown to be fatal, independent of the acidifying effects of lactic acid on the tissues.

These three examples of disturbances in water balance presented are representative of the many diseases affecting body water in animals. ■

WATER in Plant Life

T. W. Sudia

Plant physiologists in the Department of Plant Pathology and Physiology are engaged in a research program investigating long-distance transport of substances in plants. Absorption of water and minerals from the soil and their translocation to distant places in the plant is one form of this long-distance transport. This article describes the fundamental behavior of water in the plant upon which much of our long-distance transport research is based.

Since life evolved out of a watery environment, it should not be surprising that water is the most abundant constituent of plant cells and tissues. In lettuce, for example, 98 percent of the total fresh weight may be water.

Water's principal role in the cell seems to be to provide the matrix in which most chemical reactions occur. It also serves as a raw material in the process of photosynthesis. The living plant, in the presence of chlorophyll and light energy, can synthesize all the substances of the living cell from carbon dioxide and water.

Living cells are bounded by membranes which regulate the entrance and exit of materials. Water and certain other substances move readily through membranes, but many substances, particularly the large molecules such as proteins, do not. Dead cells lose the power to regulate the movement of substances.

Plants do not have a circulatory system comparable to that of animals. They do have specialized cells and tissues for conducting water and food substances, but have neither large pipelike channels nor a pumplike organ causing circulation. Plants have specialized xylem cells that become empty when they mature. These cells form the wood of a tree; they are in a continuous system from the root apex to the top of the plant. Water moves in them but must move from empty cell to empty cell, through pits or pores in the walls, or through openings in the end walls.

The water of the soil and the water of the plant form a continuous system through the xylem. The stream of water in the plant is one continuous stream from the cells at the surface of the root to the very top of the plant, no matter how tall it is. Because of the affinity of the water molecules for each other (hydrogen bonds), the water stream is pulled through the plant like a string, so that any water lost at the top of the plant is immediately replaced; water from the soil moves into the root and water in the root ascends the stem to replace water that is leaving the leaves.

T. W. Sudia is an associate professor in the Department of Plant Pathology and Physiology.

The theoretical limit of the height of a plant is the height to which water can move in an unbroken column, supported only by cohesion of water molecules for themselves (hydrogen bonds). For physical reasons alone this distance is about 450 feet, a height considerably greater than our tallest trees.

The ascent of sap in trees is an example of the same phenomenon of the movement of water in the stems of plants, driven by the evaporation of water from above-ground surfaces of the plants.

Individual plant cells have large water sacs, the vacuoles, enclosed within them. Water balance in plant tissues occurs between the water outside the plant cell and the vacuole of the plant cell.

While it is generally known that the roots of plants absorb water, it is not well known that any organ of the plant can absorb water. Since soil is the principal source of water for most plants, root absorption of soil water is the most common method of entry. However, direct absorption of water by leaves is possible if the leaves are wetted; and entry into plants of fertilizer elements, insecticides, and fungicides sprayed onto the leaves indicates that foliar absorption is effective.

In most herbaceous plants water also plays an important role in the mechanical structure of the plant.

When plant cells are full of water they become turgid and give the plant structural strength. When plants are depleted of water they are wilted and weak. In many plant diseases the disease-causing organism does not attack the protoplasm directly, but grows in and clogs the water-conducting vessels. This clogging ultimately kills the plant by producing a water shortage at the top.

The aerial surfaces of plants have small adjustable pores known as stomates. Stomates are surrounded by special guard cells that can open or close the pore by changes in hydrostatic pressure. In response to physical and chemical activities of the protoplasm the plant can regulate the entrance and exit of materials from the stomates.

Atmospheric gases are the principal materials moving in and out of the stomates, but most of the water lost from plants is lost through the stomates in the form of water vapor. When the internal water of the plant becomes low the stomates close, preventing water loss. Since most plants can lose water from any portion of their surface the conservation of water is not complete and water loss can continue even if the stomates are closed. Obviously, most desert plants *can* prevent the loss of water from their surfaces and therefore survive dry desert climate.

Transpirational water accounts for the greatest use of water in growing plants; plants growing in the field use many times their weight in water during the growing season. A mature corn plant has about 70 ounces of water in its cells and tissues, but it uses more than 7,000 ounces in transpiration during the growing season. This stream of water carries materials from the roots to the aerial parts of the plant and provides the power for the plant's circulation system.

Water is probably the single most important factor in the successful production of an agricultural crop. It

must be present in proper amounts at various times during the growing season. And it exerts a profound indirect influence through the environment; the fields must be moist enough for good seed germination but must not be too wet to work with machinery. Total seasonal rainfall is not as important as its seasonal distribution. If rain falls during the crucial times of seed fill a "good" crop may result in a year when rainfall was in short supply. Finally the moisture conditions at the time of harvest may exert tremendous influence on the quality and quantity of the crop without playing a direct metabolic role. ■

Fish and Fishing in Minnesota's Waters

Thomas F. Waters and Lloyd L. Smith, Jr.

There can be no doubt that Minnesota places among the top-ranking states in respect to the quantity and quality of fresh-water recreational fishing. Of the legendary 10,000 lakes, probably about 3,000 may be classed as good fishing lakes—still a goodly number. Nearly 2,000 miles of trout streams and the warm-water fisheries of our larger rivers add their unique recreational values.

Sport Fishing Waters

Inland Small Lakes

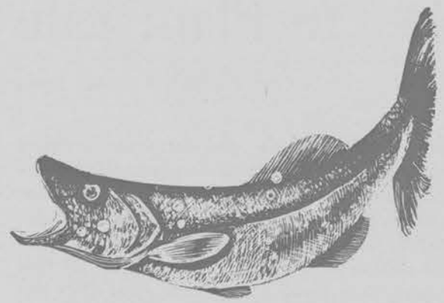
A glance at lake concentrations on a map of Minnesota reveals the famous great "C" of lakes in the central portion of the state, from Mille Lacs northward to Leech, and curving west and southward around to Minnetonka. Although several very large lakes are included in the big "C", many hundreds of smaller ones do not show on the state map. These are principally the small, weedy bass and panfish lakes, often containing northern pike as well.

Another group of smaller lakes is found between the north shore of Lake Superior and the Canadian border. These lakes are of quite a different character than that of the "C" lakes. These northern lakes are often deep, cold, and rocky, containing lake trout, walleyes, and smallmouth bass. This area includes the canoe country lakes. About a hundred smaller lakes in this area have been reclaimed by poisoning undesirable fish populations and restocking with stream trout such as brook and rainbows. This type of management has also produced experimental splake and grayling fisheries in this area.

A third group of small lakes is in the southern and southwestern part of the state. Often too shallow for fish, some are managed for waterfowl. Rough fish removal is intensively practiced in many of these lakes as a technique of fishery management and in commercial fishery operations.

Inland Large Lakes

Minnesota has some of the largest inland lakes utilized in fishery management. These include Mille Lacs, Leech, Cass, Winnibigoshish, Upper and Lower Red Lakes, and Lake of the Woods. In these waters the walleye is king of fishes, often making up more than half of the angler's catch. And about half of Minnesota's fishing waters are managed primarily for the walleye. The sauger, a close but smaller relative of the walleye, is often caught in the large lakes. The muskellunge, a rare trophy fish in Minnesota's larger lakes, sometimes goes on a biting rampage. Never to be forgotten are 5 days (July 15-19, 1955) in which 83 muskies were brought to bay in Leech Lake.



Lake Superior

Not always remembered as a recreational fishing resource, Lake Superior in the past provided high quality sport fishing for lake trout. Now reduced to extremely low levels by sea lamprey depradations, the lake trout may regain its former importance if the currently successful control measures against the lamprey continue. Superior also provides bass, northern pike, and yellow perch fishing along the shores, and of course the highly popular smelt in spring seining and dip netting. Angling in tributary streams for the migratory rainbow trout, or steelhead, is an important early season fishery. The pink salmon, a newcomer for Lake Superior, appears well established, but its value in future sports fishing remains a guess. It is the only freshwater establishment of pink salmon in the world.

Trout Streams

Two major groups of trout streams are found in Minnesota. The larger of these is the group of northern streams that flow into Lake Superior along the North Shore. These are primarily brook trout waters. Often heading in high bog country that may remain partly frozen well into the season, these streams are brown-stained, acid, and brushy in the headwater areas and, in the lower reaches, flow through rocky canyons in often spectacular cascades and waterfalls. The estuaries of some of these streams provide steelhead fishing in early spring and fall.

The second major group of trout streams lies in the unglaciated southeastern corner of the state. This group includes the Root River system, and the Whitewater River and its tributaries. These clear streams flow from cool springs over limestone beds and through wooded valleys and pastures. Fishing is primarily for brown trout; productivity is often extraordinarily high.

Large Rivers

Minnesota has several large rivers that, in addition to providing many opportunities for canoeing and boating, also include excellent fisheries for walleyes, northern pike, and especially smallmouth bass.

The Minnesota River flows from Ortonville to its confluence with the Mississippi, a distance of 262 miles, with no barriers to fishing and pleasure craft.

The Mississippi, from its headwaters in Lake Itasca, through some of our largest lakes and down to the Twin Cities, provides excellent bass, walleye, and northern pike fishing to anglers who know "the River".

The St. Croix, a favorite with canoeists in certain areas because of its spectacular scenery, is world-famous for its small-mouth fishery.

The lower Mississippi, downstream from its juncture with the St. Croix, and including Lake Pepin, is a water with almost infinite variety—walleyes in the tailwaters of the navigational dams; bluegills, largemouth bass, and northern pike in the many backwater lakes and sloughs; smallmouths along the rip-rapped shorelines near Wabasha. White bass, channel catfish, sturgeon, and American eel are found in the Mississippi River but not commonly in other Minnesota waters.

Commercial Fisheries

Since our fisheries are valued more highly as resources of sport and recreation, the commercial exploitation of fish populations are generally restricted to those which for one reason or other cannot be or, by choice, are not utilized for sport. These include the cold-water fishes of Lake Superior (formerly with emphasis on the lake trout), the walleye fishery of Lake of the Woods, the fishery of the Red Lakes restricted to the resident Chippewa Indians, the lower Mississippi River fishery for rough fish, and the commercial rough fish operations for carp, buffalo, and drum in the southwestern lakes. About 20 million pounds of fish are harvested annually in commercial and rough fish operations, mostly rough fish.

Winter Fishing

About one-fifth of the fishing trips in Minnesota are for winter fishing through the ice. Most ice fishing is for bluegills and crappies (the latter are relatively much more susceptible to icefishing), but these hardy anglers take many walleyes and northern pike in the larger inland lakes. Winter spearing for northern pike is an enthusiastically pursued sport, too, although much controversy arises between summertime anglers and winter spearers. On the basis of available evidence, winter spearing neither causes overexploitation of northern pike populations nor injures the angler's sport. The controversy appears to be an example of old fears that the other fellow is digging into our share and is not justified by facts.

Bait Fisheries

Not often considered in our fishery resources, but nevertheless important in an overall management program, is the bait fish business that largely depends on the productivity of many of our natural waters. The more important species are the sucker "minnows", fathead minnows, chubs, golden shiners, and Lake Emerald shiners. Shallow, fertile lakes in southern Minnesota are among the more important minnow-producing areas. A typical production of minnows in such aquatic farming is about 100 pounds per acre, but may run as high as 400 pounds per acre. About 3,500 people are employed in the minnow business in Minnesota, harvesting nearly 5 million pounds of these little fish for a $6- to $7-million annual business.

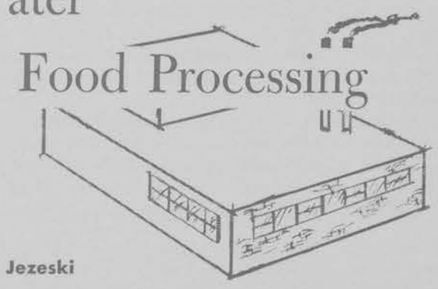
The Fisherman and His Catch

Nearly half of the adult population of Minnesota are licensed fishermen. The total number of licensed anglers in Minnesota is about 1.3 million; of this, about 16% are nonresident. Including unlicensed anglers below the age of 16, the total number of anglers is about 1.5 million. During the war years of the early 1940's, the number of licensed anglers was just over a half million; the total increased sharply after the war and has been about 1.2 to 1.3 million since then. It is continuing to increase slowly. Projected estimates place the number of licensed anglers at about 1.4 million by 1970.

Sport fishermen catch about 50 million fish—about 25 million pounds—per year. This is equivalent to about 17 pounds of fish per angler, and a harvest of over 10 pounds of game fish per acre of fishing water (excepting Lake Superior). By weight, the walleye is the species making up the highest percentage of the angler's catch—about 30 percent. Anglers take about 2 pounds of game fish per acre from the relatively infertile lakes of the northeast, 11 pounds per acre from walleye lakes in central Minnesota (4 pounds of which are walleyes), and about 38 pounds of game fish per acre from fertile southern lakes. The average Minnesota fisherman goes fishing 10 times per year; 7 of these 10 trips yield a catch of fish. In many types of fishing a relatively small percentage of fishermen take a large percentage of the total catch.

From the economic standpoint, sport fishing is big business in Minnesota. Annual expenditures for fishing are $70 million by residents and $30 million by nonresidents, for a total of $100 million. ■

Water in Food Processing



J. J. Jezeski

Food processing embraces a variety of activities which result in the conversion of huge volumes of raw materials into innumerable finished products. It is responsi-

Thomas F. Waters is an associate professor, and Lloyd L. Smith, Jr., is a professor in the Department of Entomology, Fisheries, and Wildlife.

J. J. Jezeski is a professor in the Department of Dairy Industries

ble for a substantial portion of the national income and an even greater portion of the state income. And it is one of the industrial activities completely dependent on ready availability of large volumes of water of suitable quality.

To be completely suitable for the variety of typical uses in a food processing operation, water must meet certain requirements and ideally possess certain characteristics. Our large and extensively distributed supplies of untreated surface water, although partially useful in certain limited applications such as cooling, may otherwise be largely useless. However, if properly treated, surface supplies can be more extensively used; but the extent of treatment generally determines the volume available and the cost.

Ground water supplies, if properly located and adequately protected, may require only minimum treatment prior to actual use. Under other circumstances they may require very extensive treatment to be utilizable.

Municipal supplies, while usually quite adequate for some food plant uses, may not be suitable for all applications. Moreover, particularly in small communities, the municipal system may not be able to furnish adequate volumes at peak demand, and the cost may be high. The daily demand of a food processing plant can easily exceed the domestic consumption of a fair-sized community. So, many food processing plants utilize private wells either as the sole source of water or to supplement the municipal supply.

In a food processing operation, the principal uses for water which dictate water quality requirements include:

Human consumption—for drinking, cooking, and other domestic uses.

Food processing—to add during product manufacture either to aid in mixing of raw materials or formulation of final product and/or to standardize composition.

Cleaning and sanitizing—to serve as a mechanical aid in soil removal by rinsing or flushing and/or as a solvent for cleaning and sanitizing chemicals.

Boiler feed water—to serve as a source of steam.

