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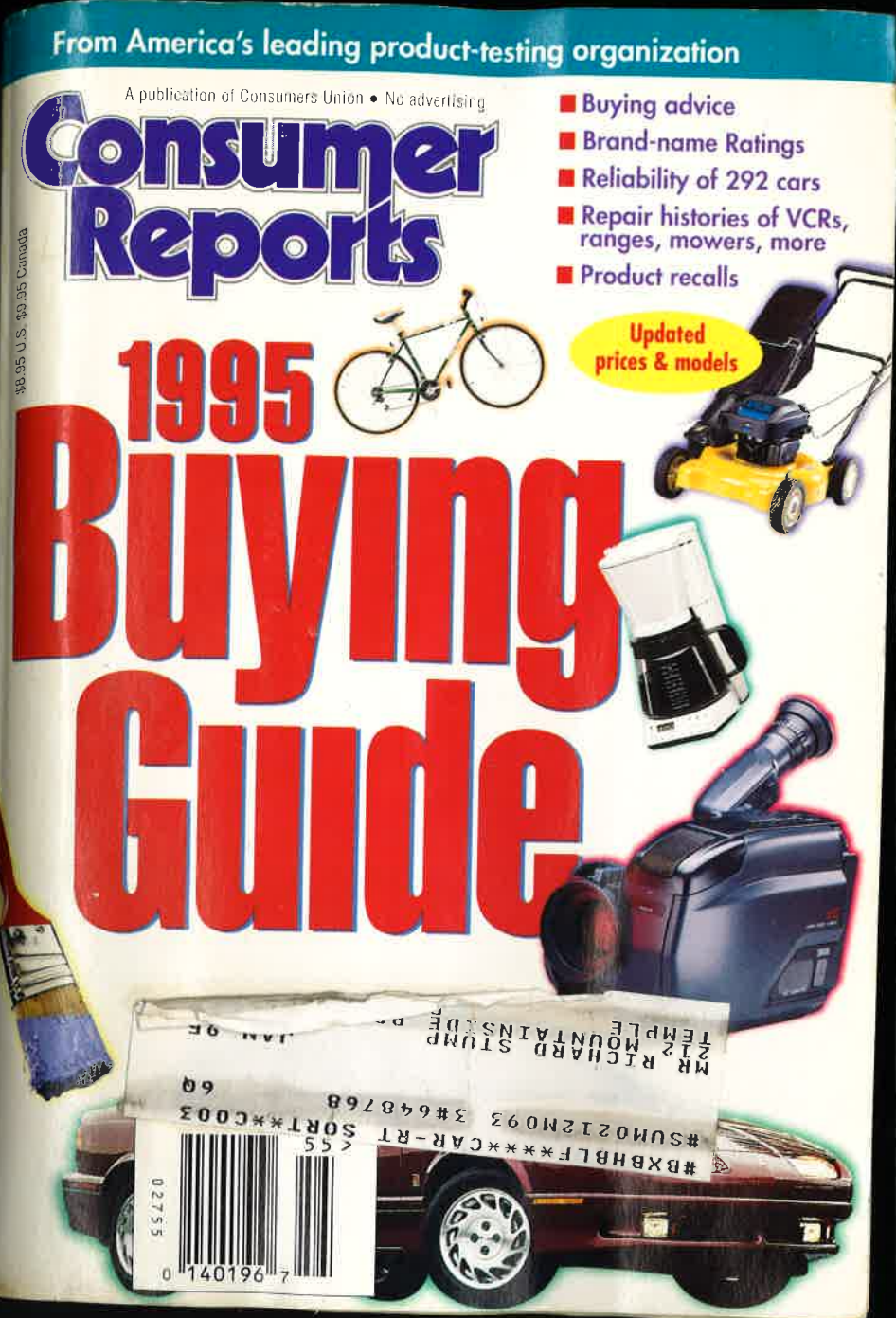

hooks around which you wind the cord. If one hook swivels or retracts, you can loosen the cord quickly. Some canisters make you wrap the cord around the tank.

