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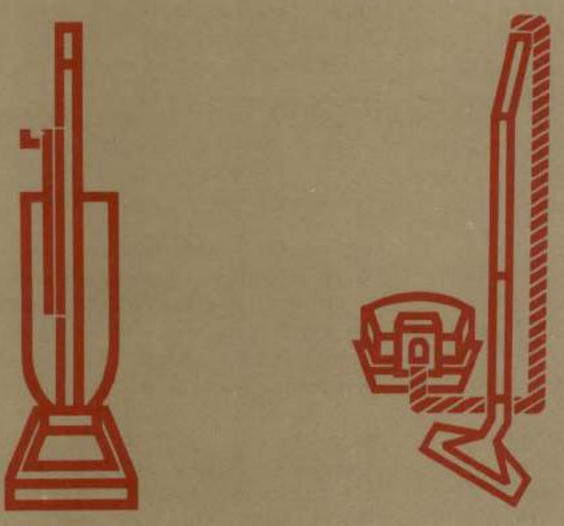
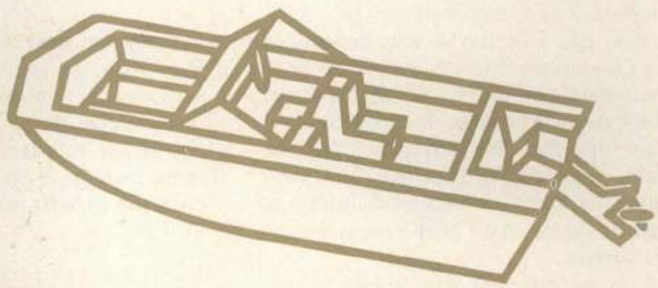
Beginning a special three-part report:

IS THE WATER SAFE TO DRINK?

VACUUM CLEANERS



OUTBOARD BOATS



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IS THE WATER SAFE TO DRINK?

By Robert H. Harris and Edward M. Brecher and the Editors of Consumer Reports

PART 1: THE PROBLEM

The United States is currently embarked on a mammoth Federal-state program to clean up our rivers, lakes, and coastal waters—a goal CU enthusiastically supports. Even if that program proceeds on schedule, however, it will take more than a decade to achieve its objectives. This month, therefore, CU introduces a three-part series of articles calling for faster action on a program to upgrade the *drinking water* now being piped into homes and businesses by some 40,000 community water systems. We urge this program for several reasons:

☐ Even if all man-made pollution were eliminated (a highly optimistic assumption), there would still be natural sources of pollution that can be avoided only by purifying the water we drink.

☐ Even under an effective pollution-control system, there will still be pollutants—from accidental spills or discharges, agricultural runoffs, and so on—that need to be removed from drinking water.

☐ If pollution-abatement is delayed in the same way that clean-air programs are now being delayed or curtailed, purportedly because of the "energy crisis," Americans could be drinking water from contaminated sources for many years.

☐ Finally, the costs of improving our drinking water promptly are reasonable enough to justify the added protection we would gain.

In short, the recommendations in this series of articles are designed to complement—and strengthen—current pollution abatement efforts.

ABOUT THE AUTHORS

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Edward M. Brecher, an award-winning science writer and investigative reporter, has been a frequent contributor to CONSUMER REPORTS since 1938. He was a principal collaborator on "The Consumers Union Report on Smoking and the Public Interest" (1963), which foreshadowed the U.S. Surgeon General's report of 1964; and he is the senior author of "Licit and Illicit Drugs," the Consumers Union report cited in 1972 by the American Library Association as one of 43 books "of outstanding merit."

New Orleans, like many other American cities, gets its drinking water from a heavily polluted source—the Mississippi River. Many industries discharge their wastes into the river, and many upriver cities discharge their sewage into it. The rainwater runoff from farmland carries a wide variety of pesticides, herbicides, fertilizers, and other agricultural chemicals that swell the Mississippi's pollution burden. Even on its better days, New Orleans drinking water has an off-taste and off-odor. Its palatability tails off further after large discharges or spillages of contaminants upriver.

Few New Orleans residents are alarmed. They have been repeatedly assured by city officials that their water, processed according to established water-treatment principles, meets the drinking-water standards of the U.S. Public Health Service (PHS) and is "safe." And so it probably is, if one takes "safe" to mean that the water won't cause typhoid, cholera, or other bacterial diseases—the diseases that standard water treatment is designed to prevent. But surely, as the senses of smell and taste testify, some things remain in the treated water that may not deserve a clean bill of health.

In 1969, the Federal Water Pollution Control Administration sampled drinking water after it had passed through the New Orleans water-treatment plant at Carrollton—by far the largest in the city, delivering more than 110 million gallons of water a day to 600,000 people. Tests were then run to identify organic compounds in the samples. Thirty-six such chemicals were identified; others were found but could not be identified.

Three of the organic chemicals (chloroform, benzene, bischloroethyl ether) were carcinogens, shown to cause cancer in animal experiments. Three others were toxic, producing liver damage in animals when consumed even in small quantities for long periods. The long-term effects of consuming small quantities of the other New Orleans drinking-water contaminants, identified and unidentified, are unknown.

Are the chemicals in New Orleans water causing illness? Are the carcinogens causing cancer, for example? That question was first raised nearly a quarter of a century ago, when a survey showed that New Orleans had the third-highest rate for kidney cancers and the sixth-highest rate for cancer of the bladder and urinary tract among 163 metropolitan areas studied. The U.S. Public Health Service also reported in 1959 that the New Orleans bladder cancer rate was three times as high as the Atlanta and Birmingham rates.

"This difference suggested that an environmental factor may be responsible for the higher incidence in New Orleans," Dr. Lucia J. Dunham of the National Cancer Institute noted in 1967. "Contamination of the drinking water is an obvious potential source for such a factor."

To check this possibility, Dr. Dunham and her associates injected newborn mice with extracts taken from New Orleans drinking water *after* it had undergone treatment. No tumors attributable to the pollutants were induced. The results were judged difficult to assess, however, partly because of the variability of the pollutants in the test samples. Nor were the researchers sure that all potential carcinogens had been extracted from the water, or that other chemicals present had not inhibited or masked their effect. Thus, the outcome of the test was inconclusive. "Whether drinking water contains agents that can produce cancer in man is still undetermined and requires further study," the Dunham study concluded. The New Orleans water supply, in short, merits what is known as a "Scotch verdict." It has neither been acquitted nor found guilty; the case against it is simply "Not Proved" on the basis of available data.

However, one fact is known beyond question about those organic contaminants found in New Orleans drinking water. All of them can be reduced in quantity, and some can perhaps be eliminated altogether, at a very small cost per household, just by routing the water through a bed of activated carbon granules before it is piped throughout the city. Those organic contaminants, in short, are not present in New Orleans water of necessity; they are there because New Orleans officials have not as yet introduced the simple procedure needed to minimize them.

CURRENTS OF COMPLACENCY

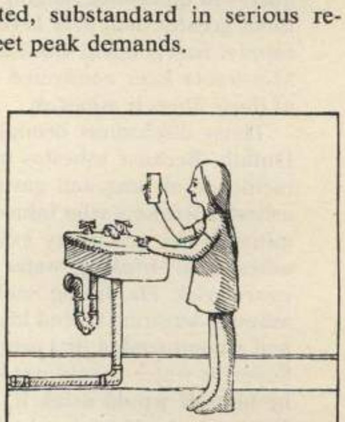
Our references to New Orleans should not be taken to imply that New Orleans water is necessarily worse than that of most other cities. Some other water supplies may be in even greater need of activated carbon treatment or other water-processing improvements. Few cities, indeed, have ever had their water tested to determine whether carcinogens or toxic organic compounds are present in it. Where the water has been tested (as in Evansville, Ind., and Ames, Iowa), the findings resemble those for New Orleans.

But the New Orleans example does furnish a reasonable point of reference from which to view the many shortcomings of our community water supplies—some 40,000 countywide, citywide, and townwide systems, most of them publicly owned and operated, which pipe water into urban and suburban homes and places of business.

Almost everyone supposes that such systems are under continuous surveillance by competent state and local health officials, that water samples are scrupulously tested at frequent intervals, that any flaws in a water system will be soon discovered and corrected—and that the water we drink therefore must be safe. Unfortunately, almost everyone supposes wrong.

True, our cities no longer suffer from large-scale recurring epidemics of typhoid, cholera, dysentery, and other waterborne bacterial infections. It was those epidemics, with their ghastly death tolls traceable to drinking water, that forced the establishment of community water supplies between the Civil War and World War I. The then-new water systems worked quite well against the hazards they were meant to alleviate. But today, many of the same water systems are overage, dilapidated, substandard in serious respects, and barely able to meet peak demands.

Their design is primitive, and they are typically staffed by people trained in an outmoded tradition or not trained at all. As the level of pollution has risen in our sources of raw water, the techniques employed to make that polluted water safe for human consumption have become less and



less adequate. Revolutionary advances in other fields of science and technology during recent decades are applicable to drinking-water purification—but they are not being applied. Instead of tooling up to meet today's environmental challenges, most community water systems remain geared to preventing bacterial epidemics alone.

Evidence for those broad generalizations comes from four separate series of drinking water investigations undertaken during the past five years:

- The U.S. Public Health Service's "Community Water Supply Study," which in 1969 reported on a survey of 969 water systems serving 18 million people—all of the community water systems in eight major metropolitan areas from coast to coast, plus all of the systems in Vermont.
- Similar studies of seven states undertaken since 1969 by the Water Supply Division of the U.S. Environmental Protection Agency (EPA).
- A report by the Comptroller General of the United States

ASBESTOS IN THE WATER: TEMPORIZING WITH CANCER

Minnesotans living along the shores of Lake Superior cling tenaciously to a kind of reverence for the purity of its water. Regrettably, their faith in the lake water is being sorely tried.

Eighteen years ago, the Reserve Mining Company—jointly owned by Armco and Republic Steel—began processing taconite, a low-grade iron ore, on the lakeshore 60 miles northeast of Duluth and dumping the mining wastes, or "tailings," into the lake. To date, the company has discharged more than 200 million tons of tailings, and it continues to dump 67,000 tons daily.

The ecological depredations have gradually become evident—reduced water clarity, suspended solids over several thousands of square miles, eutrophication, changes in life at the bottom of the lake.

Local ecological groups began protesting years ago. A suit against the mining company was eventually brought by the U.S. Government, joined by the states of Minnesota, Wisconsin, and Michigan, the Environmental Defense Fund, and four local ecology groups. The case came to trial in August 1973, some 17 years after the dumping began. The suit charged that the Reserve Mining tailings were not only altering the ecology of the lake but were also being carried southwest by lake currents, so that they ended up in the drinking water consumed by the 150,000 residents of the Duluth area.