Cooling—either by direct contact with food products by spray or immersion or indirectly through mechanical cooling equipment using heat exchange surfaces.

Aside from the necessity of adequate volumes at all times (hourly, daily, seasonally) at reasonable cost, certain other requirements related to the quality of water may apply entirely or in part to the food processing uses listed above:

1. Free of pathogenic organisms and toxic substances.
2. Free of bacteria capable of causing spoilage in perishable foods.
3. Clear and colorless, no suspended matter.
4. Free of objectionable tastes and odors.
5. Low in dissolved chemicals (both salts and gases) which may lead to scale and/or corrosion.
6. Low temperature.

Typical Requirements

Water for drinking (and this covers the basic requirements for municipal supplies) must first be free of pathogens and toxic substances; but the presence of other bacteria in reasonable numbers is not objectionable. This water also should be clear, colorless, and free of suspended materials. Mild tastes and odors may be tolerated. These requirements demand that water for this purpose, particularly if from surface supplies, be given some chemical treatment, filtration, and mild chlorination. Softening may be desirable, but it is usually not necessary except as a convenience. Ground water may require less treatment than surface water.

Processing water also must be free of pathogens and toxic substances. Bacteria potentially capable of causing food spoilage cannot be tolerated; the water must be essentially sterile. Also, water for food processing use must be free of all odors and tastes as well as clear, colorless, and without suspended matter. Hardness occasionally is a problem. Consequently, treatment may include addition of chemicals, filtration, and a substantially stronger chlorination than for drinking water or some other equivalent bactericidal treatment. Softening may be desirable in certain installations.

Cleaning and sanitizing applications also require water free of pathogens and spoilage bacteria. Again, this water should be free of suspended materials and corrosive chemicals. So it must be filtered and heavily chlorinated or given an equivalent bactericidal treatment. Hardness and some corrosion problems can be handled by the use of special chemicals during cleaning operations.

Cooling water should be low in temperature, free of suspended matter and corrosive substances, not of excessive hardness, and of low iron content. Basically, cooling water may cause erosion problems in equipment by suspended matter (sand or clay) or corrosive chemicals, and plugging problems due to scale formation and growth of iron bacteria and/or algae. Where direct contact with food is involved by spray or immersion, freedom from pathogens is mandatory and absence of spoilage organisms is highly desirable. Obviously, filtration, chemical treatment, and/or some bactericidal treatment may be necessary, depending on the nature of the cooling processes.

Boiler feed water which is converted to steam must be no more than moderately hard and insofar as possible free of corrosive chemicals and suspended matter. Filtration, possibly some softening, and chemical treatment may be appropriate. The water requirements for certain operations using culinary quality steam injected directly into a food product are extremely rigid. Although culinary steam is usually produced from steam condensate, the nature of the chemical treatment of the original boiler feed water must be restricted. Rarely if ever is a naturally occurring water used as the direct source of culinary steam.

Basic Treatments

The water treatment procedures referred to above represent only the basic processes involved. With certain problem waters these procedures become very complex.

Primary filtration removes coarse particles, including sand and clay, but removal of finely dispersed materials and colored substances may require chemical precipitation and fine filtration through sand or activated carbon. The latter also helps to reduce foreign tastes and odors, but if these are present to a high degree additional chemical or physical treatment may be added.

Softening prior to actual use may be desirable in limited applications, but in cleaning operations softening is done chemically in cleaning solutions. Removal of iron and manganese may require chemical treatment followed by additional filtration. Chlorination or other bactericidal treatments are applied to assure public health safety and to control spoilage problems. Strong tastes and odors may be a consequence of chlorination where waters are high in dissolved organic material. Here again, minimizing these tastes and odors requires additional treatment.

Source Influences Treatment

Under certain circumstances, because of availability, surface water is the choice for overall use. Water from this source may be colored and may contain an abundance of suspended material of both organic and inorganic origin. Foreign tastes and odors are frequently present. The temperature can vary greatly from season to season. Such waters are frequently high in bacteria counts and are always suspect in regard to the presence of pathogens. Hardness may vary over a wide range depending on the geographical area. Because of this wide variability in the characteristics of the raw water and the wide contact with contamination sources, this water generally requires maximum treatment to become suitable for all food processing uses.

Ground water from wells or springs is usually cool, clear, devoid of objectionable tastes and odors, and free of suspended organic matter; but sand or clay may be present. It, too, varies in hardness depending on geographic location and water stratum, and frequently is quite hard. It may be high in iron and corrosive materials. Depending on location, geological factors, and how well it is protected from surface contamination, this water is commonly free of pathogenic bacteria. However, spoilage organisms consistently occur in varying numbers. Such water generally requires fairly heavy chlorination and some softening either prior to or during actual use.

Potable Supply Not Adequate

Why, then, is not the use of a municipal supply a good solution to the water treatment problem? Municipal supplies may originate from ground water or surface water sources. Sole requirements include only an assurance of freedom from pathogens and toxic substances, reasonable bacterial counts, and, preferably, freedom from foreign tastes and odors, although these may be tolerated to a slight degree. On the basis of these specifications, water often is taken directly from a well and publicly distributed with no treatment except possibly a filtration to remove grossly suspended inorganic materials. Mild chlorination may be applied to insure the freedom from pathogens.

Sometimes a surface source must be utilized for a municipal supply. In that case, more elaborate treatments are necessary because of the greater content of extraneous materials and the greater problems of contamination by micro-organisms and chemicals from the environment. Treatment must be substantially more elaborate, yet only to the same basic end—freedom from pathogens and toxic substances, and minimal tastes and odors.

Obviously, some requirements for food processing may not have been met. The problems have been only partially solved. Any treatment (and subsequent testing) of a municipal supply is done solely to safeguard the public health. Any benefits relating to other requirements for water use generally are achieved only incidentally.

Spoilage Bacteria

From a bacteriological viewpoint, water may not be satisfactory for food processing even if pathogens are absent. Presence of psychrophiles—bacteria able to grow at temperatures below 45° F. where most other bacteria are completely inhibited—may lead to spoilage of many food products. Because of this ability to grow relatively well at low temperatures, even very small numbers of contaminants can attain high populations and exert profound effects during storage periods considered normal with respect to time and temperature. Psychrophiles can cause undesirable physical changes, color defects, and objectionable flavors and odors in fluid dairy products, cottage cheese, butter, fresh meats, poultry, and fish during the storage period from processing and packaging until consumption.

There are several reasons why an approved public water supply may contain psychrophiles even though free of pathogens and the coliform bacteria used as contamination indicators in water supply testing. First, some of these psychrophiles have a higher resistance to chlorine than do the pathogens and coliforms, and thus they may survive the conventional approved chlorination treatments used for drinking water supplies. Second, because these organisms are present in the soil they can gain access to mains and piping during repairs or alterations. Here they may survive the decontamination treatments given the water conduit and also the very low chlorine residuals commonly maintained in drinking water. Furthermore, some of these bacteria have the ability to grow in water, using the dissolved organic material and some water hardness salts as nutrients.

Under certain conditions, slowly growing cultures of psychrophiles may become established in dead ends in the piping and in storage tanks. Thus, water from wells meeting all public health requirements governing construction and water quality may contain psychrophilic bacteria.

Obviously, some additional treatment over and above that required to destroy pathogens and coliforms is needed to control psychrophiles. Greater chlorine concentrations must be used during treatment, and higher residuals than are tolerated in drinking water because of taste considerations are required after treatment. Consequently, in-plant chlorination becomes necessary for part or all of the water used in a processing plant regardless of whether the water comes from a municipal supply or from a private well. Under some rather specialized conditions, other types of bactericidal treatments, such as heating or ultraviolet irradiation, may have some application.

Chlorination Problems

Several water properties influence the efficiency of chlorine treatment to destroy bacteria in water. In both surface and ground water there may be substances (chiefly organic matter) that will neutralize the chlorine and make it undetectable in a chlorine titration and unavailable to destroy micro-organisms. The *chlorine demand* of the water is the approximate amount of chlorine

that must be applied to water before there is any substantial lethal activity against bacteria. Chlorine demand can and does vary from one supply to another. Because this value is basically influenced by the amount of organic matter present in the water, surface waters may have the highest chlorine demands. For obvious reasons, these demands vary from season to season and even from week to week and day to day. Ground waters occasionally exhibit substantial chlorine demands which may show rather surprising variations within a given supply on a week-to-week or month-to-month basis and from well-to-well and stratum-to-stratum in the water table.

Water hardness, specifically the concentrations of certain calcium and iron salts, can affect the action of quaternary ammonium compounds; and the total hardness (buffer capacity) and pH can affect the action of certain acid-containing sanitizers.

Changes in water properties are important in soil removal (cleaning) applications. Total hardness, pH, and various specific salts, such as those containing iron and calcium, affect the efficiency of cleaning compounds. Variations in water properties can also influence processing operations. Hardness (total and type) can determine the rate and nature of scale buildup on processing equipment. Excessive hardness and high pH also can influence product characteristics. Variations in bacterial content can affect product keeping quality.

Variations in Water Composition

Rapid changes in chemical and biological characteristics of water are to be anticipated in surface water supplies where seasonal, geographical, and meteorological factors can exert almost immediate effects. Sudden significant changes in the characteristics of ground water supplies seem less likely; however, they do occur frequently as indicated in figures 1 and 2. Here are illustrated on a month-to-month basis actual changes observed in some bacteriological and chemical characteristics of the water from a well which served as the sole source of water for a dairy manufacturing plant in Todd County.

Figure 1 presents data on variations in bacterial counts per milliliter of water obtained after incubation of plates at 32° and 20° C. The higher temperature was used because it is very close to the incubation temperature used in public health laboratories to determine the bacterial count of water. The lower temperature was used because it supports the growth of those organisms capable of growing at 7° C. (45° F.), and the incubation time is substantially shorter than at 7° C.

It is evident that there are changes in the bacterial flora related to season and perhaps to meteorological factors. The counts at 32° and 20° C. at Plant B were quite similar, with peaks during the summer and fall and low numbers during winter months when movement of water into the ground is restricted. Commonly, wells are chlorinated to reduce bacterial populations when trouble with product keeping quality is encountered. This procedure is generally considered of temporary value only and was the case at Plant B. After chlorination there was a period where no bacteria were detected at either 32° or 20° C., but peak populations were quickly reached within several months. There is also evidence that during this period bacteria contributing to the population measured at 32° C. basically were not the same as those which were growing at 20° C.

Periodic variations in chemical properties of the water from this well over a year's time are shown in figure 2. Relatively large periodic changes in pH, total and calcium hardness, nitrogen (organic and ammonia), and chlorine demand were observed. Iron in this water was consistently low and nitrates were absent. This well provided an excellent example of widely fluctuating chlorine demand, with highest values observed during the cold weather months.

Well depth apparently bore little relationship to the nature and magnitude of changes observed. The eight wells included in the study varied in depth from 24 to 184 feet.

Similar changes were found in all. Apparently climate, rainfall, geographic location, and geological factors are

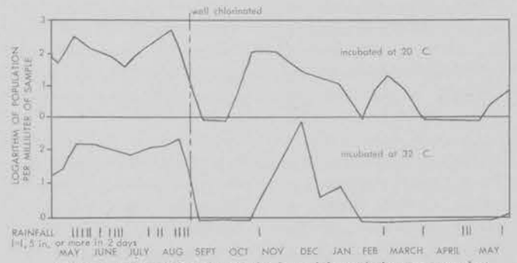


Figure 1. Seasonal variations in the bacterial populations, measured at two incubation temperatures, of untreated waters from the well at Plant B (depth 117 feet).

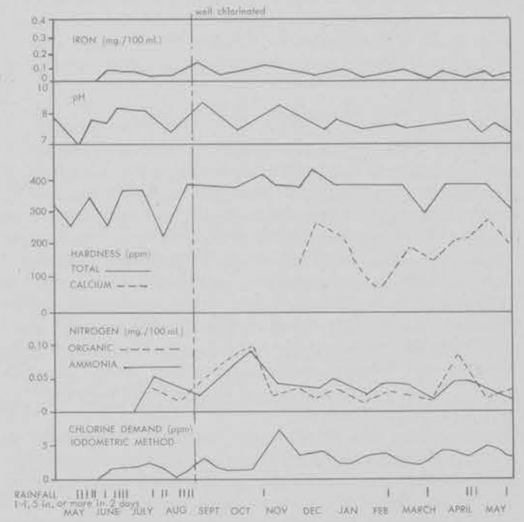


Figure 2. Seasonal variations in several chemical properties of untreated waters from the well at Plant B (depth 117 feet).

Data from "Investigations of Some Chemical and Bacteriological Properties of Several Dairy Plant Water Supplies," R. P. Ciagne. M.S. thesis, Univ. of Minn., 1955.

important in effecting chemical changes.

Although these variations in water properties take place at considerable depths below ground and some are characteristic of various water-bearing strata, most seem to be related to circumstances and conditions at the surface. Because water is a hundred feet or more in the ground does not mean it is unaffected by events at the surface. The time required for ground water to be influenced by surface conditions may be only a matter of a few days rather than weeks or months.

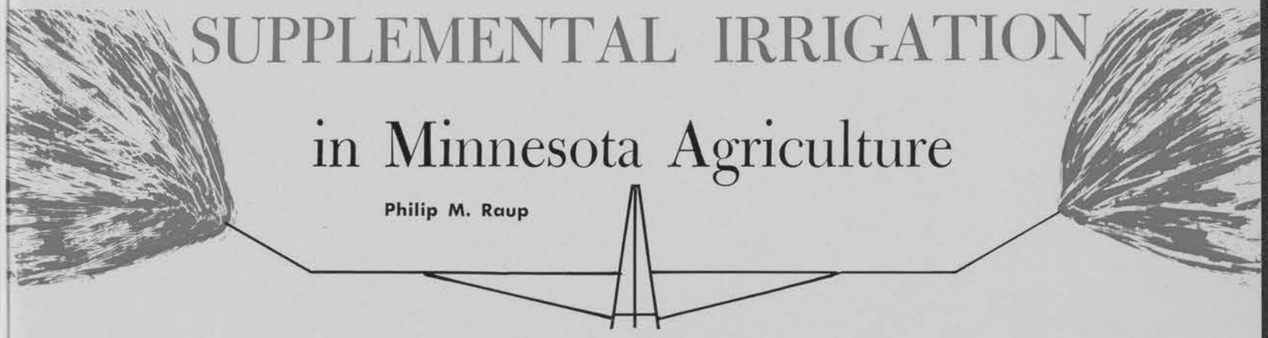
Water composition obviously is not constant and may vary significantly during the course of a year. Bacterial content, total and calcium hardness, nitrogen content, and chlorine demand all may vary several-fold. Where processing considerations call for minimum chlorine residuals in the water, changes in chlorine demand without corresponding adjustments in the chlorine concentrations added to the raw water could determine whether or not psychrophilic spoilage bacteria survive. Changes in calcium and total hardness and/or iron may affect the efficiency of cleaning compounds and thus necessitate some changes in the cleaning procedures.