The tests

We judge a vacuum's deep-cleaning prowess as follows: We embed silica and talcum into sections of medium-pile carpet, pass each vacuum back and forth over the carpet eight times, and then weigh carpet and vacuum to see how much dirt is picked up. To judge suction, we measure airflow with a new bag, and then gradually feed each machine fine sawdust to measure how fast airflow falls off.

To test hand-held models, we spread various soils—sugar, sand, gravel, dog hair, and potting soil—on wood flooring and on low-pile carpeting, then count the number of passes each machine takes to remove the debris.

We also check edge-cleaning—how close to a wall each machine can vacuum. We measure noise levels, and for full-sized cleaners, gauge how well the various models keep dust from kicking up.

Buying advice

Of the two basic types, canisters offer greater versatility. They typically provide plenty of suction and, if equipped with a power nozzle, do a decent job on carpet. And their tools usually travel on board. But uprights, known primarily for carpet-cleaning, are becoming more versatile. More and more upright models accommodate the hose and gadgets on board now, sparing you the bother of rummaging through the closet for them. Upright models with on-board attachments now outsell all other vacuums.

You needn't pay top dollar. Although you can spend more than $1000 for a heavily chromed *Kirby*, sold exlusively through at-home demonstrations, plenty of models selling for $200 or so also work quite well.

For small spaces and undemanding tasks, you might be satisfied with a compact canister model.

Most hand vacs should work well on spills and small messes. A plug-in model with a revolving brush can gobble up dirt on carpet better than a battery-powered model, but a plug-in can also scatter bits of heavier debris. And, of course, a plug-in model lacks the mobility that originally made hand-held vacs popular.

The car vacs we've tested were mediocre. If there's an electric outlet close enough to your auto, you're better off using a plug-in hand vac or a regular full-sized vacuum.

Water treatment

Public concern over the quality of drinking water often centers on the obvious: how water looks, smells, or tastes. Ironically, water that is hazardous to your health usually looks, tastes, and smells just fine. Public supplies are either comparatively clean to start with or are purified to bring them up to par, but you wouldn't know that from the frightening picture painted by some unscrupulous vendors of water filters and other water-treatment equipment.

What gives those vendors some credibility is that real drinking water problems do exist. More than 70,000 water contaminants—including industrial and agricultural wastes, heavy metals, radon, and microbes—have been identified. Of those, more than 100 contaminants are subject to water-safety regulations. The level of risk each pollutant poses, and the number of

people affected, varies widely.

Before buying any equipment, find out what's in your water. See "Getting Your Water Tested," on page 156.

Pollutants to worry about

Some substances in water such as calcium or iron, are harmless—they just make the water taste bad, refuse to lather, or mar fixtures or appliances. Other substances, like organic pollutants, typically present only localized problems. Three of the most widespread and serious water pollutants are lead, radon, and nitrate.

Lead. Significant levels of this toxic metal are more commonplace in drinking water than once assumed, and levels once considered safe are now seen as health concerns, particularly for pregnant women, infants, and children. Chronic lead exposure even at low levels may cause permanent learning disabilities and hyperactivity. In adults, such exposure is linked to high blood pressure and anemia.

Lead gets in water primarily from corrosion of household plumbing and service lines (the pipe connecting the home plumbing with the water main). There are three main sources: lead service lines (banned for nearly a decade, but widely used in many older homes), leaded solder (also banned since 1986) on copper pipes; and the brass in faucets and pumps. Very soft water and slightly acidic water leach lead from solder, pipes, and brass fixtures. To help minimize your exposure, use only cold water for cooking and drinking (hot water dissolves more lead). Running water for a minute or so to flush the pipes may help, but it's not a sure cure.

If you have more than five parts per billion of lead in your water even after letting it run, you should do something about it.