The company had long insisted that its tailings were "just sand." Actually, the tailings are composed in large part of cummingtonite and similar minerals. What is cummingtonite? No one bothered to find out until Arlene Lehto, founder of the Save Lake Superior Association, alleged in 1973 that it is a form of asbestos. Subsequent tests by EPA chemist Phillip Cook showed that Duluth's drinking water does in fact contain asbestos-like fibers—in quantities ranging from 10 to more than 100 times greater than ever before found in a public water supply. Independent studies by the EPA and the state of Minnesota later confirmed that a substantial quantity of those fibers is asbestos.

Those disclosures brought health experts flocking to Duluth. Because asbestos has been linked to a high incidence of lung and gastrointestinal cancer among asbestos workers who inhale significant amounts of the mineral, the possibility existed that large quantities of asbestos in drinking water might also increase the cancer risk. Dr. Irving Selikoff, a leading authority on asbestos hazards, voiced his concern on a visit to Duluth and recommended that people who had not drunk Lake Superior water should not start drinking it. Asked if he himself would drink it, he replied, "Not knowingly." Dr. E. Cuyler Hammond of the American Cancer Society was similarly apprehensive about imbibing Duluth's water. Dr. Cook of the EPA was quoted in *Today's Health* as saying: "I won't even let my wife shampoo the rug with it. We know this material can go from the water into the air, and we know you can't get it out once it's in you."

Dr. Selikoff reports that it takes from 20 to 30 years for asbestos-caused cancer to develop. So additional years will elapse before any effects of asbestos in Duluth's drinking water become known. Meanwhile, a search has begun for asbestos fibers or precancerous lesions in the gastrointestinal tracts of Duluthites being autopsied. The area's 150,000 residents are thus today involuntary participants in a vast human experiment to determine whether asbestos in drinking water increases the incidence of gastrointestinal cancer.

Drinking-water samples from Boston, New York, Philadelphia, Atlanta, Chicago, Dallas, Kansas City, Denver, San Francisco, and Seattle have also been tested. Sure enough, preliminary findings indicated asbestos-like fibers in each of those water systems. As yet, the presence of asbestos has been confirmed for San Francisco's water only. But a recent asbestos industry report suggests the possibility of widespread contamination of drinking water by asbestos leaching from asbestos-cement pipe, which is used by many community water systems.

After hearing nearly nine months of testimony in the Duluth case, Judge Miles Lord of the Federal District Court in Minneapolis recently concluded that the Reserve Mining tailings constitute "a very substantial public-health menace." He has ordered the company to halt the discharge of wastes into Lake Superior and to develop a plan for disposing of them on land. Reserve Mining is appealing the verdict. As this issue of Consumer Reports went to press, the hearing was scheduled to begin in the United States Court of Appeals for the Eighth Circuit. Judge Lord has also urged that Duluth promptly start filtering its water to remove at least some of the asbestos.

Meanwhile, the Reserve Mining Company is still dumping 67,000 tons a day of asbestos-rich tailings into Lake Superior. Duluthites with no other choice are still drinking asbestos in their water. So are the residents of San Francisco and possibly those of the other large cities named above—and no doubt the residents of many cities whose water has never been tested for asbestos.

Which once again illustrates a lamentable truth about our community water systems: When confronted with the danger of a bacterial epidemic, they may respond promptly enough. But when the threat is nonbacterial, like asbestos in drinking water, they may be unprepared to meet it or they may fail to respond at all.

covering 446 water systems in six states, submitted to Congress in November 1973 and commonly referred to as the General Accounting Office (GAO) Report.

- Unpublished studies of the water systems of Cincinnati, Cleveland, New Orleans, Pittsburgh, and six smaller American cities, prepared by the co-author of this series of articles, Robert H. Harris, and an associate, Dennis O'Brien.

In their collective findings, the studies demonstrate that the focus of attention on long-range abatement of our lake, stream, river, and coastal water pollution has inadvertently distracted attention from a more immediate part of the pollution problem—safeguarding the piped water that 160 million Americans are drinking, cooking with, and bathing in right now. In this series of three articles, accordingly, we shall seek to restore the balance. This month we shall broadly review what's wrong with our community drinking-water systems. Subsequent articles will consider ways to upgrade a water system, community action programs aimed at securing purer water, and the need for Federal and state drinking-water legislation and improved pollution control regulations. We shall also discuss what little you personally can do in your own home to safeguard yourself and your family from the shortcomings of your community water supply.

BACTERIA: THE PRICE OF SPORADIC VIGILANCE

Experience has shown that community water supplies must be tested at frequent intervals if intermittent bacterial contamination is to be spotted and promptly terminated. (A praiseworthy few water systems run bacteriological tests daily.) Experience has also shown that the number of samples tested should increase with the size of the system. The PHS standards prescribe bacteriological tests on two samples per month for systems serving 2000 people or less, rising to 500 samples per month for systems serving 5,000,000 people. No Federal law, however, requires a water system to conform to PHS standards. The testing schedules are more honored in the breach than in the observance, even where compliance with the standards is mandated by state law.

Of the 969 water systems surveyed during the 1969 Community Water Supply Study, 85 per cent failed to collect and test the prescribed minimum number of samples. The smallest systems were the worst offenders, but even among large systems serving more than 100,000 people, 64 per cent fell short of the standard. Similarly, the 1973 GAO survey found that 319 of the 446 systems surveyed, or 72 per cent, failed to test an adequate number of water samples for bacterial contamination.

Bacteriological tests prescribed by the PHS are primarily designed to identify coliform bacteria—types of bacteria found in feces and soil. The standards do not require a total absence of coliforms; a moderate count is permitted. A well-operated water treatment plant can do considerably better than the standards require.

Nevertheless, 12 per cent of the 969 systems in the 1969 survey exceeded the limits of the PHS coliform standards. Again, the large city systems had cleaner records than town and suburban systems. In the EPA studies, the standards were not met by as many as one-third of the water systems in some states. The 1973 GAO review likewise discovered that 81 out of 446 community water systems, or 18 per cent of those surveyed, had failed to meet the Public Health Service coliform standards in two or more months during the previous year.

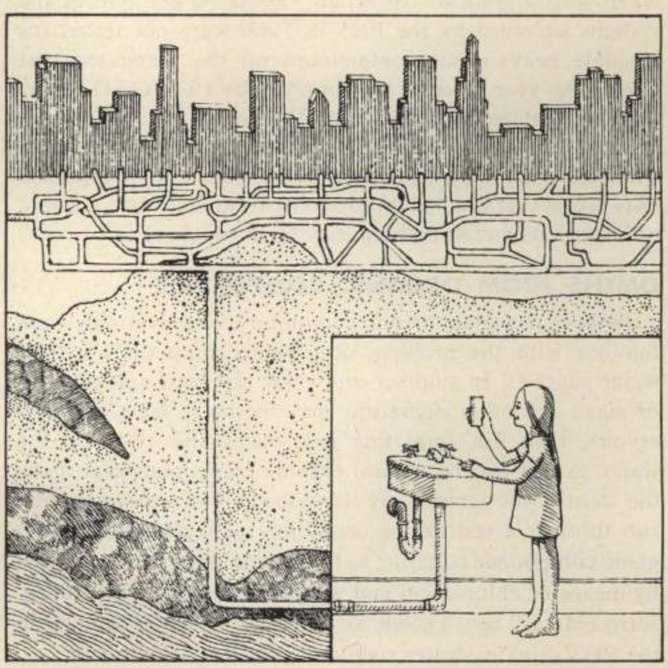
Few large waterborne disease outbreaks are reported these days. Indeed, the most recent large-scale waterborne epidemic—16,000 cases of paratyphoid gastroenteritis among the residents of Riverside, Calif.—occurred back in 1965. But smaller outbreaks traceable to drinking water are reported annually. And their number appears to be slowly increasing—from one case annually per 100,000 persons in the period from 1946 through 1960 to two cases annually per 100,000 in the period from 1961 through 1970. The actual rate may well be much higher, since few small or moderate-sized outbreaks are adequately investigated to determine their source.

In a suburban area southwest of Albuquerque, N.M., for example, residents draw their water from wells and dispose of their wastes in septic tanks. The wells have not been tested for disease-causing bacteria, but high levels of nitrates have been found in them, suggesting possible seepage from the septic tanks. If bacteria and viruses are also reaching the wells, a high rate of waterborne disease might occur.

In fact, the 1971 incidence of paratyphoid in those Albuquerque suburbs was three times the national rate. Hepatitis and shigellosis (a form of dysentery) occurred there at 10 and 28 times the national rates. Going by the circumstantial evidence, a county health official warned that the water might be contaminated. Evidence or no, the county manager was still stoutly maintaining in 1973 that charges directed at the water were "unfounded rumors."

VIRUSES: FORGOTTEN BUT NOT LOST

Engineers who planned the early metropolitan water systems knew little or nothing about viruses and didn't worry about them. The PHS Drinking Water Standards, first published in 1914 and most recently revised in 1962, set no virus standards. No routine tests for waterborne viruses have been developed, and none is required or even rec-



ommended by any Federal agency or state government.

Yet evidence accumulating during the past decade makes it clear that disease-causing viruses do get into community water supplies, that some of those viruses can pass unharmed through today's accepted water-treatment procedures, and that outbreaks of viral disease—notably infectious hepatitis—have indeed been caused by viruses in drinking water. How many sporadic (as distinct from epidemic) illnesses result from viruses in drinking water is anybody's guess.

As with carcinogens in drinking water, the problem of viruses in drinking water can be approached in either of two ways. First, we can launch broad-scale and costly research projects to determine over a period of many years what viruses remain in the water reaching us through our taps and how much harm they are doing. Alternatively, without waiting for those research findings, we can start right now to modernize our water-purification methods. CU prefers prompt action (along with research, of course). In a subsequent article we shall describe practical methods of minimizing viral hazards.

LIGHT REGARD FOR HEAVY METALS

Well publicized is the hazard of lead in the air we breathe, in the foods we eat, and in the paint in our homes. How about lead in our drinking water? It's there all right. Drawing from experience with more than 650 water supplies it periodically tests, the EPA observed in 1973 that excessive lead, along with chromium and mercury, are the hazardous metals most commonly found.

In addition to lead and chromium, the PHS standards set "mandatory" limits on five other hazardous metals—arsenic, barium, cadmium, selenium, and silver. (Mercury is absent from this list, but the EPA has recently established an interim standard.) Limits are "recommended" for copper, iron, manganese, and zinc, which are usually not classified as hazardous at the levels typically found in drinking water. Semiannual tests are recommended.