Satisfactory in-plant water treatment is the result of proper testing followed by adjustment of treatment procedures to meet changing needs and conditions. Additions of special chemicals usually cope with common water problems of a chemical nature, such as routine water softening during cleaning, and in boiler feed water treatment. The compounds used are formulated to take care of relatively small variations in water composition. From a bacteriological standpoint, there is a great need for more testing and supervision. In-plant chlorination is advisable, particularly in the processing of certain food products, whether municipal or private supplies are used. In plants where psychrophilic bacteria cause product-keeping quality problems, chlorination must be carried out at desired concentrations with no lapses in the program.

Research Benefits

There is a long history of research on the storage life of dairy products and the relation of water quality at the University of Minnesota. The benefits have been far-reaching. Where once there were many keeping quality problems directly due to bacteria from water supplies, today a churning of putrid butter or defect in fluid milk products and cottage cheese from this cause is rarely encountered. This is an outstanding example of the application of research findings to industrial practice. The benefits are directly traceable to the education of processing plant personnel.

Some immediate needs have been filled. But we do not have all of the information that can be obtained or that may be needed. Not all of the problems in this area have been solved; there is much additional work to be done. ■



SUPPLEMENTAL IRRIGATION in Minnesota Agriculture

Philip M. Raup

Although Minnesota is well-watered when measured in terms of total annual precipitation, periodic recurrent drought is a problem in some of the state's soil types and regions.

At low levels of fertilizer use and at low cost for seed and labor, there was little incentive to relieve these droughts in the past. With high rates of capital investment per acre, climbing land values, and large cash outlays for fertilizer and labor, it has become increasingly important to do something about the agricultural water supply. This is particularly the case in the light sandy soils of the Mississippi River Valley north and west of the Twin Cities.

Farmers in three counties—Sherburne, Stearns, and Todd—account for an estimated 50 percent of the total water used for supplemental irrigation in Minnesota agriculture. A field study of supplemental irrigation on farms in these counties in 1962 revealed that potatoes were the major crop irrigated. Several irrigators were potato growers that had once produced horticultural and specialty truck crops in the Minnesota River Valley fringes west and south of Minneapolis. The growing urbanization of the Twin Cities area has priced much of this land out of agricultural use, and supermarkets have all but eliminated the "farmers' markets" for vegetables and produce.

Faced with market changes and increasingly heavy land costs, truck farming has declined sharply in the

Philip M. Raup is a professor in the Department of Agricultural Economics.

Twin Cities area. Meanwhile, specialized forms of intensive vegetable and truck crop production have moved into the sandy plains of the Mississippi Valley from Anoka to St. Cloud and beyond. They are among the principal users of water for supplemental irrigation in Minnesota today.

Crops Irrigated

Potatoes are the principal irrigated crop, accounting for over half of the total land irrigated by farmers interviewed in the three counties in 1962. Corn is the second most important crop, accounting for roughly 30 percent of total irrigated acreage. Alfalfa and hay crops were a poor third, accounting for less than 8 percent. Remaining irrigated crops included less than 100 acres each of soybeans, oats, strawberries, and small areas of pasture.

Supplemental irrigation is a form of drought insurance in Minnesota, and as such is not used every year. The irrigators interviewed reported using irrigation equipment on 60 percent of the acres that could have been irrigated in 1961 from available water supplies and with existing equipment. Water use per acre ranged from 0 to 11 acre-inches for the season.

Type of Equipment

Irrigators in the three counties made almost exclusive use of overhead sprinklers. Both underground and surface water sources were used. Of the 43 irrigators interviewed in the study area, 24 used wells to withdraw ground water for irrigation, while 19 used withdrawals from surface ponds, lakes, or rivers. In total, 40 centrifugal and 14 turbine pumps were in use on the 43 farms, with the turbine pumps confined almost exclusively to deep wells. Although small rotary sprinklers were most numerous, an important recent trend has been the shift to large boom sprinklers. Over 70 percent of the irrigators owned one or more of these large booms, with 200-foot booms encountered most frequently. The large booms are capable of irrigating 4 to 4½ acres at a single setting.

Irrigators reported that savings in labor costs and reduced damage to growing crops through the avoidance of frequent changes of sprinkler location were the primary advantages of large boom sprinklers. When using hand labor to relocate a system of rotary sprinklers, labor costs averaged 1 man hour per irrigation per acre. With a boom system, the labor requirement for moving to a new location is a small fraction of 1 man hour per irrigation per acre. Several irrigators estimated that two men could move a boom to a new location in 20 to 30 minutes.

Irrigation Costs

Costs of irrigation are substantial, ranging from $12 to $35 per acre for corn, and from $18 to $40 or more per acre for potatoes, including operating costs, fertilizer, depreciation, and interest. These wide ranges in cost were due in good part to the combination of water sources and sprinkler systems used. Lower costs resulted from using large-scale centrifugal pumps to withdraw water from rivers or ponds for distribution through large boom sprinklers. Highest costs were encountered in using turbine pumps to withdraw ground water from deep wells for distribution through a system of numerous small rotary type sprinklers.

For corn, costs of irrigation per acre dropped sharply as the acreage was expanded from 20 to approximately 100 acres. Little cost reduction was apparent for acreage increases above 100 acres.

There was less evidence of increasing efficiency or reduced costs per acre as the irrigated acreage was increased for potatoes. Some of the smaller potato irrigators enjoyed costs as low as the lowest achieved by operators four to six times as large. Water use was 40 percent heavier per acre for the irrigation of potatoes than for corn in 1961. Fertilizer costs were also proportionately heavier for potatoes, with total direct costs per irrigated acre averaging about $30 for potatoes and $20 for corn.

Capital investments were also much larger on potato farms. The average farmer using supplemental irrigation for potatoes had a $21,150 investment in irrigation equipment, compared to the equivalent average for corn growers of only $7,200. With heavier rates of water use per acre, heavier fertilization, and much larger capital costs per acre, there was little evidence from the 1962 study to indicate the existence of any significant economies of large-scale production in the irrigation of potatoes in Minnesota once the irrigated acreage had reached or exceeded 40 to 50 acres.

Does It Pay to Irrigate?

The study disclosed two significantly different attitudes toward the answer to this question among irrigating farmers in central Minnesota. For some, irrigation was undertaken primarily because it promised to yield higher incomes. This was particularly the motivation among potato farmers. For others, and particularly for those growing corn, irrigation was seen primarily as an insurance against crop failure and a stabilizing influence in the farm income stream rather than a device for achieving sharply increased income per acre.

In short, potato growers were profit conscious, willing to risk large capital investments per acre, and accustomed to more intensive land use practices than were corn growers. Farmers using supplemental irrigation on corn tended to be drought conscious, cautious in their commitment of large capital investments per acre, and more conservative in their applications of water and fertilizer per acre. For them, supplemental irrigation was a stabilizing influence on the sandy Mississippi Valley soils with a history of recurrent short-term drought. ■

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League of Women Voters of the U.S.
1026 - 17th Street, N.W.
Washington, D. C. 20036

OUR WATER RESOURCES -- INHERITANCE TO SQUANDER OR DEVELOP?

by
Mrs. Robert J. Stuart, President
League of Women Voters of the United States

to the
Twenty-ninth Annual Summer Institute of Government
University of Washington - Seattle

on
"Water Resources Development --
Policy and Program Coordination in the State of Washington"

July 8, 1964

I am extremely pleased to be here today and to have the opportunity to talk with people like you and to examine some of the vital problems that face our state -- our whole section of the country -- in the field of water resources. I very much believe in this kind of get-together where public officials, the experts, and interested citizens can share ideas, learn of new developments, and grow more aware of the need to work together as we face the future.

While there is not much doubt in which of the three categories -- public officials, experts, or interested citizens -- I belong, I should like to announce publicly that I am very much a layman.

I assume that the reason I was invited to be your luncheon speaker is because of the work that has been done in the field of water resources by the League of Women Voters. Some of you may know of the cooperative work undertaken by the Leagues in the Columbia River Basin, the Leagues in Idaho, Montana, Oregon, and Washington, which not only resulted in a published study of the Basin but also made it possible for League members in this region to express their conclusions to their state legislators. As a member of the national Board of the League of Women Voters for the past four years, I have had the opportunity to hear what other Leagues across the country have been doing about water development in their communities and their regions. I hope you will not think me immodest when I say that many Leagues have accomplished much. That is, these accomplishments seem considerable until you think of all that remains to be done and the kind and extent of the problems that stand in the way of optimum development of our water resources.

Before I get in to the heart of what I have to say, let me answer the question posed in the title of this talk, which is "Our Water Resources -- Inheritance to Squander or Develop?" I am not here to advocate that we squander our resources -- water resources or any other kind. I am completely in favor of conservation, preservation, development.

I think that in managing our natural resources we should feel a concern for our children and our children's children. I think that in developing our natural resources we should try to preserve the widest possible alternative choices for coming generations.

The warning I spoke of is to tell you that I am not a native of the great Northwest. I am a relative newcomer -- I have only been here a little more than 20 years. I still have stars in my eyes about Washington. I think this state is beautiful, it is vast, it is just the kind of place where anyone in his right senses would like to live. I am pleased and proud to be a citizen, if not a native, of the great State of Washington. While I enjoy the excessive zeal said to be characteristic of any convert, I am occasionally haunted by memories of my life in other states. Since my election to national office I find myself thinking of the needs of other areas and realizing that there are other states besides Washington -- indeed there are other states outside the great Northwest.

Having acquainted you with my prejudices and having informed you that I am not interested in squandering our water resources, I should like to identify for you, if I can, some elements I see in our present situation here in Washington which make the solution of our water problems difficult. I should then like to take a look at some of the positive factors in this same situation and finally pose the question: Are wise decisions possible and if so how can we best insure that they will be made?

First, what are the negative elements? What are the barriers standing in our way?

We are all aware of the obvious blocks to the wise use of our water resources. It is not of these I wish to speak, but I want you to know I am not unmindful of them. There is, of course, the increased demand for water; there is the complexity -- creeping into each choice. There are the intergovernmental relationships involved; there are the economic effects of water development. There is no dearth of problems or of negative elements in the field of water resources, but I cannot discuss them all. I shall, therefore, mention just three -- three not as often discussed as some of the others.

You may be surprised to hear that highest on my list of these negative elements is something which isn't usually considered negative at all. I speak of the "virtue" claimed by almost every individual or group which has anything to do with water. If there is any field in the world where the "bad guys" are hard to identify it is in the field of water.

Have we ever heard of a proposal involving water resources that wasn't phrased in terms of the "good words" -- "public" -- "planning" -- "progress" -- "plenty"? No one uses words like "exploit" or "squander." Yet one man's development may be another's exploitation.

Take planning, for instance. Who is against planning? It is like Motherhood and the Flag. But planning in itself has no intrinsic virtue.

The morality of planning depends on how well it is done; a poor plan may be no better than trial and error, indeed worse. And more especially the virtue of planning lies in for whom the planning is done, whom it will benefit, whose life it will enhance.

This raises the question for whom <u>should</u> planning be done? Why, for the public, of course! And "the public" is one of those "good" words.

Recently in an address to the League of Women Voters of the District of Columbia, Assistant Secretary of the Interior John A. Carver had this to say:

> "A few days ago an experienced and seemingly sophisticated government servant said to me, 'Why doesn't the Department create a special board for the sole purpose of identifying the <u>public interest</u>?'

"A good question. Yet in the three years and almost a half I've been in the Department," Mr. Carver went on, "I can't recall any one of the innumerable controversies where each side of the issue wasn't framed plausibly in terms of the public interest. ... Yet the controversies have been deep and vigorous, and many have reverberated in the halls of Congress or the columns of the press long after they were made. In all of them, both sides of the controversy are stated in terms of the public interest, and in most of them both sides are in the public interest."

The late great Judge Learned Hand did a lot of thinking about things like the public interest and the common will. He said once, "The common will, as the official sees it, is not common at all; it is a complex of opposing forces, whose resultant has no relation to the common good." We could ask ourselves if the roar of the "opposing forces" in the Northwest doesn't sometimes drown out the voices of less committed citizens who also have a stake in water resource development.

Surely we can all sympathize with the man who wants to use his boat or the one who wants to go swimming or the one who wants to stand on the dock and fish, with the home owner with electric appliances who doesn't much care where his power comes from so long as it is efficient and the cost reasonable, with the farmer wanting protection from flood from the spring run-off, the parent concerned with the purity of his children's drinking water, the fruit-grower dependent on irrigation, and with the man who simply needs a job and doesn't care whether it is a pulp mill or an aluminum plant or what.

The voice of the average citizen -- the voice of the little guy -- is part of the public interest picture or should be. He doesn't care about the conflicts which date far back in our region's history, however much they may mean to you or me. Should memories of past battles, which so many of us share, be allowed to obscure complex issues that are just beginning to confront us?

The second barrier to good solutions of our water problems is our tendency -- and it is quite understandable -- to be possessive of our natural resources. As I mentioned earlier I am a comparative newcomer to Washington and yet I think of the Columbia as "my river" and of our beautiful mountains as "our mountains." It is of course a great deal safer -- and sounder -- to claim mountains than it is to claim rivers. Mountains at least stay in one place!

But we are not in the least bit averse to talking about "our water" even when we live downstream. This concept if held by the upstream states could some day be difficult, especially when one thinks of the problems of pollution. As a current slogan has it, "We can't <u>all</u> live upstream" -- an admonition we might all remember not only when <u>we</u> are looking upstream but when we glance downstream as well.

The third barrier to good resource management that I should like to discuss with you briefly might be described as a certain wariness on the part of public officials in federal and state agencies dealing with the natural resources, a reluctance to share their plans with the public until they are at such a stage of perfection that the public can only do one of two things: accept a plan or reject it. Under these circumstances it should be no surprise that often an ungrateful and disinterested public rejects it.

R. G. Lynch, a columnist for the <u>Milwaukee Journal</u>, puts it this way. "You cannot treat people like children, deny them the significant facts in understandable form and them complain that they lack 'public awareness and citizen responsibility.'"

Citizens need significant facts, but the experts must provide them translated into laymen's terms, not fat volumes of engineering reports. It is important to bring the public along when plans are being developed. Citizens have a right to make value judgments about developments taking place in their own areas.

Here then are some barriers -- not so often discussed but to my mind very real -- that stand in the way of decision-making on development of our water resources.

But there are some very positive and helpful signs too -- or at least so it seems to me. Foremost among these is the increased emphasis being put on the state role in the water resources picture.

Federal legislation either passed by the 88th Congress or before it for consideration provides for greater participation by the states in several significant areas. For example, the Water Resources Planning Act. S. 1111, strives to bring the states in early in the process of planning for federal water projects in their basins, so that when Congress considers projects it will have before it not only state views on federal agencies' planning but a composite plan developed jointly by state and federal people from the first planning stages. Hopefully, alternatives will be presented to Congress covering those points on which agreement could not be reached during the planning process.

This attempt to get all of the interests working together step by step from the beginning seems to us a good idea. It seems to offer an opportunity for different viewpoints to be considered and, hopefully, reconciled as the planning proceeds. An encouraging note is that changes in sections of the bill relating to the composition of the commissions and the procedures for setting them up were made in light of suggestions from the states themselves.