Radon. This probably poses a greater health risk than all other environmental pollutants combined. According to the U.S. Environmental Protection Agency, radon, a naturally ocurring radioactive gas, may cause between 10,000 and 20,000 lung-cancer deaths each year. Most of the radon seeps into homes from the ground. But some well water contains dissolved radon, which escapes into the air from sources like showers and washing machines.

Waterborne radon is usually confined to private wells or small community water systems. Large systems generally remove any radon before it reaches the tap. Before you test your water for radon, test the air inside your house. If the level is high and you rely on well water, have the water tested. If the air level is low, don't worry about the water.

Experts disagree as to the radon level in indoor air that should spur action. However, one EPA official we spoke with says you should take action if your water's radon level is 10,000 picocuries per liter or higher (about one picocurie per cubic meter of airborne radon). Radon is easily dispersed in outdoor air, so aerating the water before it enters the house is usually the simplest solution. Ventilating the bathroom, laundry room, or kitchen may also help. Other solutions include carbon filters.

Nitrate. Nitrate in water comes primarily from agricultural activities, especially chemical fertilizers and animal wastes.

High nitrate levels in water pose a risk mainly to infants. Bacteria in immature digestive tracts convert nitrate into nitrite, which in turn combines with hemoglobin in the blood to form methemoglobin, which cannot transport oxygen. The resulting ailment, methemoglobinemia, is rare but can result in brain damage or death. Some adults, including pregnant women, may also be susceptible to methemoglobinemia.

Rural families with private wells—especially those with infants or pregnant women—should have their water tested regularly. Some state health departments test

wells for free. High nitrate levels may signal that other contaminants are also present.

Treatment devices

If your water is contaminated, consider a water-treatment device before taking the expensive route of buying bottled water or, if you have a well, digging deeper to an uncontaminated aquifer. The chart opposite shows which devices work best for which substances.

Some products on the market use just one of the techniques explained below; others combine two or more. However, none of these devices are suitable for treating bacteriologically contaminated water, which requires sterilization methods using ultraviolet rays, ozone, or chlorine.

Carbon filters. They're the most popular because they can overcome a variety of problems. They remove residual chlorine, which improves the water's taste, and can also remove organic compounds—such chemicals as pesticides, solvents, or chloroform. They're basically ineffective with hardness minerals, heavy metals like lead, or microbes; under certain conditions, they actually promote microbe growth

Carbon filters come in many forms. In-line filters, which serve a single cold-water faucet, are suitable for a household that uses lots of water. They range in price from $100 to $500. Tiny, faucet-mounted filters with a couple of ounces of carbon cost $10 to $20. Pour-through or pitcher devices are priced from $10 to $25. Whole-house carbon filters, with five-foot-high tanks that can be backwashed, are especially useful for removing radon from the household water. Prices start at $1500.

The most practical method of carbon filtration is an in-line filter that treats water at a single source, such as the kitchen sink. Some models are plumbed into the water line under the sink; others sit on the countertop and attach with flexible tubes.

Filters and cartridges need periodic replacement, at costs ranging from $5 to $40. Manufacturers typically recommend replacing a filter after a certain period of time or after a given quantity of water has passed through. Some filters have a water meter built in. Expect to change cartridges for a high-volume in-line filter every six months or 1000 gallons.

Lead-removing filters. Filters designed to remove lead come in different configurations: in-line filters (under-sink or countertop), faucet, or carafe. Price: $6 to $750. If lead is your only problem, activated alumina cartridges are an effective treatment; cartridges cost $100, the housing, $50. Reverse-osmosis devices and some carbon filters can remove lead.

Reverse-osmosis devices. These excel at removing inorganic contaminants, such as dissolved salts, ferrous iron, chloride, fluoride, nitrate, and heavy metals such as lead. A carbon filter is incorporated in most reverse-osmosis systems to remove organic chemicals. At the heart of these devices lies a fine sieve of cellophanelike material that screens out all but the smallest molecules. Under pressure, only water and other small molecules pass through.