But all the mandates and recommendations seem to be taken with a grain of "So what?" Some 90 per cent of the systems surveyed by the PHS in 1969 were not tested for a single heavy-metal contaminant on the mandatory list during the year prior to the survey. The 1973 GAO report revealed that, so far as the available records went, the water in 79 of the 446 systems surveyed had *never* been tested for chemical (including hazardous metal) content. Even when tests reveal that a water supply contains an excessive amount of hazardous metal, nothing may be done about it.

OMENS FROM ORGANIC COMPOUNDS

Pioneer designers of our community water systems were familiar with the problem of organic compounds in raw water supplies. In summer and early fall, vast aggregations of algae and other organisms may bloom in lakes and reservoirs, then die, imparting foul tastes and odors to the water. A test for the natural organic compounds that made the stench was accordingly developed. Water samples were run through a test device containing activated carbon; organic compounds adhering to the carbon were then extracted by means of chloroform and weighed. That "carbon chloroform extract" test, known as the CCE, is recommended in the PHS drinking-water standards, but it is seldom run.

In recent decades, the situation has been immensely complicated by thousands of new synthetic compounds in agricultural and industrial use. Some of them (as noted above) have been shown to be carcinogens that can cause tumors in animal experiments. Others are known to damage the liver or other organs of laboratory animals in chronic toxicity experiments. For most of the new organic compounds, however, literally nothing is known about the effects of long-term consumption in either animals or humans.

When a similar problem arose with respect to the food we eat, Congress in 1958 passed the "Delaney amendment" to the food-and-drug laws, decreeing that no chemical be added to food in any quantity if it is known to cause cancer in any animal species at any dosage level. Such a principle is needed for water. No substance capable of causing cancer or organ damage should remain in the water we drink if a feasible method is available for removing it—or if it can be prevented from entering the water in the first place.

Occasionally, drinking water may be analyzed to detect specific types of organics, such as pesticides; but the search is rarely exhaustive. The 1969 Community Water Supply Study, for instance, tested 38 water systems in the New York metropolitan area for aldrin, chlordane, DDT, dieldrin, and six other pesticides. But the pesticides in widespread use there in 1969—such as parathion, malathion, and Sevin—were not tested for.

Most U.S. water supply systems today filter the raw water through beds of sand. This traps particles in the water—but organic compounds that are not in particle form can get through. If the water is thereafter passed through a bed of activated carbon granules, a far more effective purification effect is produced. Many organic compound molecules are "adsorbed" onto the surface of the carbon and held there. Activated carbon purification is in widespread use in U.S. food and beverage plants and in drinking-water plants in other countries—but it is rare in U.S. drinking-water systems.

Some U.S. plants, it is true, do pour activated carbon powder into the water on occasions, when the water's stench gets too strong, and then let the powder settle out. But this is essentially a cosmetic process, designed to reduce bad tastes and odors. Passage through a bed of activated carbon granules purifies the water continuously, not sporadically, and ensures that all the water will be exposed to the carbon. A combination of activated carbon treatment with improved disinfection measures, to be described next month, can at reasonable cost minimize organic compound hazards, virus hazards, and possibly other deficiencies (such as the presence of some heavy metals) in today's water supplies.

HAZARDS AFTER THE TREATMENT

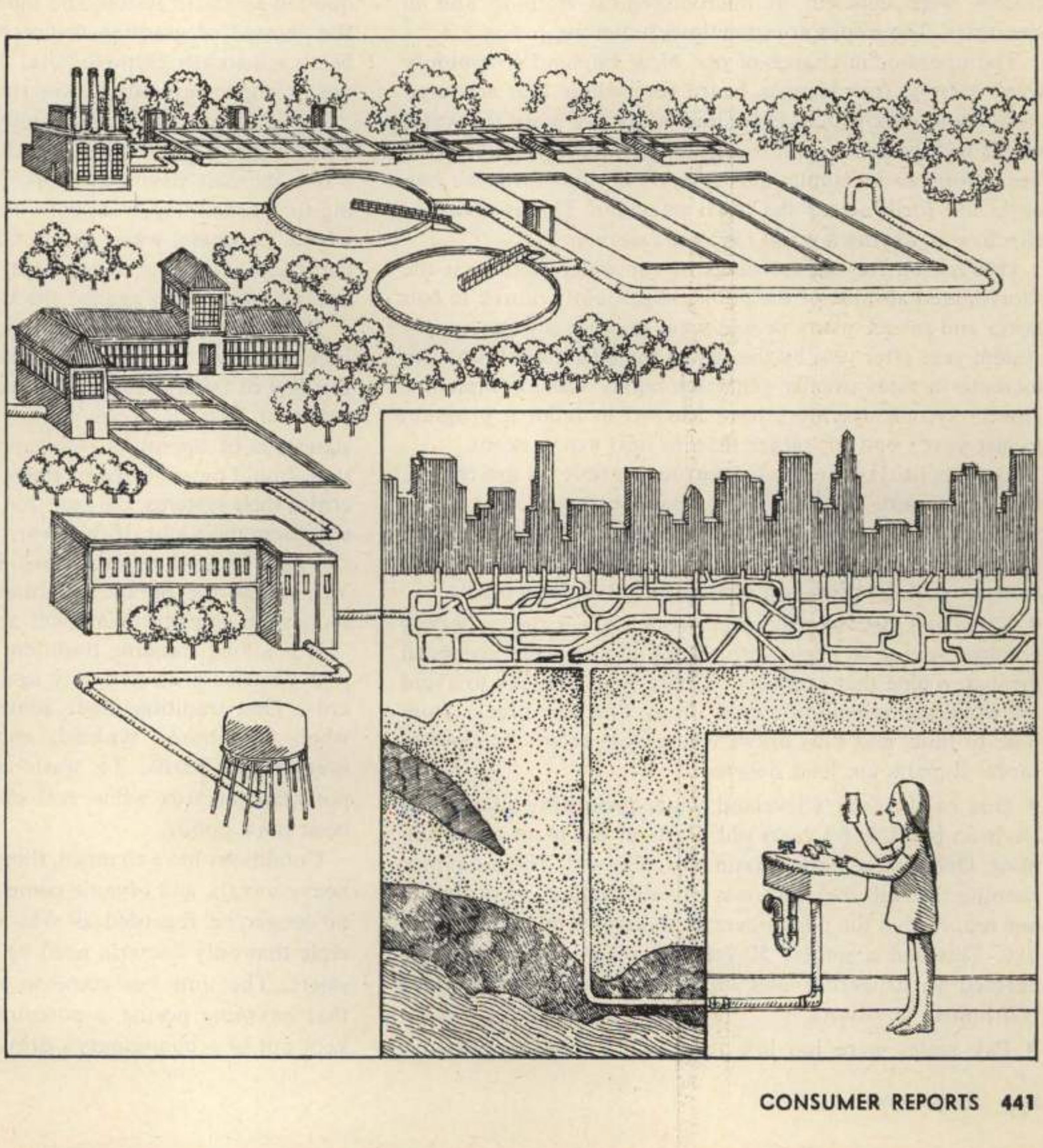
So far we have been considering types of contamination found in raw water supplies—types that can be controlled by purifying the water before it is piped to consumers. But many disease outbreaks traceable to public water supplies are due to contamination of the water *after it leaves the processing plant.* At least three significant types of contamination can occur in the distribution system.

First, contamination can be contributed by the pipes and fixtures through which the water passes. Lead pipes introduced into our water systems decades ago and never replaced, "galvanized" pipes coated with zinc (which may contain an appreciable amount of cadmium), joining solders with a high lead or cadmium content, and cement pipes containing asbestos—all can donate hazardous substances to drinking water.

Several corrective measures are needed: pretesting of all pipes and other plumbing materials for hazardous metals; conscientious enforcement of strict plumbing codes specifying what materials can be used; "conditioning" of corrosive water to reduce the amount of corrosion it causes in pipes and fixtures; and, finally, periodic testing of water at the consumer's tap—rather than just testing at the processing plant.

A second hazard arising after water leaves a processing plant results from cross-connections between water lines and sewage lines or other possible sources of contamination. A sewer line is only rarely connected to a water supply line deliberately; but there are many ways in which they can be inadvertently joined. To cite one example, an elementary school in Oregon had a lawn-sprinkling system capable of drawing water either from the school's drinking-water supply or from an irrigation ditch. The system functioned perfectly —until an unanticipated drop in pressure in the drinking-water system permitted backflow from the irrigation ditch. Twenty-four cases of diarrhea among the students alerted officials to the cross-connection. An adequate inspection program would have detected the hazard before any illnesses occurred. On new construction, cross-connection control ordinances can prevent such problems from ever arising.

Finally, water can become contaminated after it leaves the treatment plant if the pressure in the distribution system falls too low. In that event, backflow may occur—returning polluted water to the system for redistribution. Maintenance of adequate pressure, indeed, is the single most important means of preventing contamination during distribution. The EPA recommends a minimum of 20 pounds per square inch throughout a distribution system. The ever-growing complexity of distribution systems, hilly terrain, and tall buildings can make it difficult to maintain adequate pressure. Failure to provide for those conditions, or to plan for future demand, increases the likelihood of backflow problems.



A system that distributes pure water today may be in dire danger of distributing contaminated water tomorrow. Periodic expert inspections are needed to spot future health hazards. A few examples will illustrate.

Good engineering practice requires that the raw water entering a plant be effectively isolated from the purified or "finished" water leaving the plant. In more than 50 of the plants visited during the 1969 survey, only a single wall separated the raw water from the finished water. So long as such a wall remains intact, no pollution can occur. But what if it springs a leak?

Again, suppose that—as often happens—some essential element in the water-processing system (such as the filter or chlorinator) must be shut down temporarily for repairs. To obviate the feeding of raw water into the pipes during an emergency, the EPA recommends that one full day's supply of finished water be kept in storage. Many systems fall short of that standard.

Many systems, moreover, store their finished water in uncovered tanks, or tanks otherwise accessible to contaminants. That may explain the paratyphoid outbreak of 1965 in Riverside, Calif. Water-utility officials there now believe that birddroppings falling into a reservoir introduced bacteria that multiplied in the reservoir lining and eventually caused 16,000 illnesses.

To correct potentially hazardous conditions *before* contamination occurs, the PHS recommends periodic "sanitary surveys" during which someone outside of the system reviews its operating procedures and facilities. Such independent surveys are rarely made. Only 21 per cent of the water systems in the 1969 PHS study had had an independent sanitary survey during the previous year—and 56 per cent either never had such a survey or had no surviving record of one. Little information is available about the thoroughness of the independent sanitary surveys that have been made.