As the bill now stands, river basin commissions can be created only if half or more of the states in a basin concur in writing that a commission should be formed. The state representatives on the commission will be appointed in accordance with state law, or, in the absence of such law, by the Governor. And to assure that neither state nor federal interests will be overridden in the planning, no provision is made for voting in the commission.

In discussing the bill, Senator Anderson had this to say: "The planning process is one of arriving at a consensus based on the facts.... If the studies are done thoroughly, the facts make the decisions, not philosophical points of view."

So you see, the states must reach agreement-- not by voting, but by consensus. Perhaps a good first step in Washington would be for us to realize that we <u>are</u> a state and not a loose confederation of two areas known as Western and Eastern Washington!

I am quite aware that the Water Resources Planning Act is no panacea. It presents only the machinery -- the means of giving the states as well as the federal government a voice in the decision-making process. No machine is of use unless there is a willingness to use it and a willingness to work together within a state and within a basin to face problems in water which neither begin nor end within state boundaries.

Still and all, it looks as if the Water Resources Planning Act offers states an opportunity if they want to use it. Of course if we do not cooperate with one another it is likely that the federal government will continue planning through inter-agency committee as is done now.

I have described in some detail the changes made in the Water Resources Planning Act because I have found that some people evidently have not been aware of them and have viewed the river basin commission idea as another plan for valley authorities.

Another proposal in the Congress which reflects awareness of the state's role is the Land and Water Conservation Fund Bill. We are all interested in recreation, and the importance of the state's ability to participate wisely is evident. The Land and Water Conservation Bill is based on the premise that the states must take a key role in developing a balanced national outdoor recreation program.

The House Subcommittee on National Parks changed the original proposal to provide an increase in the proportion of the fund going to the states to 60 percent of all monies. And the federal contribution in grants-in-aid to state projects was increased to a 50 percent share. The Subcommittee removed the proposed limit on use of state funds for land development. This suggests that the development of areas now owned by state and local governments can be the most effective way to increase recreational opportunities.

Here is another example of the emphasis Congress is putting on the role of the states. On the last day of June final Congressional action was taken on the Water Resources Research Act and it was sent to the President for signing. This Act authorizes appropriation of federal money to establish and carry on a water resources research institute at a land grant college in each state. Also it authorizes an annual appropriation of $1 million for ten years to assist other colleges and universities, local, state, and national government agencies, and other institutions in research on water problems.

When the bill was being discussed in the Senate Committee, it was pointed out that there should not be unnecessary federal interference in the basic operations of the state institutions or centers. A "variety of approaches and the genius of many minds could better be allowed expression," they said. The Water Resources Research Act also points up, it seems to me, that Congress is making a commendable attempt to help the states help themselves to better utilization of water resources in a number of important areas.

All of this adds up to reasons why it is important that our state take a hard look at its own ability to function best not only in relation to its own intra-state waters but in partnership with other states which are part of a common river basin, just as you are doing today.

The second positive element which I see in the water resources field is closely related to the first. Congressional committees dealing with water seem increasingly to be seeking out the views of citizens.

A few years ago the Senate Select Committee on Water Resources held hearings all over the United States. The League of Women Voters became very familiar with these hearings because League members spoke at 22 out of the 23 held. At each hearing, educators, businessmen, farmers, sportsmen were heard, and the ideas of these people who knew their own area were made part of the committee record.

More recently the Jones Subcommittee on National Water Resources and Power of the House Government Operations Committee has been holding regional hearings on the operation of the national water pollution control program. Along with greater emphasis on the state role in water resource development, the tendency to seek out citizen opinion seems one of the hopeful signs.

The third hopeful sign is that citizens and citizen groups -- including the conservationists -- are beginning to listen to each other.

We all belong to organizations which have some specialized interest in water development. There are many of these people: the conservationists -- including the wildlife, sports fishing, Isaak Walton League, wilderness-preservation, Audubon Society people; there are the boat owners, the recreation groups, the garden clubs, the bird-watchers, the hikers, the mountaineers, the hunters, the rock hounds, and so on -- each group formed because of a certain point of view shared by the members. It is the members of these groups who are likely to respond to what is going on in the water resources field. Collectively they represent a force -- if they can agree and join to work for a common goal. But this force is frequently not mobilized, for these groups which might be expected to have a common cause sometimes seem to show a strong tendency to fight each other.

The late Congressman Clem Miller, one of the best friends conservation interests ever had, had this to say when speaking to one of the groups:

> "Conservationists tend to be just a little bit self-righteous. They don't bend so easily. This can be fatal. Your precious maneuverability depends on your ability to yield a little bit. ... With experience the conservationist comes to have respect for the politician. ... This means that the conservationists must learn to appeal to the utilitarian aspects of his case rather than the aesthetic. Conservation matters are increasingly 'spending' issues. They cost money. The benefits are in the future -- they are not generally immediate ... yet the public interest is discernible."

And then he said,

> "This word 'cooperation' has a magical effect on Congressmen. We are so busy being ground down by the relentless effects of political competition that those who can sign in unison are greeted with open arms. To the conciliator we are willing to give our devotion. Citizen groups, take note."

I am inclined to think that some of us have taken note. And that we have, perhaps, begun not only to see the virtues in working together for mutually desirable ends but are beginning to see our own responsibility for the problems.

As a case in point I draw your attention to an editorial in a recent issue of Conservation News published by the National Wildlife Federation.

> "At a recent workshop on pollution I sensed a bitter antagonism toward all polluting industries, where the suggestion of legitimate compromise was scorned. ... But what are these industries, and who created them? Are they not creatures of civilization, institutions founded on human demands and desires? What galls me is the total lack of acceptance by so many evangelists that all people using industrial goods have an equal responsibility in this pollution problem."

Here is an example of recognition of the complexity of the problem that must be faced today -- not a simple matter of the "good guys" and the "bad guys," but the intricate interplay of forces in society of which we are all a part.

Who knows -- if conservation organizations learn to cooperate the habit may grow; we may even find states getting together! Of course it is possible that we may get together for the wrong reasons.

Can you see, as I sometimes do, the stereotype of the Old West, the wagons in a ring and the savages whooping it up without? Could this stereotype appear in the Northwest -- with the wagons joined together in a tight circle defending our cold, clear water against the demands of the Southwest? At the same time, I suppose, California might be defending -- in the same way -- whatever Californians don't want to give up.

Complexity requires flexibility -- and the issues which are now facing us and those being hinted at do not fall neatly into sharp "good" and "bad" categories. Consider this matter of water shortages in some parts of the West. Many answers are being suggested -- from cheaper desalinization of water to giant water diversion plans involving major areas of the entire continent. Reactions to some of the solutions currently being discussed have been visceral to say the least.

But can anyone really imagine a situation many years hence when all water sources have been exhausted elsewhere? When the Southwest lies dry and parched while the Northwest enjoys its waters behind its barriers -- whether legislative or encircling wagons?

I hope we do not pull our wagons together just because of a threat from outside. While it may be characteristic of us Westerners to shoot it out over a water hole when an outsider tries to horn in and it may be that the only way we will ever get together is because of a threat from without, it is also characteristic of Westerners to know a good thing when they see it.

I am not suggesting -- because I haven't the slightest idea what it may be -- that there <u>are</u> certain advantages for the Northwest in dickering with what <u>it</u> has in abundance, with someone who may have something <u>we</u> want, but let us not rule out the possibility of the widest possible choices in the future by making inflexible decisions now. Perhaps we are now beginning to see creative proposals which involve cooperation among "opposing forces." As Judge Hand has said, "Conflict is normal; we reach accommodation as wisdom may teach us that it does not pay to fight."

In this talk with you I have reviewed some elements not frequently discussed which I see standing in the way of our making the best of our water resources in this state and in cooperation with other states in the area, and I have talked too of some of the positive factors which, if we choose to utilize them, could be helpful in finding solutions.

And now I come to the larger, tougher, and even more important question I posed in the beginning: Are wise decisions possible?

Senator William Fulbright was asked some time ago if he thought self government was still a possibility in this country. His reply was "Yes, self government is possible but not probable." I am considerably more sanguine about the answer to the question of wise use of our resources.

It seems to me that we <u>can</u> make wise decisions if we can manage to avoid the divisiveness of old issues and join ranks to grapple with the complexities with which we are faced; that we <u>can</u> make wise decisions if we make an attempt to find a way and not just react negatively against every new suggestion; that we <u>can</u> make wise decisions if we realize that old loyalties are inadequate; that we <u>can</u> make wise decisions if we think in terms of leaving the door open for future choice.

LWV of Minnesota, State Organization Service, Univ. of Minn., Minneapolis, Minn.55455
July, 1964

Memo to: Local League Water Resource Chairman
From: State Board

Enclosed are 3 copies of a form we would like you to complete before September 15. Please send one copy to the state office. Background information on these various federal programs as listed below can be found in past issues of Current Review of CR's under "Water":

P.L. 660 - Fed. Water Pollution Control Act (amended)
PL 87-658 Public Works Acceleration Act
Army Corps of Engineers - Navigation

USDI Flood Control
U.S. Geological Survey - Dep't. of Interior
Fish & Wildlife Acquisition Program-for wetlands and refuges
USDA
P.L. 566 - Watershed Protection and Flood Prevention Act
P.L. 87-27 Area Redevelopment Act
1962 Food & Agriculture Act - Resource and Conservation Development
Rural Areas Development Program

Here are some suggestions to help you proceed:
Check your League's water resource files (and perhaps check with past water resource chairman)
Check your telephone directory under U.S. Gov't to find agencies in your area.
Contact your County Auditor (in some counties the County Engineer may also be helpful.)
Contact your City Engineer, City Sanitarian and the head of your City Water Dep't ---also your Public Health Officer.
Regional information should be available from your County Auditor.

Here are some suggestions for use (we plan to compile information for the entire state for your future use):
As a basis for early fall meetings before other national material is available.
Distributed to your members through your bulletin.
Update your members and renew their interest in this important League Program.
Use the results of the survey in conjunction with material in the enclosed copy of Minnesota Farm and Home Science.

LWV of Minnesota, State Organization Service, U. of M., Minneapolis, Minn. 55455
August 1964

S P E C I A L A N N O U N C E M E N T

URBAN PLANNING FOR ENVIRONMENTAL HEALTH

Kahler Hotel - Rochester, Minnesota
September 21 - 26, 1964

This course is designed for health and planning personnel, public officials, and lay citizens who are interested in planning a more healthful environment. It presents basic environmental health problems, methods of attacking these problems, and approaches to their solution. Considerable time is devoted to the initiation and preparation of an environmental health survey, proposed recommendations, and suggested programs for implementation of the recommendations.

This course is replacing an earlier scheduled two-week course of which these dates were the first week. The change was felt to satisfy the many requests to attend such a course with less time required away from the office.

CONDUCTED BY

Metropolitan Planning Training
TRAINING PROGRAM
Public Health Service
Robert A. Taft Sanitary Engineering Center
Cincinnati, Ohio

CO-SPONSORED BY

Minnesota Department of Health
Rochester-Olmsted County Health Unit
Public Health Service Region VI

Submit your application to:

Director, Training Program
Robert A. Taft Sanitary Engineering Center
4676 Columbia Parkway
Cincinnati, Ohio 45226

AGENDA

Monday, September 21

8:00 Registration
8:30 Welcome Addresses
9:15 Course Objectives
9:30 Quiz on Advance Study Material
10:00 Water Problems Conference
11:00 Sewerage Problems Conference
12:00 Lunch
Talk: Role of citizens Groups
1:30 Refuse Problems Conference
2:30 Air Pollution Problems Conference
3:30 Break
3:45 Housing Problems Conference
6:00 Dinner
Keynote: Rochester and the Mayo Clinic

Evening Session
7:30 Role of Local Planning Agencies
8:30 Role of Regional Planning Agencies

Tuesday, September 22

8:00 General Health Problems Conference
9:00 Recreation Problems Conference
10:00 Environmental Health Planning Guide and Previous Applications
11:00 Group Assignments for Field Exercise
12:00 Lunch
1:00 Data Collection - Rochester, Minn.

Evening Session
7:00 Assembly of Data Reports

Wednesday, September 23

8:00 Data Collection - Rochester

Evening Session
7:00 Assembly of Data for Reports

Thursday, September 24

Work groups will present their data, evaluations, and recommendations to the class and a panel of experts for discussion.

8:00 Water Group Report
9:45 Sewerage Group Report
11:30 Preliminary Implementation Report
12:00 Lunch
1:00 Refuse Group Report
2:45 Air Pollution Group Report

Evening Session
7:00 Report Preparation

Friday, September 25

8:00 Housing Group Report
9:45 Planning Group Report
11:15 General Health Group Report
12:45 Lunch
1:45 Recreation Group Report
3:15 Implementation Group Report

Saturday, September 26

8:30 Summary of Recommendations
9:30 Role of PHS Research Grants
10:15 AMA and Environmental Health
11:00 PHS and Environmental Health
11:45 Course Critique and Closing

State

AUG 14 1964

LEAGUE OF WOMEN VOTERS
OF THE UNITED STATES
1026 17TH STREET, N. W., WASHINGTON, D. C. 20036

August 11, 1964

Mrs. Roy Letourneau
National Program Chairman
League of Women Voters of Minnesota
2706 Brookridge
Minneapolis 22, Minnesota

COPY

Dear Mrs. Letourneau:

Mrs. Rosenblum was extremely interested in the July Memorandum from the Minnesota State Board to Local League Water Chairmen. We think this will stimulate local Leagues' interest in the water item and it will certainly supply the state with information on which Leagues to turn to for illustrative material. Mrs. Rosenblum has asked me whether you could send her a copy of Minnesota Farm and Home Science referred to in the last line of your July 1964 Memorandum.

send me

I am enclosing a copy of an editorial from the Red Wing (Minnesota) Daily Republican Eagle. Perhaps paragraphs 6 and 7 suggest one of the values which could be obtained from a river basin commission which would be considering the development and planning for the entire basin.

Sincerely yours,

Mrs. C. F. S. Sharpe
Program Secretary
Water Resources

LS:llw

cc: State LWV

Encl.

Special Announcement

urban planning for environmental health

ROCHESTER, MINNESOTA

September 21 - 26, 1964

This course is designed for health and planning personnel, public officials, and lay citizens who are interested in planning a more healthful environment. It presents basic environmental health problems, methods of attacking these problems, and approaches to their solution. Considerable time is devoted to the initiation and preparation of an environmental health survey, proposed recommendations, and suggested programs for implementation of the recommendations.

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11:45 Course Critique and Closing

Office

September 4, 1964

Mrs. John Dettman, President
League of Women Voters of Duluth
1405 N. 8th Ave. E.
Duluth, Minnesota

Dear Luella:

We are setting up a state Water Committee and need representation from your area. Who can you recommend to serve on this important committee?

This will be primarily an action-oriented committee for we want to update our members and be prepared to act on specific legislation in next year's legislature.