High levels of hardness minerals can gum up these filtering devices. And reverse osmosis works slowly, producing only a few gallons of fresh water per day. Such devices are inefficient, wasting several gallons of water for every gallon they purify.

Some versions attach to the cold-water line under the sink; others sit on the counter. Under-sink models cost more than countertop models. Price range: $400 to $750.

Reverse-osmosis membranes need replacement every few years; filters, more often. Replacement membranes and filters cost $5 to $40.

Distillers. A distiller boils water, then cools and condenses the steam; the resulting distillate drips into a jug. Some models

Water problems and solutions

The maximum contaminant level is set by the Environmental Protection Agency. MCLs can be used as a general guide to safe and unsafe levels.

	Maximum contaminant level [1]	Carbon filter	Reverse osmosis [2]	Distiller	Water softener	Activated alumina cartridge	Aerator
AESTHETIC PROBLEMS							
Dissolved iron	—				✔		
Rust stains	—			✔			
Calcium	—				✔		
Magnesium	—				✔		
Chlorine	—	✔					✔
Salty taste	—		✔	✔			
'Skunky' taste	—	✔					
Total dissolved solids (TDS)	500 ppm		✔	✔			
HEALTH HAZARDS—Organic							
Benzene	5 ppb	✔					✔
Carbon tetrachloride	5 ppb	✔					✔
Lindane	0.2 ppb	✔		✔			
Methoxychlor	40 ppb	✔		✔			
Trichloroethylene	5 ppb	✔					✔
Trihalomethanes (THM)	100 ppb	✔					
HEALTH HAZARDS—Inorganic							
Arsenic	50 ppb		✔	✔			
Barium	2 ppm		✔	✔	✔		
Cadmium	5 ppb		✔	✔	✔		
Chromium	100 ppb		✔	✔			
Fluoride	4 ppm		✔	✔		✔	
Lead	15 ppb [3]	[4]	✔	✔		✔	
Mercury	2 ppb	✔	✔	✔			
Nitrate	10 ppm		✔	✔			
Selenium	50 ppb		✔	✔		✔	
HEALTH HAZARDS—Radiological							
Dissolved radon	10,000 pc/l	✔					✔

[1] *ppm = parts per million; ppb = parts per billion; pc/l = picocuries per liter.*
[2] *Most will also remove organic substances.*
[3] *Action level.*
[4] *Some remove lead and accept lead-removing cartridges.*

include a tiny carbon filter. Countertop units hold from one-half to 2½ gallons. Prices range from $150 to $425.

Distillers work best on brackish water or water polluted with heavy metals; they demineralize it. Anything that won't boil or evaporate remains in the boiling pot. Boiling water can also kill microorganisms, but don't rely on distillers for that purpose.

Distillers aren't effective against volatile organics like chloroform and benzene, which vaporize in the distiller and may wind up in the condensed water. A carbon filter might help remove such chemicals, but the filters incorporated into distillers are too small to do the job reliably.

Distillers are slow, taking a couple of hours to produce the first quart of water. Since they collect and concentrate minerals, scale can build up quickly and must be cleaned out. And, they use a lot of electricity—about three kilowatt-hours per gallon of purified water.

Water softeners. Water softeners, the

GETTING YOUR WATER TESTED

Despite possible contaminants, most people have water that's safe to drink. That's particularly true for people served by a large municipal water system. But if you have doubts about the water's quality, here's how you can find out if the water is fit to drink.

Consider the source. If you have municipal water, ask the utility for a copy of its latest water analysis. Federal law requires most public water companies to have the water tested regularly and to make the results available.

The test results will tell you the condition of the water when it left the reservoir or treatment plant. It won't tell you the condition at the tap—a shortcoming if you're concerned about lead, which generally leaches into the water from the plumbing.