ADDING UP THE RESPONSIBILITIES

Operating even a small community water supply is a serious responsibility, requiring at least an elementary understanding of microbiology, chemistry, and engineering. Hence most states provide for the certification of the "principal operator"—that is, the "person whose wrong acts or failures to act could adversely affect water quality."

The findings of the recent surveys are hardly reassuring in that respect. More than 60 per cent of the principal operators in the 1969 survey had never taken even a short course in water treatment. About three-quarters of the operators were deficient in microbiological training and in chemistry. The results are sometimes ludicrous.

The operator in charge of one New England community water supply, for example, heard somewhere that activated carbon will remove foul tastes and odors. So, when the water smells bad, he fills a cloth bag with activated carbon powder, ties a rope to it, climbs into a rowboat, and tows the bag back and forth across the town reservoir. This is about as effective as waving a wand over the reservoir.

One reason for shortcomings in our water systems is the shortsighted attitude of the public. Apparently inured to bad tastes and smells, many people seem to judge a water supply system year after year by the size of the bills it sends out. An increase in rates usually generates highly vocal complaints. Hence, system operators have learned to tailor a program to last year's budget, rather than to next year's needs.

Local politicians are also in part responsible. In this regard, Cleveland until recently set a classic example. For many years, that city's officials boasted of having "the least expensive water in the United States." If true, it was at an enormous cost in deterioration of the water system. To wit:

- Cleveland draws raw water from Lake Erie, a heavily polluted source to begin with. Much of the water comes in through a pipe that extends 2½ miles into the lake to avoid the worst of the pollution near shore. The pipe breaks from time to time, and thus draws water from relatively close to shore. Repairs are long delayed.

- One of the four Cleveland water-processing plants, the Division plant, is 60 years old. Parts of the plant are crumbling. One sedimentation basin has collapsed. The main pipe running through the plant was so badly pitted, according to one report, that the plant operator thought it might burst any day. This and a similar 50-year-old plant (Baldwin) were deemed so dangerous and unsightly that they were ruled "off limits" to visitors.

- Pay scales were too low to attract qualified personnel. A strike for higher wages, which might have cut off the city's water altogether, had been threatened.

But why continue ticking off a sorry water system's weak points when a single incident will illustrate the extent of plant deterioration?

After a power failure on May 8, 1969, a chlorine gas line at the Baldwin plant broke and deadly gas began to escape. The plant lacked an alarm system for detecting such leaks. Employes needed gas masks to get to the turn-off valves. The only masks on hand were locked in a cabinet in the gas-filled room. And they were of World War II vintage; one of them was labeled "not good after 1963."

Unable to reach the valves, employes called the fire department, which in due course arrived with suitable masks. Meanwhile, the employes turned on an exhaust fan, which blew deadly chlorine gas out of the building toward a row of houses across the street. The heavier-than-air gas drifted along the ground into the houses. Some 35 gas victims were hospitalized, and two died.

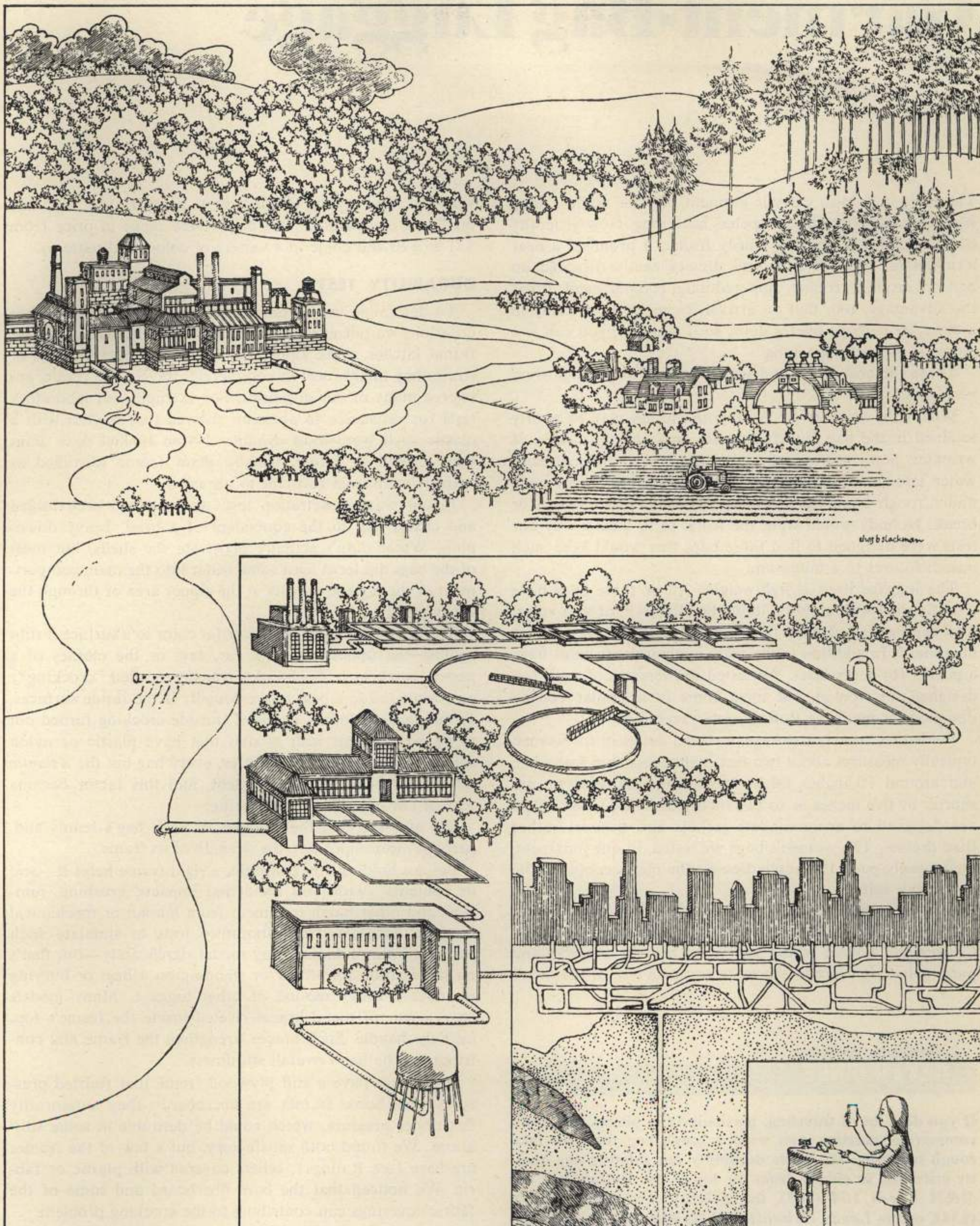
Plaintiffs who sued the city following the incident were awarded approximately $1,300,000 in damages; the award is now on appeal. Regardless of the final award, it is glaringly obvious that the money could better have been spent in safeguarding the water system before the tragedy occurred. More than a year before the accident, the plant operator had requested an alarm system and repairs in the chlorine building. But instead of granting the necessary funds, Cleveland officials apparently chose to boast that "Cleveland's water rates are . . . the lowest among America's 40 major cities."

A bit of progress has recently been made in Cleveland. Salaries have been raised to attract trained personnel, and a rate increase has been proposed. But funds are still lacking for needed improvements. The officials of nearby towns, which purchase water from Cleveland, have obtained a court injunction barring the rate increase on the ground of rate discrimination against the suburbs.

The officials who might be expected to lead the fight for improvements are those appointed to run our water systems. But few of them speak out. Some are simply unaware of the potential hazards. They think that adhering to outmoded standards of operation—no typhoid and no cholera—is all that should be expected of them. Others would like to modernize their systems, but fear that campaigning for funds may cost them their jobs. If they warn that the water is unsafe, the city may respond by firing them for purveying unsafe water. Yet, unless the public *is* warned and demands action, the money for improvements will not be forthcoming.

It is a long-standing tradition that community water supplies need be protected only against *known* and *proven* hazards. That tradition made some sense half a century ago, when waterborne typhoid, cholera, and dysentery were ever-present perils. To waste effort in protecting against potential hazards while real epidemics raged would have been poor policy.

Conditions have changed, though. The presence of viruses, heavy metals, and organic compounds in drinking water can no longer be regarded as side issues. The traditional principle that only bacteria need be controlled is long since obsolete. The time has come to adopt the broader principle that *anything* posing a potential threat to health must be kept out of a community's drinking water.



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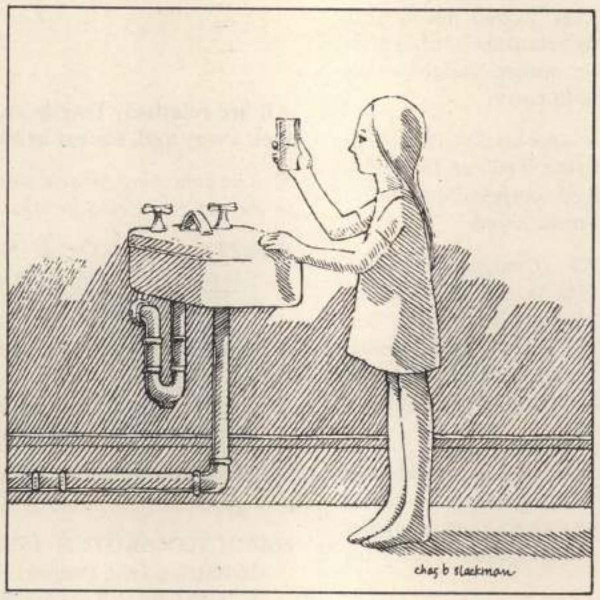
IS THE WATER SAFE TO DRINK?

By Robert H. Harris and Edward M. Brecher and the Editors of Consumer Reports



PART 2: HOW TO MAKE IT SAFER

In recent decades, many lakes and rivers from which millions of Americans obtain drinking water have become increasingly polluted. Uncontrolled dumping of industrial wastes and municipal sewage, combined with the runoff of agricultural chemicals, have created serious contamination in our sources of raw water.

Safeguarding the quality of today's drinking water, accordingly, requires more than protection against the traditional hazards. But most community water systems are still geared mainly to preventing bacterial disease or curbing unwanted tastes and odors. Many systems ignore the potential dangers of viruses, heavy metals, and organic chemicals in water. Others do not even meet *minimum* standards of good practice.

Last month—in Part 1 of this series—CU discussed the failure of typical community water systems to face the changing threat to local water supplies. And we urged adoption of improved standards of drinking-water quality. This month we describe steps the water-supply companies can take to achieve such standards. Next month, the concluding article in this series will explore citizen-action programs aimed at improving the safety of drinking water.