No doubt you have some members who have shown particular concern for water. Its conservation is becoming increasingly important in your part of the state. We may need some special research related to your particular problems so it is important to have a Duluth member on this committee.

I would appreciate having your recommendations as soon as possible.

Sincerely yours,

Mrs. Wm. W. Whiting
President

ATW/mc

Office

September 4, 1964

Mrs. Edmonton
League of Women Voters of Red Wing
c/o Mrs. James Konsella
1010 W. 4th St.
Red Wing, Minnesota

Dear Mrs. Edmonton:

"Water, water everywhere and not a drop to drink."

You have shown by your interest in the subject that you are well aware of this old saw and interested in doing something about it.

We need your help -- as a member of our state Water and National CR committee. As you know, we are trying to update our members on the Water item as it relates to Minnesota so that we can get permission to work on legislation this winter in the state legislature.

In order to carry out such a program we need state-wide respresentation on our committee. This will be an action-oriented committee although there may be the need for special research and/or study plus a workshop.

I know you will find this a challenging assignment. I am anxious to have your answer so that the committee can meet and start planning soon.

Sincerely yours,

Mrs. Wm. W. Whiting
President

ATW/mc

SEP 21 1964

STATE OF MINNESOTA
WATER POLLUTION CONTROL COMMISSION

Notice of Public Hearing on
Classification of the Minnesota River and
Tributaries from Carver Rapids to the Mouth,
Establishment of Standards of Water Quality and Purity
Therefor and Adoption of
Regulations Relating Thereto

Pursuant to authorization of the Water Pollution Control Commission and in accordance with applicable statutes, a public hearing will be held by said Commission or by one or more authorized members, employees, or agents thereof in the auditorium of the State Office Building, St. Paul, Minnesota on October 19, 1964, at 10:00 a.m., for the purpose of investigating, considering, and acting upon the classification of that portion of the Minnesota River and its tributaries from Carver Rapids to the junction with the Mississippi River, establishment of standards of water quality and purity therefor, and the adoption of regulations relating thereto.

Proposals for such classification, standards, and regulations on file in the office of the Commission at the Department of Health Building, University Campus, Minneapolis, will be open to inspection by any interested person, or copies will be mailed to any such person on request, but the hearing will not be limited to such proposals, nor shall any action of the Commission on the matters aforesaid be limited thereby.

R N Barr

Robert N. Barr, M.D., Secretary
Water Pollution Control Commission

Dated: September 14, 1964

office

September 4, 1964

Mrs. J. A. Callahan
410 16th Street SW
Rochester, Minnesota

Dear Mrs. Callahan:

"Water, water everywhere and not a drop to drink."

You have shown by your interest in the subject that you are well aware of this old saw and interested in doing something about it.

We appreciated your contribution to our lively issues VOTER.

We need your help -- as a member of our state Water and National CR Committee. As you know, we are trying to update our members on the Water item as it relates to Minnesota so that we can get permission to work on legislation this winter in the state legislature.

In order to carry out such a program we need state-wide representation on our committee. This will be an action-oriented committee although there may be the need for special research and/or study plus a workshop.

I know you will find this a challenging assignment. I am anxious to have your answer so that the committee can meet and start planning soon.

Sincerely yours,

Mrs. Wm. W. Whiting
President

ATW/mc

Office

September 4, 1964

Mr. Keith E. Brodin, President
Minnesota Conservation Federation
4313 Shady Oak Road
Hopkins, Minn.

Dear Mr. Brodin:

Thank you for the agenda and invitation to your Twelfth Annual Assembly.

The League of Women Voters continues to be interested in water problems on the national level. We will watch with interest the results of your meeting.

Sincerely,

Mrs. Wm. W. Whiting
President

ATW/mc

Office file water

October 13,,1964

Mrs. Archie Johnson, President
LWV of Minnetonka Village
5204 Kimberly Road
Minnetonka, Minnesota

Dear Arlene:

Thank you so much for your prompt, personal and interesting reply to my request for information on your League's activities on "water and sewers." This material was of value to me in the preparatinn of a speech I gave last week at a U. S. Public Health workshop ón Rochester on urban planning for environmental health.

Some of the problems discussed were so typical of the Minnetonka situation. When the final survey conducted as a part of the workshop is printed, I will send you a copy. It may give you ideas for continuing your work in this important area.

Best wishes for a successful year.

Sincerely yours,

Mrs. W. W. Whiting
President

ATW:rw

Water Office file

October 13, 1964

Mrs. DeWayne Chesley, President
League of Women Voters of Brainerd
612 North 8th Street
Brainerd, Minnesota

Dear Elaine:

Thank you so much for your prompt, personal and interesting reply to my request for information on your League's activities on "water and sewers." This material was of value to me in the preparation of a speech I have last week at a U. S. Public Health workshop in Rochester on urban planning for environmental health.

Best wishes for a successful year for the League in Brainerd.

Sincerely,

Mrs. Wm. W. Whiting
President

ATW:rw

Office - water

October 13, 1964

Mrs. Daniel Neale
1101 East River Road
Minneapolis, Minnesota

Dear Caryl:

The visual aids were just right! This was a luncheon meeting (poor men had to pay for this part of their workshop) so they did not have their workbooks with outlines, etc., so your approach couldn't have been better.

These participants were all quite human with a real desire to snooze after a rather heavy lunch but with your help we kept them awake. Thanks so much for a very special job in such a hurry. People like you are the bonuses we find in working for League.

Sincerely,

Mrs. W. W. Whiting
President

ATW:rw

Water-office

October 13, 1964

Mrs. David J. Edwards, President
League of Women Voters of Atlanta
43 La Fayette Drive, N. E.
Atlanta, Georgia 30309

Dear Mrs. Edwards:

Thank you for sending me the copy of Mrs. Tillinghast's speech on the role of the citizen and civic group in urban planning for environmental health.

It was interesting to note how similar our appraaches were to this problem. I would assume too that the reaction of the participants was similar -- renewed respect for LWV and the role of this women's organization.

I appreciated your assisting me in this way and hope that in the future we may reciprocate in some way.

Sincerely yours,

Mrs. W. W. Whiting
President

ATW:rw

Water & Office

October 13, 1964

Mrs. E. G. Fisher, President
League of Women Voters of Colorado, Inc.
1545 Tremont Street
Denver 2, Colorado

Dear Margaret:

Enclosed is your speech and program of the Denver conference on urban planning for environmental health. Thanks so much for sending them to me for I found them very helpful in preparing my speech for the Rochester workshop held this last week.

Your discussion of the "metropolitan consciousness" was particularly apropo. It was interesting to hear how each "specialist" recognized this problem of area-wide solutions. Because of your comments I felt I had been "clued in" just right.

Best wishes for another successful year for LWV in Colorado.

Sincerely yours,

Mrs. W. W. Whiting
President

ATW:rw
enc.

office - water

October 13, 1964

Mrs. L. V. Rozycki, President
League of Women Voters of Roseville
33 East Oaks Road, North Oaks
St. Paul, Minnesota

Dear Nancy:

Thanks so much for your prompt and personal response to my request for information on the Roseville League's activity in the field of environmental health.

Although you probably don't look upon this League action as a success story there were elements in your report that were of real value to me in discussing the role of the citizen and the civic group in the implementation of urban planning for environmental health.

It is unfortunate that the Roseville Board continues its policy on Board member participation on commissions, committees, etc. To be successful, such civic groups should include leadership from groups such as the League which have already shown interest in and support for the program under consideration. It might be helpful for your Board to give further consideration to Mrs. Phillips' advice on this in her farewell address at convention.

I have given all the material you sent me to Mrs. Walker our new state chairman for Local Agenda. I know she will find it interesting and of real value in working with other Leagues.

Sincerely,

Mrs. W. W. Whiting
President

office - water

October 13, 1964

Mrs. Glyndon Webb, Presidnnt
LWV of St. Cloud
Route # 2
St. Cloud, Minnesota

Dear Beverly:

Congratulations on the new League member in the Webb home. If she brings you just half the joy the Whitings have found in their daughter, you are in for a special treat.

I appreciate ;your taking the time to respond so quickly to my special requests for information. It was very helpful in the preparation of a specch I gave last week at the U. S. Public Health's workshop on urban planning for environmental health.

Mr. Lemont from St. Cloud was one of the participants. He is particularly interested in an areawide approach to your particular problems of environmental health and wondered how he could work with the League on such an approach. Because of the intergovernmental complexities of your particular situation I am suggesting that Mrs. Mann (Lois) and Mrs. Walker (Kay) consult with you and Mr. Lemont to see what the possibilities might be for League study.and implementation of some kind of planning for environmental health. Perhaps we can use this as a pilot project for other areas if there is sufficient interest in your League. This ties in with your present local water item as well as the national water item.

Thanks for all your help.

Sincerely yours,

Mrs. Wm. W. Whiting
President

LWV of Minn., State Organization Service, U. of M.,
Minneapolis, Minn.
October 1964

Please send the following information to me at the below address:

Name of League _____
Water Resource Chairman:
Name _____
Address _____

No person assigned this responsibility _____

Thank you.

Mrs. G. E. Mann
638 W. Laurel
Fergus Falls, Minn.

MEMO

TO: State water committee

FROM: Lois Mann

SUBJECT Notice of meetings

DATE 10/16/64

LEAGUE OF WOMEN VOTERS OF MINNESOTA
STATE ORGANIZATION SERVICE
UNIVERSITY OF MINNESOTA
MINNEAPOLIS, MINNESOTA 55455
PHONE: 373-2959

Water Pollution Control Commission Meetings:

October 19, 1964 - 10:00 a.m. - auditorium of State Office Building
Public Hearing on classification of Minnesota River and Tributaries from Carver Rapids to the Mouth, establishment of standards of water quality and purity and adoption of regulations relating thereto.

November 4, 1964 - 10:00 a.m. - State Office Building auditorium.
Public Hearing on report on comprehensive sewage works plan for the Minneapolis-St. Paul metropolitan area as required by laws of 1963.

Office - water committee

October 13, 1964

Mrs. James Konsella
1010 West 4th
Red Wing, Minnesota

Dear Fran:

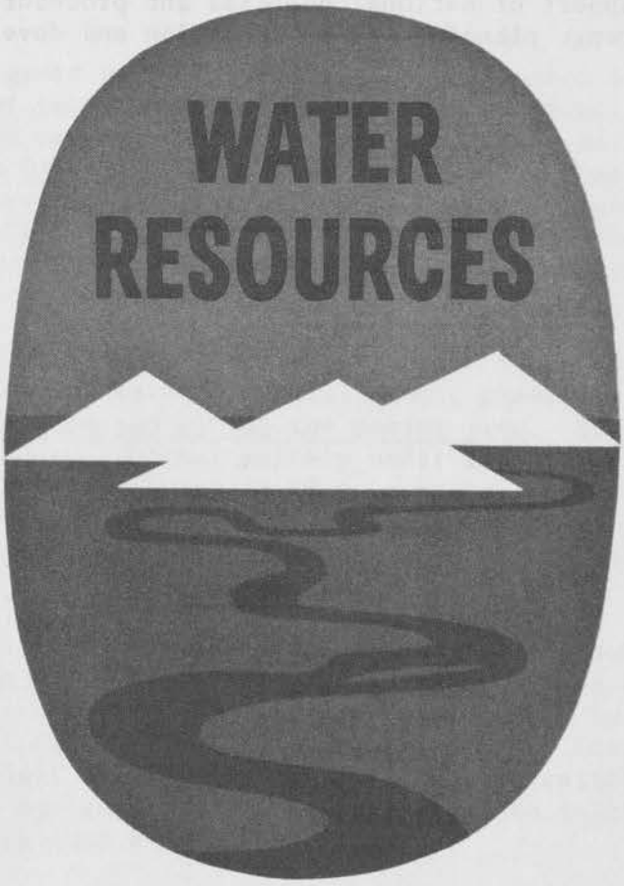
Thanks so much for all the excellent information you sent me to use in preparing my speech on the role of the civic group in urban planning for environmental health.

Not only was it fascinating reading but it also provided just the kind of information I needed on activities in our area. It may appear that at times you are making little progress but this kind of action does not show results over night. I hope you can keep your League members informed and active for this is the kind of regional activity that we should continue to promote.

I appreciate your tracking down "Mrs. Edmonton" for me. Mrs. Edstrom is undoubtedly the Red Wing member who was recommended for our state committee. I am worry that she is working and not able to assume this additional responsibility at this time. Because of the strategic location of your League it is important to have a representative from Red Wing on this committee. Who can you suggest? Perhaps one of the Board members would like this experience. Now that Mrs. Mann has come back on the Board to serve as our Water chairman we are anxious to have an active committee as soon as possible.

Sincerely yours,

Mrs. W. W. Whiting
President



LEADERS GUIDE & BIBLIOGRAPHY

LEAGUE OF WOMEN VOTERS OF THE UNITED STATES

1964-1966 NATIONAL CURRENT AGENDA ITEM

WATER RESOURCES: Support of national policies and procedures which promote comprehensive long-range planning for conservation and development of water resources.

Publication #305
September 1964
Price: 35¢

League of Women Voters of the United States
1026 17th St., N.W., Washington, D.C. - 20036

WATER RESOURCES

LEADERS GUIDE AND BIBLIOGRAPHY

SYNOPSIS

Water is one of the great natural resources of the United States, but its development remains one of the nation's great domestic problems. Because the water resource affects each member personally, League leaders will find they can present this item in lively ways. Use the local or regional situation to stimulate member interest, relate this to the national situation, show how the League has been involved in water work, and indicate how the League may be called on henceforth for informed comment, legislative support, community education.

League work on water will be carried on in 1964-66 much as it has been from 1962-64. The scope of the water item will remain generally the same. No new national consensus is expected during the coming year. Some inter-League groups will come to consensus on regional matters under the national water CA. If your League is included in such a group or if your state League is asking for an expression of consensus in expectation of action on some phase of water, you will hear about this directly from your state resource chairman or representative on an inter-League steering committee.

Since 1960 League activity on water resources has been growing. The trend toward more action on regional, state, and local levels is expected to continue. At all levels of government, League assistance is sought by organizations and agencies interested in water resource development. The League can maintain its reputation in this field and continue to carry on the caliber of work it has done only if members continue "to learn, to inform, to influence, to accomplish." It is your job to help them do this.

Although League effectiveness depends on member knowledge, members need not become experts on water. You and those working closely with you will have broader background and more detailed information, but everyone in the League need not be equally well informed. You and your resource committee will organize information, condense facts to illustrate principles involved, enliven by examples from community or region, so that League members can grasp concepts about organization and responsibilities of government in the water field without knowing the intricate details which inevitably are part of the issue at hand. When you and your committee have done your job, the members of your League will know more about water than the average citizen knows, the members of your League will have an informed citizen's understanding of broad principles and general policies, they will have a basis for value judgments on alternatives experts propose.

As a constant guide you will use the NATIONAL BOARD REPORT. Begin with the post-Convention issue of May 1964 and watch for three each year. Also use other important League aids mentioned below; each will help you do your job.