Test for lead if your house is more than 30 years old or if the plumbing pipes are joined with lead solder. If you draw your water from a private well, call the local public health department to find out if any groundwater problems exist. If you drink well water, you should have it tested for radon, and periodically for bacteria, inorganic compounds, organic chemicals if the well is within a mile or two of a gasoline station or refinery, a chemical plant, a landfill, or a military base. If you live in an agricultural area, have the water tested for nitrate and pesticides.

Where to go for tests. Companies that sell water-treatment equipment often offer a free or low-cost water analysis as part of the sales effort. Don't depend on that kind of test: It's like asking a barber if you need a hair cut. Consult a state-certified, independent laboratory instead. You can often find one in the Yellow Pages under "Laboratories—Testing."

Or use a mail-order lab. Our past tests turned up three reliable labs: Clean Water Fund, 704 251-0518, $17 (lead only); Suburban Water Testing Labs, 800 433-6595; National Testing Laboratories, 800 458-3330.

Over the years, we've found that all labs tend to overstate or understate results occasionally. If a test report says the water has an especially high level of contaminant like lead, nitrate, or radon, have the water retested before taking costly remedial action.

granddaddy of water-treatment alternatives, remove calcium and magnesium, the hardness minerals, along with iron and lead. These devices don't remove radon, nitrate, or pesticides.

A water softener consists of a large tank of tiny resin beads loosely coated with sodium ions. When hard water flows in, minerals take sodium's place on the resin. The softener periodically reverses its flow, taking salt out of a tank to regenerate the resin beads. The minerals are flushed down the drain. Some models regenerate at preset intervals, using a timer. More sophisticated models ("demand control" models) regenerate according to water use.

Softeners differ in size. "Cabinet" units are the most compact. The average price for a softener is about $1000, but prices vary with installation, local water conditions, and competition among local dealers.

A water softener needs little maintenance, except for the salt you add periodically. You can adjust the level of salt consumption. A high setting ensures softer water but means more frequent refills. A lower setting saves salt and money, but the resin may regenerate less completely.

Iron removers. Iron dissolved in water can leave brown stains in the bathtub and sink, which are actually rust from the dissolved iron oxidizing with the air. You can use a water softener to remove the iron. Special devices are available for water where hardness is not a problem. An iron remover uses an oxidizing agent to precipitate the iron and is the best device for removing dissolved "ferrous" iron. One common design is a canister similar to a water softener. Iron removers are priced from $400 to $650.

Buying advice

The chart on page 155 summarizes the best way to treat the most common water problems. Before doing business with a water-treatment company, especially one with an unfamiliar name, it's a good idea to call the Better Business Bureau or a local consumer-protection agency to find out if there are unresolved complaints against the company.

In evaluating the various treatment systems, some key points to consider are:

■ **Carbon filter:** The more carbon the better. Based on our tests, small pour-through filters and fist-sized units that thread onto the faucet can improve the taste of water, but are simply too small to remove hazardous chemicals. High-volume under-sink or countertop filters do a much better job. Look for those with a replaceable filter cartridge. Cartridges made either with a "carbon block" or granulated carbon are better than those made with powdered carbon.

Carbon filters with a built-in sediment filter may clog before the carbon is used up if your water contains a lot of undissolved solids. To extend its life, install a separate sediment prefilter upstream of the carbon filter. A 5- to 10-micron mesh is fine enough. A clear plastic sump on the filter housing indicates when the cartridge needs changing.

■ **Distiller.** Check how easy the unit is to fill or clean. In our tests we found little variation in how well distillers removed inorganic compounds.

■ **Water softener.** Any model will do an acceptable job of removing minerals, according to our tests. For peak efficiency and minimum salt consumption where household water use varies from week to week, choose a demand-control model, which regenerates automatically according to water use.

■ **Iron removal.** Expensive models have the advantage of removing more iron and regenerating automatically rather than manually. They're designed for high iron levels. Aeration devices can precipitate and remove iron and also radon.