Many industries dump their wastes into the Kanawha River. The wastes include chemicals with such exotic names as alpha-methyl benzyl alcohol, acetophenone, isophorone, tetralin, and many more. Not surprisingly, the river stinks. Indeed, you can sometimes smell Kanawha water even after a gallon of it has been mixed with 1300 gallons of odor-free water. Until recently, it was from the Kanawha River that the city of Nitro, W. Va., drew its water for drinking, cooking, bathing, and other uses.

No one denies that the organic compounds dumped into the Kanawha offend the senses. But are they also harmful? Can they, for example, cause cancer?

To determine separately the long-term effects on health of each Kanawha River pollutant would be an overwhelming undertaking. So 12 years ago, Drs. Wilhelm C. Hueper and William W. Payne of the National Cancer Institute took an experimental shortcut. They first ran Kanawha River water through a test device containing activated carbon; many organic molecules are adsorbed onto (that is, stick to) activated carbon surfaces. They then injected the extract from the water into some mice and rubbed it onto the skin of others every two weeks over a period of months. Cancers developed in several of the mice of both groups. Cancers did not develop in control mice—mice not exposed to Kanawha River pollutants.

Nitro residents, of course, did not drink water raw from the river. In fact, their water-treatment plant employed more than the usual number of water-processing measures commonly used in the United States today. Among other things, the water was aerated, treated with powdered carbon, chlorinated, and filtered through beds of sand. That series of treatments reduced the stench considerably. (Treated Kanawha River water still smelled bad, but it took only several gallons of clean water—rather than 1300—to "deodorize" a gallon of it.)

Nevertheless, Drs. Hueper and Payne found that even the treated water contained chemicals that could cause tumors in mice and shorten their overall life expectancies. Thus, despite a purification program that many other cities might envy, hazardous substances remained in the water.

The two scientists pointed out in their report that the route of administering the chemicals to mice was not comparable to human exposure. They concluded, however, that their results with mice raised a serious question as to whether long-term consumption of water containing minute amounts of such pollutants "might play a direct primary or contributory role in the production of cancers." They urged comprehensive studies to answer that question.

More than 10 years have elapsed. The studies they urged have still not been undertaken.

But there was (and is) no reason to await the outcome of further research. Take Nitro's experience, for example: Prodded by taste-and-odor complaints and the Hueper-Payne findings, the West Virginia Water Company merely replaced the sand in Nitro's filter beds with activated carbon granules. The rationale was simple: If pollutants would stick to the activated carbon in the small Hueper-Payne test devices, they would also stick to the activated carbon in beds large enough to purify the entire city water supply.

The remarkable purifying power of carbon has long been known. Eighteenth-century sea captains stored drinking water in charred barrels to minimize contamination on long ocean voyages. By the end of the 19th century, London was routing some of the filth-laden water of the Thames through carbon before drinking it.

Activated carbon is often used today for treating industrial wastes and the water that goes into bottled soft drinks. But it's seldom used for purifying drinking water; only 35 or 40 American water systems (out of an estimated 40,000) route their whole supply through activated carbon beds.

Until a decade or so ago, activated carbon treatment methods had serious shortcomings. Granular activated carbon used to be relatively costly, and it quickly lost its adsorptive power during use. When consumers began to complain of water tastes and odors, tons of exhausted carbon had to be replaced by tons of costly fresh carbon.

Because of its cost, and because few sources of drinking water were heavily polluted with organic compounds, activated carbon treatment did not become part of standard American water-processing practices. Activated carbon, if used at all, was merely added to the water in powdered form from time to time to improve taste and odor.

WHY USE CARBON NOW?

The condition of water supplies has changed radically over the years. American rivers and lakes have been freighted with ever heavier cargoes of industrial wastes and agricultural chemicals. Yet water-treatment practices have not changed enough to keep pace.

Activated carbon can remove many such pollutants effectively and, these days, economically as well. Activated carbon is a porous form of carbon that presents an enormous surface area to contaminants. A single pound of tiny granules exposes more than four million square feet of surface to which organic molecules can adhere.

While the carbon is being "activated," moreover, those vast surfaces can be altered in ways that render them chemically "sticky." Many organic molecules are thereby adsorbed on its surfaces as water flows through.

A recent development in water treatment is the procedure for recycling spent carbon. The carbon is "traded in" for a fresh supply, then reactivated and resold for further use. Or it can simply be regenerated at the plant site and reused. Only about 5 per cent of it is lost during each cycle, thereby reducing the cost factor.

Carbon granules not only adsorb molecules but can also act to filter out suspended particles. So beds of activated carbon can be substituted for sand filtration merely by filling the sand beds with carbon granules, as was done in Nitro, W. Va. Communities that have replaced sand with carbon find that it filters out particles as well as sand does, or better. Meanwhile, it efficiently removes organic compounds dissolved in the water, which sand cannot do. For best results, however, it's often preferable to add an activated carbon bed *after* the sand filtration.

Carbon's adsorptive capacity also provides another bonus. In the event of an accidental spill upstream or some other unforeseen pollution incident, the capacity of current treatment units may be exceeded, allowing some polluted water to reach consumers. The same drawback exists when powdered carbon is used; the water superintendent can only guess at how much powder to add and when to add it. In contrast, a system with activated carbon beds lends itself to better control. A spill or other emergency simply uses up more of the carbon's adsorptive capacity, so that it must be recycled sooner.

The cost of activated carbon treatment is surprisingly low. Two water experts at the Environmental Protection Agency (EPA) reported in 1972, for example, that the cost in Nitro was less than 1¢ per 1000 gallons treated. That meant an increase of only 5¢ per month to treat water for a family of four—including construction, operation, taxes, and insurance. For water that's less polluted than Nitro's, a smaller cost can be anticipated. If activated carbon beds are added (instead of just substituting carbon for sand, as in Nitro), the initial cost would be somewhat higher.

There is no guarantee, of course, that activated carbon (or any other treatment) will remove *all* pollutants from water. But activated carbon treatment is by a wide margin the best water purification measure currently available at reasonable cost. Besides removing organic pollutants, it can also trap some of the viruses and heavy metals that may be present. Those contaminants, too, as noted last month, constitute known or suspected drinking-water hazards. "Although carbon is not a universal panacea," Dr. F. M. Middleton of the EPA notes, "it does have a high capability for adsorbing those organics that are of greatest concern."

Where a system is not prudently operated, however, problems can arise. That was the case in Nitro. The chief concern of the water company there was to minimize taste-and-odor complaints. Tests showed that a fresh carbon bed effectively removed tastes, odors, and nonodorous pollutants for several weeks. Then nonodorous pollutants began to pass through. Instead of replacing the partially spent carbon, the water company went right on using it until tastes and odors again became noticeable.

The issue is now moot in Nitro, for early this year the water company shifted to another source of raw water. But the underlying principle remains crucial: No matter what treatment methods a water system follows, they should be used to remove pollutants in general—not merely those that happen to cause unwanted tastes and odors.

CU advocates activated carbon treatment for *all* drinking water drawn from rivers or other sources subject to pollution. Even where water is relatively unpolluted, such treatment will guard against spills and other unforeseen pollution emergencies. Where pollution is low, the carbon will last a long time and the annual cost will be trivial. If it must be replaced frequently, that in itself is proof that this form of treatment is needed.

A CHALLENGE TO TRADITIONAL TREATMENT

Like the principle of sand filtration, the principle of adding chlorine to the water is firmly lodged in water-treatment textbooks and state regulations. It's *the* way to disinfect water, say the traditionalists. Chlorination has served the

HEART DISEASE AND DRINKING WATER: ANY CONNECTION?

Diseases of the heart and circulatory system are more common in some states and communities than in others. Several surveys in the United States since 1960 suggest that an area's cardiovascular death rate might be affected by the quality of the water its residents drink. While evidence is conflicting, a number of studies in Canada, Great Britain, Sweden, the Netherlands, South America, and Japan tend to support this theory. Several explanations for it have been offered.

Some English health authorities believe there's a link between the absence of certain minerals in soft water and cardiovascular disease. They point to studies showing that towns with soft water (averaging 32 parts per million of "hardness" salts) have a cardiovascular death rate 50 per cent higher than towns with very hard water (averaging 290 parts per million of hardness salts.) In August 1971, accordingly, the British Department of Health and Social Security circulated a notice cautioning all medical health officers about softening community water supplies. Since then no new community water softeners have been installed, and some English towns and cities have discontinued softening their water. A few have even begun to add water-hardening chemicals, such as calcium and magnesium, to the water.

Another theory focuses on the amount of sodium in water. Sodium intake is often restricted in patients with certain types of heart disease. In communities with soft water and high cardiovascular death rates, the sodium content of the water is frequently high. A study of this phenomenon by Dr. Harold W. Wolf and his associates at Texas A & M University has led Dr. Wolf to infer that sodium levels may be a factor in such death rates.

Soft water is also often corrosive. Studies by Dr. Henry Schroeder of the Dartmouth Medical School suggest that this may be the factor. Corrosive water dissolves heavy metals from some pipes through which it flows. Dr. Schroeder suspects that it may be these heavy metals—notably cadmium—that contribute to the cardiovascular death rate. If so, various measures are available for lowering the corrosiveness of drinking water.

Conceivably, any, all, or none of these theories might be correct. The need for further research is obvious. Meanwhile, the possible link between water supply and cardiovascular death rates is another example of why the United States cannot rely solely on pollution control to assure a safe water supply. Even if pollution were reduced to zero, cardiovascular death rates in some areas might conceivably be affected by the *natural* characteristics of water supplies. The need to monitor such supplies—and to take precautions where indicated—is essential for protecting public health.

Meanwhile, the use of a domestic water-softener in your own home raises an additional question. The popular home water-softeners are ion-exchange devices that exchange the calcium and magnesium in the water for sodium. If any member of your family or any frequent guest is (or should be) on a low-salt diet, raising their sodium intake in this way is unwise. In such homes, accordingly, CU recommends that the cold water pipe to the kitchen be connected to the incoming supply line at a point *before* the water-softener—and that the cold water be used for cooking as well as for drinking.

public well for many years. But tradition has its drawbacks. Alternative possibilities—whatever their merit—are rarely given serious consideration. Indeed, some state health regulations rule out alternatives to chlorination.

One American community that successfully challenged that viewpoint recently is the borough of Strasburg, Pa. Back in the 1890's, Strasburg's city fathers bought a collection of springs located on a hill a few miles away and ran a pipe down to the town. Taste-free, odor-free water flowed by gravity from the hilltop into Strasburg's homes without any processing whatever.