ORGANIZING YOUR WORK

Everyone working on the water resources item must consider the effect of having had this subject on the League Program for eight years. Most all Leagues have members who took part in the 1956-60 study and don't want to waste time hearing again about the numbers of federal agencies, congressional committees, laws and amendments to laws in the water field. Some of these members are devoted water-buffs who want to work on specifics. Some are members who personally never want to hear about water again. All Leagues also have new members who need basic information about water resources in order to understand the position the League reached in 1960 and the action the League has since taken.

While it isn't easy to devise a plan which can satisfy members of such different backgrounds, it is necessary 1) to face up to this diversity and 2) to decide the aim of work on water in your League this year. Then when you, in consultation with your League Board, know where you are heading, you can choose, again in consultation with the Board, what seems the most interesting, feasible way to get there.

Careful planning is needed to stimulate interest and involve members by showing them that the national water item is closely related to women's other interests and to League concern with government. To continue League effectiveness on the water item, many members, old and new, need to know what is going on (the issues of today) and understand how the League acts (what it supports and why) under its national position. For only by so doing will members feel the sense of satisfaction that comes from participation in action on regional, state, and local, as well as the national level under the national water CA. (For explanation of four level action, see NATIONAL BOARD REPORT, May 1964, pp. 36, 40-41.)

How your League handles the national water item will depend on the number of working members, the amount of leadership, and the League's commitments in other areas. A number of arrangements for assigning leadership responsibilities are described in the NATIONAL BOARD REPORT, May 1964, pp. 7-8. The important thing is to adjust your pattern to fit your cloth, always aiming to use the pattern the local Board has decided upon in such a way that your League's members will have the information and be helped to develop the understanding they will need to be ready for action.

Whether you have a large committee, one or two helpers, or are combining with an adjacent League to form a joint committee on the national Program item, the general way to proceed will be the same, though the amount the committee can take on will differ.

1) You, as leader, plus some other members will make it your business to be informed about all aspects of this item. This group, whether large or small, will want to do the following, but the extent and depth will depend on how many there are in the group (committee) and how many other responsibilities each one has.

   a) Keep up to date by reading and clipping articles about water.

   b) Discuss whether and how new developments fit with League position and past action.

   c) Examine especially your local, county, regional, or basin water problems and think how they fit into and illustrate the national water situation.

   d) Keep up with national legislation on which the League has taken a position. Such legislation will be described in

      . a publication for leaders, CURRENT REVIEW OF WATER RESOURCES, which will come out from time to time

      . KULP (Keeping Up With League Program) in THE NATIONAL VOTER

      . NATIONAL BOARD REPORTS

      . the descriptive page accompanying a Time for Action

      . testimony by national Board members, a copy of which is sent to each League, which usually gives reasons for League support or opposition.

2) You, as leader, will keep the League Board informed about the water committee's activities and about developments in the item, particularly in relation to the local, state, or regional situation. This can be as formal or informal as your Board likes, but it is extremely important that those responsible for the water item maintain a working relationship with the Board. In long-standing Program items there is a tendency for individuals to become increasingly expert and for a gap to widen between their expertise and the grasp which the Board and the general membership has of the subject. You will want to start right now to avoid this gap or to bridge it.

3) You and your committee will plan ways to get information to members, to keep up their interest in what's happening on the water front, and to handle action on this item.

PLANNING MEMBERSHIP MEETINGS

Your League has room in its timetable to schedule a meeting on water? Splendid! Meeting time (whether discussion group or general membership) is the usual way to involve the most members.

The General Plan — A meeting centered around League background and present interests will probably do more to reach your aim than will one at which an outsider speaks of his interest. In planning a meeting to be put on by League members, the committee will come to grips with what is taking place on the water front. Discussion at the meeting will give new members a chance to participate and may draw old water enthusiasts back into the item.

If most of the members in your League have a good background and have kept up on this item, the water committee may decide to use outside experts on some newly developing facet of particular interest in your area. A panel is better than a single speaker, in most cases. Careful planning by the League committee is necessary with a speaker or a panel. In order to have outside talent do the

kind of job you want, each one needs to understand very clearly what is expected of him and what others on the panel are doing. Whoever is to tell this to outside experts, must first know it very clearly herself.

Ideas for Meetings — Meeting formats used successfully by some Leagues were published in CURRENT REVIEW OF CONTINUING RESPONSIBILITIES, No. 6, August 1963, 25 cents. Although different meeting plans are grouped in that publication according to time-schemes for bringing CRs to members' attention, the format for almost any single meeting could be adapted to a meeting on water. You might take a meeting plan that sounds interesting, no matter what the subject, and try recasting it in terms of the water item.

Here are two more ideas for consideration.

1) If your committee wants to start a meeting with a short movie, consider this new one in colorful, modern animation. Presented by the Soap and Detergent Association, "Every Drop / To Drink" is a 16 mm. sound film, running time 14½ minutes, available on free loan from Association Films, Inc. whose regional film centers are at

   Ridgefield, New Jersey — Broad at Elm
   Oakmont, Pennsylvania (Allegheny Co.) — 324 Delaware Avenue
   La Grange, Illinois — 561 Hillgrove Avenue
   Hayward, California — 25358 Cypress Avenue
   Dallas, Texas — 1621 Dragon Street

Part of this film simply and clearly explains the industry's changeover to soft detergents (see THE NATIONAL VOTER, August 1964, "Detergent Dilemma"). But the opening is a refresher explanation of the importance of water and the conclusion points out that the nation's water problems can be solved only by joint efforts of public and private agencies, of industry and individuals, all supporting modern effective sewage treatment in every community. If you send for this film, objective, factual, and fun to watch, copy this

order form

Please send me the 16mm Free-Loan film, "Every Drop / To Drink"

on _____ (1st date) or _____ (alternate)

☐ If the film is not available on the dates indicated, please schedule it for the first open date.

NAME _____ TITLE _____

ORGANIZ. _____

STREET _____

CITY _____ STATE _____ ZIP CODE _____

☐ Please send information on available speakers.

If you use "Every Drop / To Drink," you will probably want to plan carefully to have the meeting go on from the idea of joint effort in pollution abatement to joint effort in other areas -- basin planning, flood control, research, etc. Help your members avoid spending more time on detergents than their importance merits.

2) Another way to start with pollution abatement (not a bad opening for a meeting since the subject has visceral appeal lacking in "state-federal planning for river basins or regions") would be to use a new filmstrip from the U.S. Department of Health, Education, and Welfare, Public Health Service. This filmstrip, "Clean Water is Everybody's Business," can be borrowed free from the Communicable Disease Center, Atlanta, Georgia 30333, Attention: Public Health Service Audiovisual Facility. A leaflet prepared to accompany the filmstrip shows the pictures used and suggests a narrative to accompany them.

YOU WON'T NEED TO SEND FOR THIS LEAFLET. IT WILL COME TO YOUR LEAGUE PRESIDENT FROM THE U.S. PUBLIC HEALTH SERVICE ABOUT THE TIME SHE RECEIVES THIS LEADERS GUIDE. Each page contains interesting additional material and on the last page there are questions about your community. If after examining a copy of "Clean Water is Everybody's Business" you wish copies to distribute to your members at the meeting or for other uses in your community, these can be obtained from:

Mr. Robert Hutchings, Chief - Information Branch
Division of Water Supply and Pollution Control
U.S. Public Health Service
Department of Health, Education, and Welfare
Washington 25, D. C.

You will need to order the filmstrip from Atlanta (see paragraph above) if after examining the booklet you decide to use the filmstrip. One advantage of a filmstrip is that you can stop it whenever you want, introduce your own remarks, raise questions or add information about local conditions. It might be interesting -- if your League has a photographer among its members and starts in time -- to set up two projectors side by side, one to project the U.S. Public Health Service filmstrip and the other for color slides illustrating local and state conditions. Using two projectors, the local shots could be interspersed in appropriate places during the filmstrip.

OTHER WAYS

If there isn't a place on the local League calendar for meeting time on the water item, utilize another way to make your members aware of what is happening on the water front and what the League is supporting and why. The alternative that immediately comes to mind is to encourage members to inform themselves through home reading and study. After all, the League is made up of members who want to know, who like to read, who prefer a plan to random sampling. The water committee might try to:

1) Sell League publications on water to the members

2) Persuade members to keep up-to-date through THE NATIONAL VOTER, forthcoming FACTS & ISSUES, and newspaper and magazine articles on water resources

3) Publish material on water in your local and state Bulletins. Before reprinting or summarizing from another League publication, ask yourselves whether this makes the best use of time, money, and Bulletin space. Would it be shrewder to push purchase of the original pamphlet? (NRCs 1962-1964, CR of CRs No. 5, FACTS & ISSUES, for example?)

4) Set up a shelf in your community library and distribute a sequential reading list with questions which point up the relationship to League interests and position. If your library has few up-to-date publications on water, the League water committee, however small, might make a collection of pertinent materials available free on request (some listed NATIONAL BOARD REPORT, May 1964, p. 43 and some below p.13) and contribute it to the library.

5) Stimulate some of your members by arranging go-and-see trips or interviews with knowledgable officials. The two might be combined. You can take advantage of programs, symposiums, conventions, hearings, enforcement conferences, conferences, or workshops arranged by other groups. Other organizations interested in water resource development seem to welcome League members as guests at their events. Ask your state water chairman or off-Board consultant in water to help you keep informed about opportunities.

DECIDING WHAT TO COVER

In 1964-66 League work on water will be carried on much as it has been in 1962-64. Now that water is again a CA item, it is possible to expand League position by reaching consensus on a phase of the subject not covered by our present League position, but no new national consensus is expected on this item during the coming year.

Each year there has been more action under Water Resources. Perhaps this year your League will become interested in taking inter-League action on water matters in your river basin or region or in taking state or local League action on state or local legislation involving a principle in the national position or on which there has been national League action. If so, your members will need to know -- and you will want to bring to their attention

- . the particular regional, river basin, state or local water situation in which your League is interested
- . the League's national position on water resources and any regional, state, or local position which is relevant
- . the kind of bills the LWVUS has supported since 1960
- . the action proposed for the near future.

Fortunately water legislation usually moves in stately pace through the two sessions of a Congress so there is time to get information to members about bills which the national Board decides will carry out League position and merit League action. The national Board arranges to have information on these bills sent to

League Presidents in periodically published leadership aids, intended to help resource chairmen and their committees keep abreast of what is happening on subjects related to League Program. This leader material is in considerable detail, for committee members always want to be secure in their understanding and prepared for all variety of questions. It is the water committee's responsibility to pass along some of this information to members of your League so that they too will be ready when the time comes for action.

The 88th Congress is winding up its session at the time this **LEADERS GUIDE** is being written. This Congress has passed an unusual amount of legislation in the resource conservation field, including the League-supported Water Resources Research Act (S. 2) which became P.L. 88-379. Since the Water Resources Planning Act (S. 1111 -- passed by the Senate and reported favorably by the House Interior and Insular Affairs Committee September 1, 1964) and amendments to the Federal Water Pollution Control Act (S. 649 -- passed by the Senate and reported favorably by the House Public Works Committee September 3, 1964) may come up on the House floor before the 88th Congress adjourns, the fate of these bills is not known at the time of writing this **GUIDE**. Passed or not, they are examples of water legislation supported by the League. If S. 1111 and S. 649 do not pass, the ideas incorporated in them can be expected in bills introduced in the next Congress.

During 1964-66, Leagues will probably have many opportunities to consider state and local legislation to carry out programs which received League support on the national level. If, under the national water item, your League -- alone or with other Leagues -- sends the national Board a request for permission to take action on a local, state, or regional water problem, one of the questions the national Board asks is whether members of your League understand and are in agreement with the proposed action. It is the water committee's responsibility to supply the information and arrange for the consensus taking on which local or regional position rests. If you belong to a regional inter-League group, the steering committee of that group will prepare substantive material for use in all the Leagues in the group, but each water committee will plan how best to use such material in its local League.

Even if there seems no prospect for action on a local or regional water problem, you can build your meeting on this national item around an interest-rousing aspect of water important to your community. You will find your state water chairman or state water consultant a help.

Some Examples:

- At New York State's Area Conferences on League Program, the following format was suggested for an interesting meeting on water --

  1) Explain the 1960 national position and what the League studied to come to these conclusions. With a background of facts, give the member an understanding of why we reached our current support positions (20 minutes).

  2) Report on the various kinds of action that have been taken under these positions. Review past national legislation and update members on current and pending bills. This is a good place to point out that we can act on a bill without taking a position on all of its parts (i.e., water quality control in S. 649, Amendments to

the Federal Water Pollution Control Act). Point up regional legislation where applicable. Point out the possibilities for action on the state level. Describe the many types of action at local level, stressing variety /see CONVENTION WORKBOOK - Part I, 1964, pp. 52-56; 1962, p. 36. CR of CRs, No. 7, March 1964, p. 2/ (30 minutes).

3) Report on the local picture. Discuss the Jones Committee, what League work in other fields has shown about the local water situation. Know about local water supply and pollution control. Get into a regional or basin-wide discussion (Erie, Susquehanna, Genesee, Ohio) with national position in mind. Leagues in the Delaware River service area in New York will have a different program, for these Leagues will work toward a regional consensus. Upstream Leagues will want to give special attention to P.L. 566, Watershed Protection and Flood Prevention Act, and rural-urban watershed development (40 minutes).

- Leagues in the Ohio River Basin will want to build their meetings around the new and readable inter-League publication, The Ohio River Basin. Leagues in the Southeast may want to look at what the Plan for Southeast River Basins, published by the U.S. Study Commission, 1963, proposes for their particular drainage basins. Leagues in the five-state area in the arid Southwest may want to give some attention to the general recommendations of the Department of Interior's proposed Pacific Southwest Water Plan as modified after consideration of state objections and suggestions.

- Perhaps your League has a local or regional situation which would make a good illustration, as each of the following will for the Leagues concerned: floods in Montana, proposed construction of a big power plant on the St. Croix River, enforcement progress-conference on abatement of packing house pollution on the Missouri at Omaha, proposed formation of a soil conservation district in suburban Westchester County, U.S. Army Engineers Study of the Connecticut River, U.S. Public Health Service's Study of the Apalachicola-Chattahoochee-Flint Basin, multipurpose use of the reservoir of Lake Meade, complex effects of increasing salinity of Colorado River waters. Each illustrates, though differently, points made in the League's 1956-60 study of water resources and expressed in League position.

INTERESTING OTHER ORGANIZATIONS AND INDIVIDUALS

League members, 135,000 in Leagues in all 50 states, multiply their influence by encouraging like-minded community leaders and organizations to express opinions where and when they will be effective. Senator George D. Aiken's incredulous, "...Only 135,000 of them? I thought there were millions," is a tribute to this multiplier effect.

Asking other organizations, officials, or citizens to take action when the time is ripe should not be a last minute affair. Successfully drawing others in when the League receives a Time for Action depends on empathy built up over a long

prior period. It is up to you and your committee to start to establish friendly relations with water-oriented organizations and individuals and with others whose primary interests make them naturally receptive to League positions on water resources. You can help them understand League viewpoint and positions on water, supply them with information (marked League publications, for example) and reasons for League support, and notify them when the time to act has come and to whom the action should be directed. Many organizations supply information to their members, but few are set up to tell members when the time to act has come, where the bill is, and to whom the letter should be addressed. This is a League of Women Voters special skill, one which can be shared to mutual advantage.

Some organizations whose members are likely to be interested in water legislation are listed below. Can you identify chapters or members of some of these in your community? Have you been in touch with the pertinent committee chairman? Do you know in which respects the interests of that organization and its members run parallel to League position under the water item?

Some Organizations

American Camping Association
American Fisheries Society
American Municipal Association
American Recreation Society
American Shore and Beach Preservation Society
Applachian Mountain Club and similar organizations

Boy Scouts of America (adult leaders)
Business and Professional Women

Campfire Girls (adult leaders)
Chamber of Commerce and Junior Chamber
Conservancy Districts
Council of State Governments

Daughters of the American Revolution
Defenders of Wildlife
Ducks Unlimited

Federation of Homemakers
Federation of Western Outdoor Clubs
Four H Clubs (adult leaders)
Future Farmers of America

Garden Club of America
General Federation of Womens Clubs
Girl Scouts (adult leaders)

Izaak Walton League

Keep America Beautiful

National Wildlife Federation (state & local affiliates)
National Audubon Society
National Campers and Hikers Association
National Council of State Garden Clubs
National Parks Association
National Recreation Association
National Rural Electrical Cooperative Association
National Farmers Union
Nature Conservancy
Nurses Associations (state & local affiliates)

Outboard Boating Club of America
Outboard Industry
Outdoor Recreation Institute
Outdoor Writers Association
Oyster Association of America

Sierra Club
Society of American Foresters
Soil and Water Conservation Districts
Soil Conservation Society of America
Sport Fishing Institute
Sportsmen's Association
Wilderness Society
Wildlife Society

(local) River Improvement Association
(local) Watershed Council or Association

Some Individuals

Boaters, campers, fishermen, hikers, foresters
Game, Fish, Water and Conservation Commissioners (state & local)
Reporters and writers on outdoor subjects
TV and radio station program directors
Planning commission members and staffs (state, local, regional)
Faculty and staffs of Land Grant and Agricultural Colleges
Faculty and staffs of biology, botany, geology, geography departments and college outing clubs
Personnel of Soil Conservation Service, Reclamation Service, Forest Service, Park Service, and Water Pollution Control Boards (state and national)
Personnel of experiment stations, health departments, rural electric co-ops
County agents, watershed council and extension service personnel
Heads of construction companies, cement, and pipe companies
Interstate water agency members and staffs

LEAGUE PUBLICATIONS

Material listed here (except river basin pamphlets) is available from the national office only if listed in the latest PUBLICATIONS CATALOG. Out-of-print publications not in your own League files may possibly be borrowed from your state League or from a nearby local League.

"Must" Reading

NATIONAL BOARD REPORT, May 1964, pp. 35-44

NATIONAL CONTINUING RESPONSIBILITIES 1962-1964, pp. 3-12, November 1962

CONVENTION WORKBOOK Part I, 26th National Convention, April 20-24, 1964, pp. 27-28, 49-58

Procedural Guidance

NATIONAL BOARD REPORTS

January 1964, pp. 6, 53-54 (On testimony for Jones Committee and for Enforcement Conferences)

September 1963, pp. 29-31 (On preparing for Jones Committee testimony)

May 1963, pp. 19-21 (Explaining support of water pollution abatement under League position)

May 1962, pp. 16-18 (Explaining relationship between regional position and national position on water resources; caution about preparation necessary for action on specific projects)

May 1960, pp. 16-20 (On organizing and acting in river basin or regional groups)

Basic Resource Material

CURRENT REVIEW OF CONTINUING RESPONSIBILITIES

No. 7, March 1964, pp. 1-20, "Water, Increase in Interest and Activity"
No. 5, May 1963, pp. 1-24, "All About Water"

THE NATIONAL VOTER

August 1964, pp. 3-4, "Detergent Dilemma"
p. 4, KULP, Passage of S. 2, Water Resources Research Act
May-June 1964, pp. 1-2, Statement and explanation of water item on Program adopted for 1964-66
May-June 1963, p. 4, "High Tide-High Time" (a short review of current trends and League action)

For additional list of Basic Resource Material on water, see NATIONAL CRS BIBLIOGRAPHY, November 1962, pp. 3-4. These may be in your League files.

Background for Action (Attached to Time for Action)

August 4, 1964 "In Support of the Water Resources Planning Act of 1964 (S. 1111)"
February 4, 1964 "In Support of the Water Resources Research Act of 1964 (S. 2)"
March 29, 1961 "In Support of a More Effective Program of Water Pollution Control (H.R. 4036)"

Testimony

December 6, 1963	Hearing on Federal Water Pollution Control Act Amendments S. 649 and other bills; by Mrs. Rosenblum before the House Public Works Committee
October 1, 1963	Hearing on Water Resources Research Act S. 2 and other bills; by Mrs. Rosenblum before the House Interior and Insular Affairs Committee
June 18, 1963	Hearing on Federal Water Pollution Control Act Amendments S. 649 and other bills; by Mrs. Rosenblum to the Special Subcommittee on Air and Water Pollution of the Senate Public Works Committee
June 3, 1963	Hearing on U.S. Problems of Water Pollution Control; by Mrs. Rosenblum before the Natural Resources and Power Subcommittee of the House Committee on Government Operations

River Basin Pamphlets

Except for the last, which is out of print, each of the following is available from the address given. NONE is available from the national office.

The Ohio River Basin, 52 pp. (prepared by the Inter-League Survey Committee for the Ohio River Basin which includes the Leagues of New York, Pennsylvania, West Virginia, Ohio, Kentucky, and Indiana) from

League of Women Voters of Peters Township, 348 Bellwalt Drive, Bridgeville, Pennsylvania, 75 cents.

Sudbury, Assabet, Concord River Basin Study, 46 pp. (prepared by SuAsCo River Basin Group of local Leagues in Massachusetts) from Box 92, West Concord, Massachusetts, 30 cents.

The Susquehanna, 26 pp. (prepared by the local Leagues in the Susquehanna Inter-League Council, Pennsylvania, New York, Maryland) from League of Women Voters of Pennsylvania; Strawbridge and Clothier, 8th and Market Streets, Philadelphia, Pennsylvania 19105, 75 cents.

Man and the River, 54 pp. (prepared by the Inter-League Council on the Delaware, Leagues of Women Voters of Delaware, New Jersey, New York, and Pennsylvania) from League of Women Voters of New Jersey, 460 Bloomfield Avenue, Montclair, New Jersey, 07042, 50 cents.

Red River of the North, 39 pp. (prepared by the Red River Basin Committee, Leagues of Women Voters of Minnesota and North Dakota) from League of Women Voters of North Dakota, 433 - 8th Avenue, South, Fargo, North Dakota, 58101, 25 cents.

Great River of the West, 32 pp. (prepared by the Inter-League Committee on the Columbia River Basin, Leagues of Women Voters of Idaho, Montana, Oregon, and Washington) out of print.

SOME SUGGESTED NON-LEAGUE PUBLICATIONS

Selected for general interest, non-technical presentation, recent publication, and low cost.

General

***U.S. Soil Conservation Service, Water Facts, envelope size (4 x 6"), 14 pp., revised. U.S. Department of Agriculture, Soil Conservation Service, PA 337, May 1964. (Best basic piece for those with no understanding of water. Explains watersheds, groundwater, hydrologic cycle, consumptive use, water losses, etc., simply and clearly.)

***U.S. Department of Agriculture, Water for Farm and City, notebook size, 8 pp., PA 411, December 1960. (Good companion piece to above. Explains water functions of Departments of Agriculture, Interior, HEW, Army.)

***U.S. Geological Survey, Water and Industry, envelope size (4 x 9"), 11 pp., U.S. Department of Interior, Geological Survey, Water Supply Division, 1962. (Rounds out material in two publications above. Concludes there is enough water for industry and industry's water problems are largely economic.)

With ON THE WATER FRONT, the basic League publication, out of print and not available for new members, the three publications listed above can be used in its place. Taken together, they cover much of the

material which appeared in ON THE WATER FRONT. They have the additional advantage of now being more up to date. These three can be obtained in quantity, upon request, and can therefore be distributed to new members for orientation, used for unit meeting preparation, etc.

For the first two, address requests for a quantity to
Mr. Ray Heinen, Assistant to the Administrator
Soil Conservation Service
U.S. Department of Agriculture
Washington, D. C. 20250

For the third, address requests for a quantity to
Mr. E. S. Osselsine, Publications Section
Water Supply Division, U.S.G.S.
Department of Interior
Washington, D. C. 20240

Leopold, Luna B. and W. B. Langbein, A Primer on Water, 50 pp., 1960. Available from Superintendent of Documents, U.S. Government Printing Office, Washington, D. C. 20402, for 35 cents. (Well worth the money for those who want to know more about the characteristics of water. Written in non-technical language by two recognized experts to help meet heightened citizen interest in general information about water and its use and control. Part I, 32 pp., tells about hydrology, the science of relation of water to our earth, with profuse, simple, explanatory diagrams. Part II, 17 pp., describes development of water supplies and use of water.)

Periodicals

Conservation News, twice a month, free from National Wildlife Federation, 1412 - 16th Street, N.W., Washington, D. C. 20036. A postcard or letter to Mr. Thomas Kimball, Executive Secretary, National Wildlife Federation, will place an individual on the regular mailing list for this publication. (Articles and news on conservation subjects, including water; an educational service of the Federation.)

***Conservation Report, weekly while Congress is in session, free from National Wildlife Federation (see above). Write individually to Mr. Thomas Kimball, Executive Secretary, National Wildlife Federation and ask to be placed on the mailing list for this publication. (A weekly report on developments on federal bills in the conservation field -- including water resources. Will enable you to keep up to date more quickly than waiting to hear from the League's national office.)

Acid Mine Drainage

U.S. Public Health Service, Acid Mine Drainage, 24 pp., U.S. Department of HEW, Public Health Service, Division of Water Supply and Pollution Control, 87th Congress, 2nd Session, House Committee Print No. 18,

April 19, 1962. Available free on request from House Public Works Committee, House Office Building, Washington, D. C., 20515. (A comprehensive report on acid mine drainage pollution from active, marginal, and abandoned coal mines; emphasis on nature and scope of problem and on various control measures that may be applied.)

Bond Issues

Portland Cement Association, Keys to Successful Promotion of Public Bond Issue Campaigns. Free from Portland Cement Association, 33 W. Grand Avenue, Chicago, Illinois, 60610. (A new packet of practical hints, guides, booklets designed to help citizen organizations and public officials conduct campaigns for bond issues, particularly for water pollution control facilities.)

Pollution Abatement

***U.S. Public Health Service, Focus on Clean Water - An Action Program for Community Organizations, U.S. Department of HEW, Public Health Service, Division of Water Supply and Pollution Control, Pub. No. 1184, 35 pp., 1964. ONE COPY OF THIS WILL BE MAILED BY PHS DIRECTLY TO THE PRESIDENT OF YOUR LEAGUE. BE SURE YOU GET IT FROM HER. Other copies available free on request from above agency, Washington, D. C., 20201. (Reviews uses of water, ways it is polluted, who's in charge of water quality at three government levels, what citizen organizations can do to improve the situation.)

Recreation

***Citizens Committee for the Outdoor Recreation Resources Review Commission Report (CORC), Action for Outdoor Recreation for America, 40 pp., bibl., rev. 1964. Available from CORC, 1001 Connecticut Avenue, Washington, D. C., 20036, 25 cents, 10 cents each in lots of 10 or more; single copy free on individual request. (A digest of the ORRRC Report. Includes case histories of successful state and community programs illustrating individual initiative and leadership in community, county, and state outdoor recreation, including water-based recreation. One example is a League's successful action.)

U.S. Geological Survey, Water for Recreation, ORRRC Study Report, No. 10, 65 pp., ill., 1962. Available from Superintendent of Documents, Government Printing Office, Washington, D. C., 20402, 45 cents.

Watersheds

U.S. Soil Conservation Service, Multiple Purpose Watershed Projects under Public Law 566, U.S. Department of Agriculture, SCS, Watershed Planning Division, PA 575, 13 pp., May 1963. Available free on request from above agency, Washington, D. C., 20250, probably in quantity. (What multiple purpose, small watershed projects can do for rural and urban communities with land and water problems; how they can be started and financed in basins up to 250,000 acres.)

STATE OF MINNESOTA
WATER POLLUTION CONTROL COMMISSION

Notice of Public Hearing on
Report on Comprehensive Sewage Works Plan
for the Minneapolis-St. Paul Metropolitan Area
as Required by Laws of 1963, Chapter 882

Pursuant to authorization of the Water Pollution Control Commission and in accordance with applicable statutes, a public hearing will be held by said Commission, or by one or more authorized members, employees or agents thereof in the auditorium of the State Office Building, St. Paul, Minnesota, on November 4, 1964, at 10:00 a.m.

This hearing is for the purpose of investigating, considering and acting upon the proposed comprehensive plan for construction and financing of facilities required by the entire area served, or to be served by the Minneapolis-St. Paul Sanitary District as prepared by said District, and for obtaining information for preparation of a written report on this comprehensive plan as required by Laws of 1963, Chapter 882.

R N Barr

Robert N. Barr, M.D., Secretary
Water Pollution Control Commission

Dated: October 1, 1964

WILL WE HAVE ENOUGH WATER?

With wise use through conservation, redistribution, and quality control, there should be 'plenty' of water

IT FREEZES at 32 degrees Farenheit, vaporizes at 212 degrees, and flows as a liquid anywhere between. It covers 70 per cent of the globe, constitutes exactly the same percentage of our bodies, and makes the earth hospitable to life. It will dissolve more substances than any known liquid. Its specific gravity permits ice to float and melt, else it would probably pile up on the ocean floor, raise sea levels to flood the land, and gradually turn the earth into another frozen planet.

Water, next to air, is man's most plentiful and precious resource. But he has blithely taken it for granted, using and misusing it with too little thought of the future. Only in recent years have conserving the world's water supply and developing new sources become vital concerns. Converting salt water to fresh has been successful but is still economically impractical; science has also experimented with rainmaking and weather control. One water expert has even suggested towing giant icebergs from the Antarctic Ocean for fresh water. He estimates floating one to Los Angeles would take a year and only half its bulk would melt along the way.

Some people think we are running out of fresh water and that when we drink it or use it to irrigate a field, it is lost forever. Most scientists, however, agree that the amount of water on and in the earth has diminished little within historic times. No matter what you do to it, water eventually comes back. "Would this were true of our other natural resources," comments one conservationist.