But even crystal-clear water can carry organisms that cause disease. In 1967, the Pennsylvania Department of Health decreed that all community water supplies in the state had to be disinfected to guard against bacterial contamination—and chlorination was the only approved method. When Strasburg ignored the decree, the state sued to enforce its ruling. The residents, who didn't want the taste of chlorine in their water, continued to resist.

The borough's attorney, John M. Ranck, accordingly sought some kind of compromise that would satisfy the state while leaving the water chlorine-free. In a technical journal, he found what he was after.

The French city of Nice, he learned, had been using ozone instead of chlorine to disinfect its water for more than 60 years. Paris and 200 other European cities also use ozone disinfection, as do many cities in the Soviet Union, Canada, and Japan. In the United States, ozone is used to disinfect water for soft drinks, bottled water, and industrial wastes; and one community (Whiting, Ind.) has used ozone since 1941 to control foul tastes and odors in its drinking water.

But *disinfecting* community water supplies with ozone was unknown in the United States. After prolonged negotiations with state health officials, Ranck secured temporary permission for Strasburg to ozonate its water. After engineering plans had been approved by the state, the ozone system went into operation on a trial basis late in 1972.

The Strasburg ozone is produced at the water-processing site in a self-contained ozone generator, which passes an electric current through ordinary air or oxygen. The current converts oxygen molecules (composed of two oxygen atoms) into ozone molecules (composed of three oxygen atoms). These are then bubbled through the water to ozonate it. The ozone molecules are short-lived. By the time the water reaches consumers, little or no ozone is left.

The capital cost of the Strasburg ozone installation was about $22,000. Amortized over a 20-year period, that comes to about 33¢ a month for a family of four. And much of the $22,000 can be attributed to the fact that this was a small pilot project requiring extensive preparatory study. Operating costs in Strasburg are negligible—$5.75 per million gallons of water ozonated, or less than 4¢ per month for a family of four.

Eventually, Pennsylvania confirmed that ozone provides acceptable disinfection. The state has now dropped its suit, and Strasburg residents drink the water they prefer.

If present standards of drinking-water purity were adequate, there would be little reason to improve our present water-disinfection practices. But in at least three respects, CU believes, the current standards established by the U.S. Public Health Service (PHS) are lax.

First, they sanction 10 coliforms (bacteria found in feces and in soil) per liter of water. This may be contrasted with Maryland's standards for *sewage* discharged into certain bodies of water. Only *one coliform* per liter of water is permitted. Thus, it may be illegal to discharge into a Maryland river the very water that the PHS deems fit to drink. In contrast, the World Health Organization recommends a coliform standard for drinking water that's 20 times stricter than that of the PHS.

The second shortcoming of current standards, as CU noted last month, is that they are inadequate to control *viruses* in drinking water. Like bacteria, viruses can be inactivated by various disinfectants. The effectiveness of the disinfectant depends on its germicidal power, the concentration present, and the length of time an organism is exposed to it. The concentration and time required vary from organism to organism. Disinfection that's adequate to kill coliform bacteria may fail to inactivate more resistant types of viruses, such as those that cause polio or hepatitis. Thus, improved disinfection standards are necessary to reduce the threat of viruses in drinking water.

A third shortcoming of the present PHS standards is their inadequacy to protect against bacterial spores, protozoan cysts, and some other potentially dangerous organisms that can survive current disinfection practices. Like viruses, protozoan cysts and bacterial spores can be much more resistant to disinfection than coliforms are. That fact was recently brought home sharply to residents of Essex Center, Vt. Although their water met the PHS coliform standard, an outbreak of *giardiasis* hit their community. An intestinal infection caused by a protozoan, *giardiasis* is one of the world's most common parasitic infections. But PHS standards are not stringent enough to prevent it.

ROUTES TO SAFER WATER

One way to improve today's usual chlorination procedure is to use chlorine more precisely. First, enough chlorine must be introduced to react with ammonia and other compounds in water that reduce chlorine's effectiveness. Then, further additions of chlorine become free to react with—and kill—bacteria and other target organisms. Customary chlorination today often fails to develop enough "free available chlorine" for effective disinfection. What is needed, in short, is better understanding of chlorine chemistry and more exact control of the chlorination process.

Can ozonation achieve the same goal as effectively or, in some cases, more effectively? Professor J. Carrell Morris, Harvard chemist and authority on chlorine chemistry, reports there is "no question that ozone exerts a more powerful germicidal action than even free chlorine against all tested forms of microbiological life." That is no doubt one reason why ozonation is widely used in some countries, such as France. But experience with ozone in U.S. drinking-water systems is still sadly lacking.

Three objections are sometimes raised to ozonation:

First, it is alleged that generating ozone wastes electric power at a time when power is short. But generating and transporting chlorine also requires energy. And in•either case, the amount is a trivial part of overall energy use.

A second objection is that ozone is a dangerous gas. But so is chlorine. Since ozone is generated at the site and used immediately, there is no hazard with transportation and storage, as there is with chlorine. Ozone's rapid disintegration into ordinary oxygen after it enters the water is a further safety factor.

The third objection to ozonation is much subtler. Under current chlorination practices, a barely detectable chlorine residual (one-fifth to two-fifths of a part per million) is normally left in the water that reaches the consumer's tap. It is commonly assumed that this is to protect consumers from possible contamination of the water as it flows through the distribution system. Ozonation is inferior to chlorination, it is argued, because the rapid conversion of ozone to oxygen leaves no residual. In fact, however, the chlorine residual provides little, if any, protection against significant contamination. If large amounts of contaminated water enter the system, the chlorine residual will be diluted; and if there are living organisms or other chlorine-using pollutants in that water, they will use up the chlorine. The residual, in short, can give a false sense of security.

The original reason for a residual, in fact, was not to prevent contamination but to retard slime growth on the inside surfaces of pipes. Such slime can make the water esthetically unattractive.

A more important reason for leaving a chlorine residual, however, is that it serves as an *indicator* of pollution. If tests disclose that the chlorine is being used up, it's a sign that contaminated water is entering the system—and that the problem must be located and corrected.

But nothing prevents a water system from using ozone disinfection and then *adding* a chlorine residual. In fact, that combination is already used in many European and Canadian drinking-water systems. There's no mystery about the procedure—only misconceptions.

In short, like activated carbon treatment, ozonation is neither new nor exotic. But pilot studies are needed to adapt it to local conditions and to assure its safety and efficacy. Despite its advantages, ozone may also have drawbacks that will sometimes limit its application. Ozonation, for example, cannot be adjusted to fluctuating levels of water quality as conveniently as chlorination can. In such situations, free available chlorination may be the method of choice. In other situations, ozonation followed by residual chlorination may offer the maximum flexibility. But unless a beginning is made, neither ozonation nor any other alternative to current disinfection practices will ever come into widespread use.

RECOMMENDATIONS

On sensitive matters of pollution, defenders of the status quo inevitably rally to a common cry: "We need more research." That's a reasonable plea in many instances. But it can also serve as a convenient excuse to stave off remedial action or practical reforms.

CU would hardly argue against the need for more drinking-water research. But pure research is not a substitute for pure water. And the safety of such practical measures as activated carbon treatment is not at question. We believe that research in this instance can—and should—accompany *immediate* improvements in today's drinking-water supplies. CU recommends the following ways of combining research with prompt action:

1. A representative group of water-processing plants should be designated as "pilot projects" for studying improved water-treatment techniques. Plants of different sizes, plants drawing on a variety of sources (river, lake, and well water), and plants facing various types and levels of pollution should all be represented.

2. Samples of water from each system should be subjected to activated carbon treatment and to improved methods of disinfection. The disinfection methods in this pilot stage should include ozonation, free available chlorination, and combinations of ozonation with chlorination. At sites where the water is corrosive, various control measures should be compared. As soon as modes of treatment are confirmed to be safe, effective, and adapted to local water conditions, a full-scale demonstration plant should be built. The pilot projects and subsequent demonstration plants should be financed with Federal funds. (Legislation now pending before Congress would, if enacted, probably authorize such funding.)

3. As the demonstration plants go on line, research should focus on how effectively they are operating, how they can be improved, and how to run them economically.

4. Careful monitoring of organic chemicals, heavy metals, viruses, bacteria, and other potentially hazardous substances or organisms should be conducted. Simultaneously, improved monitoring methods should be developed.

5. Research should continue on ways of identifying and removing any unwanted substances remaining in water *after* it has undergone improved treatment procedures—a far more manageable task than tracking down and disposing of all those that can persist after current water processing.

6. Sophisticated desalination techniques (such as reverse osmosis and electrodialysis) that have been developed to remove a wide range of metals and minerals from brackish or ocean water should be explored for their possible applicability to severely polluted water.

There is no need whatever to delay improvement in current water-treatment processes while such research goes on. Indeed, some of the research will proceed faster if it focuses, as CU recommends, on water that has already passed the latest quality muster.

QUOTE WITHOUT COMMENT

"A visit to a new major water treatment plant is an interesting and exciting experience. One finds accurate and well-designed chemical feeders with automatic controls, completely equipped laboratories, ample facilities for material handling, and instrumentation for communication and control, not only throughout the plant but throughout the entire water system. Approaching the treatment units, however, the calendar rolls back 50 years and one is faced with the melancholy fact that water treatment is still an art and not a science. One sees before him the same old mixing basins, flocculators, and sedimentation basins that have served as treatment units for more than five decades. Nature purifies water by settling and filtration and, after all these years, man still continues to do so too."—*J. E. Singley and A. P. Black in* JOURNAL OF THE AMERICAN WATER WORKS ASSOCIATION, *January 1972.*

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IS THE WATER SAFE TO DRINK?

By Robert H. Harris and Edward M. Brecher and the Editors of Consumer Reports

PART 3: WHAT YOU CAN DO

After years of inertia and neglect, the United States is now taking action to clean up the nation's waters. But even if pollution abatement proceeds on schedule, there will still be a need to assure the purity of the *drinking water* that's piped into homes and businesses by some 40,000 community water systems. Two earlier articles in this series described the problems of those systems and some ways to achieve higher standards of drinking-water quality. Our concluding article focuses on what citizens can do directly, in their community, to improve the local water supply and assure its safety.

When it comes to substandard drinking water, consumers are a long-suffering lot. They tend to view bad water, like bad weather, as a bane that can't be remedied. That, until recently, was the view of the 10,000 residents of Niles and Decoto, Calif.—two communities in Alameda County, 30 miles southeast of San Francisco.

The surrounding communities receive reasonably good water at reasonable rates from a public agency, the Alameda County Water District. But Niles and Decoto residents are served by a private corporation, the Citizens Utilities Company (CUC); and they had much to complain about.