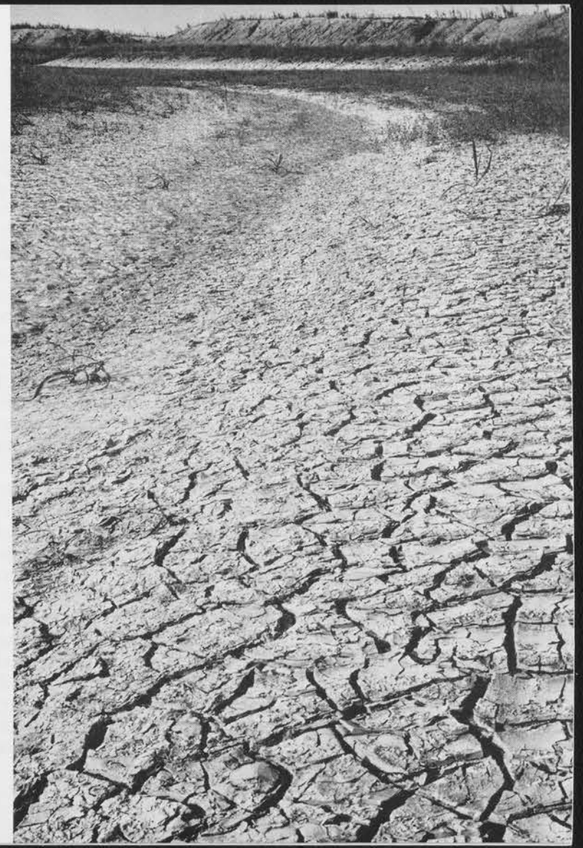
While water distribution is constantly changing, the hydrological cycle returns it to lakes, streams, and the ocean. Evaporated into the atmosphere, it is purified by a mysterious process and falls—often thousands of miles away—as rain or snow. The water we drink today may contain the same hydrogen and oxygen molecules that composed Cleopatra's bath or floated Noah's ark.

Yet, maintaining supplies of clean fresh water is our most serious conservation problem. In this country, we have always used water with almost profligate abandon. We cut vast forests to fill a seemingly insatiable appetite for lumber. We plowed up grasslands for farms to feed an exploding population, and then saw destructive floods sweep millions of acres of our rich virgin topsoil down creeks and rivers, silting up lakes and spilling into the oceans.

Modern agriculture is one of the biggest water users. Plant life consumes fantastic amounts of moisture and with notable lack of efficiency. An estimated 1,250 gallons of water are required to grow one pound of cotton. Even corn and sugar soak up 120 gallons of irrigation water per pound of crop. Thousands of wells drilled in areas needing more rainfall have lowered water tables so drastically that many hydrologists are predicting once-productive croplands will become deserts unless something is done to replace ground water.

In recent years, industrial water

Reprinted from THE HUMBLE WAY



Parched patchwork of dry lake bed typifies effect of blazing sun and lack of rainfall.

requirements have skyrocketed to surpass all others. Vast quantities are needed for steam generation of electric energy; a large steel, aluminum, or paper mill may daily use enough water to supply all the normal requirements of a sizeable city. In this regard, the distinction between water use and consumption becomes important. U. S. industry, a large user but a relatively small consumer, makes water go a long way by renovation and multiple use.

The petroleum refinery, for example, uses and re-uses about seven gallons of water in making a gallon of gasoline. This water is not consumed, however, but is cleaned and returned to the stream. To conserve fresh water, many industrial plants are equipped to circulate brackish water in their cooling systems. In certain dry areas, there's a growing use of municipal effluent for this and other processes.

In the early days of U.S. industrialization, cities and plants sprang up on our rivers, gulping great volumes of water and spewing wastes back into these streams with little or no regard for users downstream. In many cases, not only sewage but acids, caustics, and other chemicals were released, killing fish and other wildlife, and posing a health hazard to humans.

Today, most industrial water users take precautions to avoid this danger. Oil refiners have spent and are spending huge sums on settling basins, biological filters, and other purification methods. In addition to scientific analysis, many refineries test renovated water by running samples of effluent through tanks stocked with schools of fish. The Humble Company's Baton Rouge Refinery on the Mississippi River uses goldfish; Humble's Baytown Refinery uses native minnows from Galveston Bay.

America's population shift to urban areas has placed increasing importance on an abundance of clean water. The average city-dwelling family of four uses about 600 gallons of water daily—a little for drinking and a lot for bathing, sanitation purposes, and watering lawns and gardens. Innovations such as dish and clothes washers, garbage disposals, air conditioning, and an increasing number of residential swimming pools push consumption rates higher. Municipal systems also supply billions of gallons of water for small industry and business, fire fighting, and flushing streets and sewers.

Will we eventually run out of fresh water? This is a question that troubles more and more people, especially in heavily populated areas. Their fears are accentuated by reports of occasional temporary local shortages: Chicago suburbanites forbidden to sprinkle lawns and wash cars; residents of a Texas city buying drinking water by the gallon at supermarkets; a New Jersey city outlawing leaky faucets under threatened penalty of 30 days in jail.

But Dr. Gilbert White, international water conservationist and former United Nations consultant on the problem, speaks for many authorities when he says, "I believe there is more than enough water to go around for our growing country. We just have to use it more wisely."

WATER...WATER...

...but not everywhere nor always fit to drink

ON A NATIONAL scale, we get far more water—in the form of rain and snow—than we need. An estimated 4,300 billion gallons of fresh water descends from U. S. skies each day, an average annual rainfall of 30 inches. The problem is one of distribution and timing: we don't always get water in exactly the right amounts, in the right places, and at the right times.

For example, the Pacific Northwest's Olympic rain forest is deluged by 140 inches a year. Down the coast in southern California, populous and industrial Los Angeles receives less than 15 inches a year. Seasonal imbalance creates temporary shortages in other places. Large parts of the U. S. are either too swampy or too arid for human habitation. In areas denuded of ground cover or scarcely able to support vegetation, torrential rains give rise to rampaging floods. Mountains of silt are washed down slopes and gullies to pollute rivers and reservoirs.

Ancient civilizations battled silt—still today's No. 1 pollutant—as far back as 8,000 years ago. The Sumarians invented irrigation to increase crop yield from the fertile plains of Mesopotamia but their canals from the Tigris and Euphrates Rivers gradually became clogged with mud.

In the sixth century, B.C., the Romans built an ingenious storm sewer called the *Cloaca Maxima,* and also used it to dispose of city sewage. Great numbers of slaves captured in wars of conquest labored in vain to keep the big ditch free of silt and garbage. Probably one of the reasons for the decline of the Roman empire was that farmlands near the capital city turned into a disease-breeding swamp.

The highly-advanced Mayan Indian culture of Mexico also began to crumble because of water problems. The Mayans understood little about proper drainage and conserving topsoil. Lush harvests were replaced by crop failures and eventual famine. Our own Lake Mead, formed by Hoover Dam on the Colorado River is only 30 years old, but silting up at an alarming rate.

Soil erosion and silt pollution of our water supply has been greatly alleviated since the Dust Bowl days of the thirties. Contour plowing, flood control, reforestation, and the planting of quick-growing grasses have reclaimed millions of acres of damaged plains and barren slopes. Numerous ponds and dams now catch and hold water runoff. Over-irrigation and other water abuses are being corrected by a new generation of scientifically-trained farmers and agricultural engineers.

With America's galloping population growth, one of the increasing threats to plenty of clean water is contamination and pollution from city sewage. Many metropolitan sanitation systems need to be enlarged and modernized; not enough cities have separate storm and waste disposal sewers. Some of the more foresighted cities have installed, in addition to primary and secondary methods, tertiary treatment plants where experiments with radiation and chemicals show much promise to destroy problem waste and make more clean water available.

Detergent foam—a nuisance clogging many municipal waterworks—appears to be nearing abatement. Several oil and chemical companies produce raw materials for "soft suds" which bacterial action can break down in conventional treatment plants. Humble research, through its scientific affiliate in New Jersey, led the development of the new biodegradable detergent. Intensified research is opening other new avenues to prevent pollution and contamination of water. In many cases, industry scientists and hygienists work cooperatively with city, state, and federal health and conservation agencies.

Our nation's high standard of living and continued prosperity are inseparably linked to industrial growth, which in turn depends on an adequate and suitable water supply. The quality of water employed in various industry operations is, of necessity, often affected. Unfortunate pollution accidents still occur which generate "scare" publicity and receive blame for ill effects before proper investigation. But most companies requiring large amounts of water—particularly those making petroleum products, chemicals, steel, paper and textiles—have long recognized a social responsibility and an economic necessity to prevent pollution. Wise water use makes good business sense.

Petroleum's stake in future water supplies, like that of the individual, cannot be exaggerated. The average human being can survive about five days without water. It's doubtful the oil industry could function at all.

HOW HUMBLE SAFEGUARDS CLEAN WATER

Spray pond cools and aerates water circulated in Humble refinery system. Water returned to streams is often cleaner than before use.

OIL INDUSTRY contributions in conserving water and keeping it clean are manifold. Considering its size, scope, and the nature of its operations, the industry adds remarkably little to pollution problems. As early as 1926, some 50 members of the American Petroleum Institute voluntarily agreed to wage a campaign to prevent and curtail contamination of the nation's water resources.

A pioneer in this effort, Humble takes every step possible to protect and purify water associated with drilling, producing, manufacturing, and transporting oil and its products. A few examples suggest how company policy is translated into actual

practice in all phases of operation:

At refineries and plants, maximum reuse is made of water; harmful wastes are never permitted to enter rivers and streams. This program includes designing units to operate on less water, recycling water several times in cooling systems, neutralizing acids and other chemical compounds, restoring oxygen content by aeration, and treatment by oil filters, separators, skimmers, and settling basins. A new oil separator built recently at Humble's Billings, Montana, Refinery purifies water flowing back into Yellowstone River. In July, Baytown Refinery placed in service a new 380-acre reservoir with three separate stabilization ponds to retain and treat effluent for a full six weeks before discharge into the Houston ship channel. During the last four years, Humble has spent $6 million on pollution prevention at manufacturing installations alone.

In drilling and production operations, salt water from oil wells is injected back into underground saline formations. Small amounts of salt water are pumped into pits lined with butyl rubber and allowed to evaporate under controlled conditions. Waste oil and drilling fluids are disposed of in an approved and sightly manner. Clean-up and good housekeeping is the rule in oil field operations, whether on a Colorado mountaintop or far offshore in the Gulf of Mexico.

Ocean-going tankers and barges operating on inland waterways also guard against water pollution. Tanker ballast is discharged at bilge disposal units at port and refinery docks. Special precautions are taken to prevent spillage at terminals. Ship garbage is taken ashore in plastic bags. Inland, small airplanes regularly patrol pipeline routes to detect leakage. When a leak is spotted, repair crews are dispatched to the site to fix the leak and clean up spilled oil.

In addition to its anti-pollution program, Humble manufactures special products which help promote water conservation. One of these is an agricultural mulch, spread on sand dunes and barren slopes to stabilize the soil, give vegetation a chance to take root, and retain moisture. Another product, a petrochemical liquid, is aerially sprayed on lakes and ponds in drouth areas to form a thin surface film which reduces evaporation.

Developments such as these are the fruit of research and engineering projects which illustrate a growing awareness of America's water dilemma. The combined efforts of science, industry, and concerned citizens can assure enough water for the future by conserving and redistributing our nation's supply, using it more efficiently, and keeping it clean for coming generations.

Within the dotted lines on this aerial photograph are the three sections that make up Baytown Refinery's 380-acre ponding system. After the effluent level builds up in Section 1, it will flow, as indicated by arrows, into Sections 2 and 3 (now dry as shown) before it is finally discharged into the Houston Ship Channel. Total retention time of effluent in the ponding system: 45 days.

BAYTOWN KEEPS IT CLEAN

Reprinted from HUMBLE NEWS

They've built a 380-acre pond at Baytown Refinery and will stock it with fish. But don't reach for your rod and reel. The purpose of this Texas-size pond is to protect fish, not hook 'em.

The man-made pond is part of a system which is the latest step in Baytown's continuing program to remove impurities from its waste water stream before it is discharged into the Houston Ship Channel. The channel flows into Galveston Bay where fish thrive in great numbers, to the delight of

Research Technician Carl P. Tyler watches fish swim in an aquarium he is filling with effluent water treated in the pilot unit of Baytown Refinery's new ponding system. Healthy fish demonstrate system's effectiveness.

Carpenter J. O. Whiteside, left, and Machinist C. W. Kirkland work on the pumps which will "pick up" the refinery's waste water stream from a canal near its previous outlet and deliver it to the ponding system.

ardent anglers for miles around.

In line with the Humble Company's policy of working toward the elimination of pollution at its refineries, plants, and other facilities, Baytown Refinery, since World War II, has spent more than $10 million upgrading the quality of its air- and water-borne wastes, known as effluents. As a result of these endeavors, the refinery's waste waters have been cleaner generally than the water in the Houston Ship Channel—even before the ponding system was completed in July.

"Call our new system the frosting on the cake," says H. H. Meier, general manager of Baytown Refinery. "It is in line with Humble's efforts to do a better job."

The new ponding system consists of three sections into which waste water is pumped after it has already gone through the refinery's regular waste treatment facilities. (Like all refineries, Baytown uses several barrels of water for every barrel of oil it processes. Cold water is used to cool products and to condense oil vapors. Water is also used to "wash" some of the products themselves, as well as equipment. In the form of steam, water drives turbines to make electricity, heats lines and tanks, preheats feed stocks, warms buildings, and cleans out vessels.) The new ponding system has a throughput of 15 million gallons of effluent per day.

Two pumps are delivering 6,000 gallons per minute of the refinery's effluent water into the first section which occupies 176 acres. As the effluent level builds up, it will flow into an 84-acre section and thence into the third section of 120 acres. From there, it will flow into the Ship Channel. Altogether, the refinery's effluent is retained in the ponding system for some 45 days. This retention time will allow natural aeration of the water and assimilation by bacteria and algae of materials that might cause pollution.

The treatment is carried out by nonharmful bacteria which are present in all natural waters. These bacteria oxidize organic carbon to carbon dioxide. The algae present in the pond take up the carbon dioxide and through photosynthesis release the oxygen from the carbon dioxide back to the water where it is again used by the bacteria to oxidize more organic carbon.

What seems to be a relatively simple device for improving effluent

This small, divided pond served as the pilot unit for research on the biological treatment of refinery effluent water at Baytown. Watching are Research Technician Carl Tyler and Research Specialist Sid Brady.

quality (provided you've got 380 acres to spare) is actually the result of several years research and testing, carried out jointly by refinery and Baytown Research and Development personnel.

The research program included the construction of a miniature version of the three-stage ponding system. This pilot unit enabled Baytown people to conduct many scientific tests of the effectiveness of the system; but, the most popular test of all was one which required no instruments or slide rules. It consisted of stocking the effluent from the pilot unit with fish. That was almost a year ago. And they're still there—alive and healthy.

When the effluent water now building up in the pond reaches the proper level, the third and final section will be stocked with fish, too. Like their finny little friends in the pilot pond, the fish destined to swim in the big pond can look forward to long, peaceful lives. And to Humble they will serve as living proof that the refinery's waste stream does not pollute surrounding waters.

Additional copies available upon request to Humble Oil & Refining Company
Public Relations Department, P. O. Box 2180, Houston, Texas 77001

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