Their water frequently emerged from the faucet so discolored by manganese that many residents were loath to bathe in it, much less drink it. Many bought bottled water—not only for themselves but for their pets as well. The piped water not only tasted and smelled bad, it also imparted an off-flavor to coffee, tea, and foods cooked in it. The water clogged hot-water heaters. Sometimes the pressure fell so low that water merely trickled from the faucet.

From time to time during the 1960's, a local citizens' group attacked the water company and passed resolutions. But the water did not improve. Instead, water rates went up—until by 1973 they were 27 per cent higher than the rates paid by surrounding communities to the Alameda County Water District.

THE LAST STRAW

Then, on January 27, 1973, local newspapers reported that the Alameda County Health Department had found hazardous quantities of bacteria in the CUC water and had issued a "boil order." People in Niles and Decoto were instructed to boil their water for at least five minutes before drinking it, brushing their teeth in it, washing fruit with it, and so on.

When Irene Vincent, of Niles, read that boil order, she reached for the phone and called several of her neighbors. They phoned their neighbors, and soon the local papers had another story to report:

> "Fremont [Cal.]—More than 40 women gathered yesterday noon in Niles to castigate Citizens Utilities Co. and draw up a petition. . . . They're boiling mad."

Four days later, 350 angry Niles and Decoto residents, recruited by the 40 women, crowded into a local school auditorium. By then, the bacteria count had fallen and the "boil order" had been withdrawn. But those in attendance were not content merely to vent their annoyance and go home. They formed a consumer action group—People for Better Water—elected officers, and appointed committees.

Another startling disclosure served to fuel their ire. Bacteria-laden water had first been drawn from the CUC system 18 days before local newspapers carried the "boil order." Delays in testing the samples and notifying the public had taken more than two weeks. Furthermore, since the health department sampled the water only once every two weeks, Niles and Decoto residents could well have been drinking contaminated water for a month.

Local health officials insisted that no reports of excess illness had been received. But People for Better Water decided to take nothing on trust. They circulated their own questionnaire—and, as might be expected, turned up cases that hadn't been reported to the health department.

Testing procedures are better now, thanks in large part to the community group's efforts. The county health department now draws samples once a week instead of every two weeks and gets the test samples to the laboratory on the same day. A new California law, introduced at the group's request, now requires that each water system in the state make its own test findings known to the health department within 24 hours if contamination is discovered.

People for Better Water also tackled the problem of notification. CUC, like many other water systems, lacked any advance plan for notifying consumers of hazardous conditions. No printed warning notices were available, nor was a loudspeaker truck on hand. Many CUC customers were Spanish-speaking; little effort was made to publicize the "boil order" in Spanish. Stimulated by People for Better Water, the California legislature passed a new state law requiring each water system to prepare plans for emergency notification—and to have those plans approved in advance by the state health department.

But on the basic issue of upgrading the water, People for Better Water found itself stymied. The local CUC manager had no real authority; he reported to company headquarters in Sacramento. And CUC in Sacramento, in turn, was a subsidiary of Citizens Utilities of Stamford, Conn., a sprawled-out holding company with water systems and other utilities scattered through 10 states from Vermont to Hawaii.

Officials of the water company, like officials of many publicly owned water systems, were more concerned with water rates than with water quality. Their request for a 42 per cent rate increase was then pending before the California Public Utility Commission, which, like the company, was primarily concerned with rates. After considering these and numerous other factors, People for Better Water resolved to support an earlier plan for acquisition of the local CUC facilities by the Alameda County Water District.

That, of course, would cost money. Experts employed by the water district estimated that $2.85-million would be needed for acquiring and upgrading the CUC facilities. The amount would have to be financed by a bond issue, which required a two-thirds vote of the residents. So People for Better Water next tackled the job of securing popular approval for the bond issue in the November 1973 election.

They held meetings, circulated petitions, and passed out handbills in both English and Spanish. They flooded radio and TV stations with press releases. They buttonholed politicians of both parties and secured their support. The payoff came on November 6, 1973, when the votes were counted. Instead of a mere two-thirds majority for the bond issue, the vote was 1544 to 307—a five-to-one landslide.

A MODEL FOR ACTION

In only one respect does People for Better Water fall short of being a model for other communities. *There is no need to wait for a bacterial emergency to launch an improvement program.* A water action group can be formed, or an existing community group can add drinking water to its concerns, *before* a crisis surfaces.

The first step a community group should take is to familiarize itself with the facts about drinking water. In addition to this series of CONSUMER REPORTS articles, CU recommends for this purpose two publications of the League of Women Voters Education Fund, 1730 M Street N.W., Washington, D.C. 20036: "The Water You Drink: How Safe Is It?" and "Safe Drinking Water for All: What You Can Do." Each costs 25¢.

Another useful publication is the 62-page "Manual for Evaluating Public Drinking Water Supplies." Single copies are available free from the Water Supply Division, Environmental Protection Agency, Washington, D.C. 20460.

Thus briefed, your next step is to find out how your water measures up. As a start, call on the local water superintendent and invite his cooperation. Make it clear that your goal isn't to criticize but to secure public support for any upgrading the system might need.

If the local superintendent or manager welcomes your concern, your fact-finding task may be relatively easy. A conscientious superintendent who has nothing to hide should be willing to show you the results of water-sampling tests and sanitary surveys, and may even be eager to discuss improvements that would be worthwhile.

When a water system is subpar, however, such cooperation is unlikely. The official may simply view your group as meddling busybodies and insist that the water is already safe. If so, ask for concrete evidence.

First, request copies of water test reports. Water systems in most states are required to file such data periodically with the state or local health department.

If those reports are withheld, go next to the local health department, and then to the state. If those moves also fail to blast out the reports, inform the local newspapers, radio, and TV stations. The fact that the results are being kept secret could be a major news story. What are they trying to hide? (In the Niles-Decoto situation, it turned out that the test reports had frequently shown bacteria-contaminated water through most of the previous 10 years, and no adequate corrective action had been taken.) A lawyer can advise you about whether or not to pursue court action to secure the information.

When you get the test reports, compare them with the Public Health Service standards set forth in the "Manual for Evaluating Public Drinking Water Supplies." What is being tested for? Are the standards being met? Are tests being run as frequently as Federal drinking-water standards specify? Are they run in a certified laboratory? If the water is not being adequately tested, inform the media.

Next, find out when your local water system was last inspected by someone not associated with it. Such a sanitary survey, as CU noted earlier in this series, should be conducted periodically to review operation procedures, plant facilities, and the adequacy of the distribution system. If there has been a recent sanitary survey, ask to see the report. If, as is probable, no survey has been made in the past year or two, ask that one be made. (Eight water systems out of 10 have not had a recent sanitary survey. Vermont public health officials point out that such periodic surveys would probably have averted the outbreak of *giardiasis* in Essex Center, Vt., which was discussed in Part 2 of this series.) If your group's resources permit, offer to bring in your own experts to make a sanitary survey in accordance with the EPA's manual.

In some cases, if your group is firm and persistent as well as diplomatic, even an initially hostile water superintendent may see the light. In other cases, it may be necessary to campaign for a better superintendent.

If your local system already comes reasonably close to meeting current Federal standards, the possibility of achieving even higher standards should next be broached. Is your local water, for example, merely being filtered through sand? Or is it also being purified by passage through beds of activated carbon granules? If the water is chlorinated, is "free available chlorination" being practiced? Or, if that's not feasible, has thought been given to alternative methods of water disinfection—such as ozonation or a combination of ozonation and chlorination? As CU noted last month, these possibilities are worth considering as a means of controlling viruses, protozoan cysts, and bacterial spores as well as bacteria.

Sometimes such upgrading can be swift and effective. When citizens of Billerica, Mass., learned two years ago that their tap water was contaminated with viruses, they demanded immediate action. Within a few days, the city abandoned its inadequate disinfection practices and substituted free available chlorination, which is designed to maintain a precise, effective level of free chlorine in the water at all times. The EPA reports that subsequent tests have demonstrated an absence of viruses in Billerica's water.

Also find out whether your water is corrosive. If so, are measures being taken to improve it? Reducing corrosiveness not only pays off in longer plumbing life; it can also minimize the amount of potentially hazardous metals that might leach from distribution pipes into the water supply.

Remember, too, that the quality of your water should be tested at the tap as well as at the treatment plant. Residents of both Boston and Chicago can testify to the difference that makes. Only when their actual tap water was tested did they discover that the water was so corrosive that it was leaching dangerous metals from the plumbing.

In short, try to determine the *exact* condition of your local water supply—what's good, what's bad, and what improvements are needed. Once that's done, the next step is to explain the need for any changes to local political officials and to the public. Often, the period before a local election is the most strategic time to campaign for better water.

GOOD WATER COSTS LESS THAN YOU THINK

Don't be surprised if your reform proposals are met with the usual allegation that they will cost water users or taxpayers "millions of dollars." Ask for detailed estimates. If you get them, have them reviewed by a qualified engineer. If estimates are refused, have your own prepared. In some cases, companies that supply equipment—or a state engineer—may be willing to do so. You may also be able to secure help on this and other technical matters from the regional officers of the EPA located in Atlanta, Boston, Chicago, Dallas, Denver, Kansas City, New York City, Philadelphia, San Francisco, and Seattle.

Have an accountant translate the overall costs into terms that can be easily understood: how much each improvement will add to the average family water bill. Water

NITRATES: SOLVING THE IMPOSSIBLE FOR 70 CENTS A MONTH

Nitrate contamination presents one of the more difficult challenges to the safety of a community's drinking water. Until recently, there was no practical way of removing nitrates, or at least no one thought so.

When tests showed nitrate content exceeding the Public Health Service's limit, local officials often chose to ignore it. Several states solved the problem handily. They adopted a standard double that of the PHS.

For infants, excess nitrates in water pose a direct hazard—infantile methemoglobinemia, or the "blue baby" syndrome. Some 2000 cases of this potentially fatal disease have been reported worldwide since 1945. Minnesota alone has had 139 cases and 14 deaths, all from drinking nitrate-laden well water. And in some of the cases, the nitrate levels were *below* the PHS limit of 45 parts per million. In older children and adults, whose digestive systems are more able to handle nitrates, the effects of excess nitrate intake are still undefined. Two recent reports—one by the National Academy of Sciences, the other by the Illinois Institute for Environmental Quality—both suggest potential hazards and recommend a more intensive research effort.

Whatever the possible effects, two communities on opposite sides of the United States recently chose not to gamble with their health. One took the only recourse that has sometimes been open: seeking another source of water supply. Working through a committee on water quality, citizens of the La Sierra section of Riverside, Calif., applied constant pressure on the Riverside Public Utilities Board. Ultimately, they succeeded in getting the agency to buy the private water company serving La Sierra, and to supply them instead with uncontaminated Riverside water.

But alternative sources of water aren't always available. What then? The Garden City Park Water District on Long Island, N.Y., didn't set out to solve that problem, but eventually wound up doing so.

During a routine expansion of its well system in 1969, the water district took samples from a test well indicating acceptable nitrate concentration. But after $300,000 had been invested in the well, subsequent samples showed nitrate levels *double* the PHS limit.

Faced with rigorous enforcement of the PHS standard by local public health officials, the water district sought a solution. And they found it—a newly developed ion-exchange process designed to remove nearly all the nitrate present in the water.

The treatment cost—about 12.5¢ per 1000 gallons—is high compared to usual water-treatment processes. But the community endorsed it, and the process is now operating successfully on an experimental basis. Since all of the water in Garden City Park need not be treated, the increase in the monthly water bill for an average family of four is expected to run about 70¢ or less. Like the citizens of Garden City Park, CU believes that's a reasonable price to pay for safety.

treatment in most cases represents only about 10 to 20 per cent of the cost of supplying water to your home. Thus, even doubling treatment costs may add only a small amount to your water bill. Your group may be amazed to discover how much improvement can be purchased for a dime or a quarter per family per month.

To take an extreme case, let's suppose that yours is a city of 600,000 that is drinking wholly untreated water. Your community action group concludes that the water should be subjected to coagulation and flocculation followed by sedimentation, then filtered through sand, purified by flow through beds of activated carbon granules, and chlorinated—in short, installation of a complete modern water treatment system. Opponents of your proposal may point out that such a system would cost $15-million. Your group's accountant may be able to reply that even so, the entire new plant can be built, financed over a 25-year period, and operated at a cost that adds less than a dollar per month to the bill of a typical family of four. For water systems serving fewer people, the monthly cost per family will be somewhat higher; for larger systems, the cost per family will be lower.

Or say your system already subjects the water to coagulation, flocculation, and sedimentation, filters it through sand, and chlorinates it. Installing beds of activated carbon granules should add only about 20¢ per month to the average family bill in a city of 600,000; about 40¢ per month in a city of 60,000.

An accountant may also help you determine whether the water rates you pay bear a reasonable relation to the cost of water. Some cities use the money collected from water bills to finance other services besides water supply. Albuquerque, for example, recently raised its water rates to finance garbage collection.

If yours is a small community served by a local water company, consider the possible advantages of merging with a larger system. Home rule is in many ways a blessing. But the sad fact is that a system serving only a few thousand families or less is seldom able to command the expertise or technical assistance required to assure adequate water quality. Merger with a larger system (as in Niles and Decoto) may often be the only practical road to better water.

Citizens of small communities (less than 10,000) should also urge their local officials to check with the Farmers Home Administration of the U.S. Department of Agriculture to find out whether the community is eligible for loans or grants to upgrade its water system.

Sometimes the need for reform will lead from City Hall to the State Capitol. You will probably find your state health department undermanned and underequipped in general, with most of its resources devoted to problems other than routine drinking water surveillance. So approach your state health department initially as you approached local water officials. Assume that those assigned to water want to do a better job and would welcome your support. If you find them indifferent to water problems or unable to help, go to the state health commissioner and if necessary to the governor.

One major reform to stress is a state law requiring routine publication of water test reports and sanitary surveys. State and local health officials may oppose such a law because they fear a public panic each time a water report shows bacteria or other contaminants. But if test reports are kept secret, public support for upgrading community water supplies may never emerge. No other reform is as likely to accomplish as much in the long run as keeping the public informed.

Finally, don't neglect action on the Federal level. At this writing, a "Safe Drinking-Water Act" has already passed in the Senate. But a similar bill, H.R. 13002, had until recently been sidetracked in the House Committee on Interstate and Foreign Commerce.

Both bills are designed to provide much needed Federal funding to bolster state drinking-water programs. They would also promote better reporting of water data and more adequate public notification procedures, and would enable the EPA to set strict national drinking-water standards to protect public health. The EPA would be authorized to enforce those standards in certain circumstances where state or local agencies fail to do so. The House bill also contains a provision aimed at protecting underground water supplies from careless waste-injection practices.

Although the bills are far from perfect, they represent the first meaningful Federal legislation on drinking water in this century. In CU's view, they merit public support.

THE LIMITS OF HOME REMEDIES

The steps you can take in your own home to assure safe water are unfortunately very few. Indeed, some of the most widely promoted "cures" leave much to be desired.

Bottled water. Whenever the quality of a community water supply deteriorates, the first impulse of many users is to have bottled water delivered or to buy it at the store. But the fact that the water comes in an attractively labeled bottle is little assurance of its purity.

The EPA recently surveyed 25 bottled-water plants (out of 500 in the country). Four of the 50 bottled-water samples tested were found to be contaminated wth coliform bacteria. After 25 bottles were left unrefrigerated for a period, four of them showed growth of bacteria in numbers "too numerous to count." One sample exceeded the Public Health Service standard for lead. Bacteriological surveillance was inadequate in more than half of the companies, and chemical surveillance was inadequate in almost all of them. Not a single bottling plant escaped demerits for sanitary deficiencies.

When the U.S. General Accounting Office (GAO) looked into the bottled-water situation in 1973, it found similar deficiencies. The GAO also noted that "neither the Federal nor the [five] State agencies included in our review had effective programs for insuring that bottled water was pure, safe, and free of potential health hazards."

Since then, the FDA has published new product standards for bottled water. But CU believes those are deficient in several respects. They set no limits, for example, on organic compounds or pesticides in the water. And water violating the standards can still be shipped in interstate commerce if the departure from standards is noted on the label. Meanwhile, water sold in the state where it's bottled is not subject to FDA standards at all. Unless the state has an effective surveillance program, there's no assurance that the water meets acceptable safety criteria.

Water filters. Another supposed way to compensate for bad water is to install a home water filter. Evidence indicates, however, that this cure may be worse than the disease.

The trouble with many sinktop water filters is that the material that sticks to the filter can also become fodder for bacteria. Any disease-causing bacteria that get trapped by the filter might feed on this material, enabling them to grow and multiply—especially overnight or during periods when the water isn't running. Turning on the tap may then release dangerous levels of the organisms.

To evaluate that hazard, the Department of Virology and Epidemiology of the Baylor College of Medicine in Houston conducted tests with local tap water and four popular sinktop water filters.

The Baylor researchers simulated daily use of the filters and each morning counted the bacteria that multiplied in the water overnight. As the nutrient load increased with time, the bacteria count soared higher. From initial counts of about 100 bacteria per 100 milliliters of water, the bacteria populations reached some 7 million per 100 milliliters within a week. Many tests produced similar results.

The researchers concluded that if dangerous bacteria became concentrated in a water filter, they could multiply to a dose high enough to cause illness.

Unrelated to the Baylor research, CU purchased 10 popular models of sinktop water filters for testing in our own labs. On inspection, all the filters turned out to be canisters of activated carbon. Impurities dissolved in the water are supposed to stick to the surfaces of the carbon granules.

All the filters were judged capable of removing some solid particles and turbidity from drinking water as well as many organic contaminants that give water a bad taste and odor.

No manufacturer of a tested filter made any claims concerning bacterial contamination. But only one filter in the group carried an explicit warning not to use the unit "with bacteria or virus infected fluids."

To test for contamination, we connected the units to water supplies containing bacteria and allowed them to stand unused for a weekend. The first water samples drawn on Monday morning showed sharp increases in bacterial concentration. When we drew second samples after letting the water run for 15 seconds, as you might when letting the water get colder, there was only a slight reduction in the concentration.

Thus our findings corroborated those of the Baylor researchers. Since no water supply is consistently free of bacteria, we feel that installation of a carbon filter may introduce an unwarranted risk of contamination and possible infection. (That hazard does not apply to the use of activated carbon beds at a water-treatment plant, because the water is also *disinfected* at the plant.)

To get around the bacteria hazard, some manufacturers impregnate their carbon filters with silver, which they claim provides disinfection. The *Ogden Water Purifier*, for example, has been advertised as providing water "that is 100 per cent free of all pathogenic bacteria." According to one *Ogden* ad, the filter is supposed to kill bacteria that "can spread hepatitis, cholera, dysentery, typhoid and many other diseases." CU did not test the *Ogden* filter or any other filters of its type, so we don't know how effective they are against bacteria. But *Ogden's* claim of killing hepatitis "bacteria" gives us pause. Hepatitis is caused by a *virus*.

When Idaho's Department of Environmental and Community Services tested the *Ogden* filter last year, it turned up some sobering results. The *Ogden* leached silver into the water at levels several times the maximum permissible limit set for drinking water by the Public Health Service. Silver toxicity can cause permanent discoloration of the skin, eyes, and mucous membranes.

Whether *any* sinktop water filter is entirely safe is open to question. In the words of one EPA official, "Some are plainly hazardous and others are purely dangerous." Thus far, CU has found none that we can recommend.

RECOMMENDATIONS

There are a few minimum precautions you can follow in your home to reduce your possible intake of heavy metals. If your water is corrosive, the amount of heavy metals in it depends in part on the length of time it has been standing in pipes and fixtures. So letting water run for a minute or so in the morning or after several hours of nonuse is advisable before drawing it for drinking or cooking. In homes with copper plumbing, a common sign of corrosive water is the appearance of blue-green stains under the faucets.

Some studies also indicate that hot water tends to have a higher metal content than cold water. Accordingly, avoid drawing hot water for cooking or for preparing an infant's formula. Boiling formula water for long periods—whether from the hot or cold tap—is also unwise, because any heavy metals or nitrates in the water will be more concentrated in the final amount.

If your water is frequently contaminated with bacteria, however, boiling it is essential—especially in emergency situations such as that described earlier in Niles and Decoto.

Beyond such basic measures, there is little an individual consumer can do at home to compensate for bad water. The stopgap expedients of bottled water or sinktop filters are expensive at best and hazardous at worst. One public health official who has investigated more than 60 separate instances of drinking-water problems in the home told CU that he has yet to find a single homeowner who received accurate, reliable advice from a supplier of water-treatment devices.

In the final analysis, success in upgrading water quality is most likely to come when citizens organize and demand pure water from their *community* supplies, and are willing to pay for it. No other remedy promises to provide a better guarantee of safety for one's family at so low a cost.

The Environmental Defense Fund, 1525 18th Street, N.W., Washington, D.C. 20036, and Ralph Nader, Suite 711, 2000 P Street, N.W., Washington, D.C. 20036, sponsors of some of the water studies discussed earlier in this series, are continuing their research into drinking-water problems. They would like to hear about your problems and experiences—and so would CU.