The principle of use-reuse applied directly to many of our most common natural resources. As examples, steel used in automobiles is salvaged and re-used again, even in automobiles; the oil drained from crankacses is often refined and reused. Wood products are refinished and reused, perhaps occasionally as an antique but more often as a raw material for cardboard or pressed wood manufacture or, at least, as a fuel in some domestic or industrial furnace. Wool and cotton are reprocessed and rewoven into cloth. The air we breathe, even now, has been inhaled and exhaled by others and used previously in manufacturing, combustion, or cooling processes. Soil and minerals are re-used—the whole concept of crop rotation is built upon this principle and building materials, brick, stone, concrete, are frequently re-used, if not directly in construction then in landfill or breakwaters. Even the fashion world has jumped on the reuse bandwagon—hair cuts provide the source material for toupes and wigs. And on it goes—the examples are almost endless.

If we did not purposefully reuse our natural resources, it would be as if we traded in the family car every time it got dirty. We cannot afford that luxury or, rather, that needless extravagance. So it is with water—along with air, our most basic and most essential natural resources. We wash our cars when they get dirty; likewise, we must "wash" our water when it becomes dirty.

The hydrologic cycle

The volume of water on this earth is fixed. This volume has served the needs of this planet over and over again through a natural use-purification-reuse process called the hydrologic cycle. Briefly, water evaporates from the ocean into the atmosphere, it condenses to rain and falls on the land, it is "used" by man, by animals, by nature, and then it flows into our rivers to the ocean where it evaporates again, and the cycle continues. But water is used and re-used much more directly when we consider the withdrawal of water from streams by cities and by industries to be used and then returned to the very same streams as wastewater.

Many people have heard the old adage that a stream is purified every seven miles. This natural renovation of used water is what we call "stream self-purification" and there is some validity to the concept. In simpler times stream self-purification was often able to accomplish satisfactory results. Unfortunately, by today's standards and with today's waste burdens, natural purification can cope with only a small fraction of our wastes and with only the simpler, non-persistent types.

Giving nature a hand

What pollution control scientists of the Department of the Interior are trying to do, in essence, is to supplement the natural treatment involved in stream self-purification and in the hydrologic cycle. Research and development in water pollution is aimed at obliterating the pollution burden which man is placing on the natural water purification cycle and simultaneously at supplementing the earth's natural supply of fresh water by providing man-made purification systems allowing the purposeful and direct recycling and reuse of water. In other words, we are trying to find ways to renovate wastewaters so that they are no longer detrimental to the environment and so that they, effectively, become "new" supplies of clean, fresh water.

Because man's and industry's wastes are complex and are becoming increasingly more complex, the new purification methods being developed are quite sophisticated and advanced technologically. These methods to combat water pollution are among the highest examples of the scientist's and engineer's art. They are being developed by the Department of the Interior's Federal Water Pollution Control Administration, and in a sense may be looked upon as analogous to a scientific formula. Like a formula, advanced waste-treatment systems are composed of numerous factors which may be fitted together and interchanged to solve particular pollution problems or to produce reusable water of a desired quality. The more difficult the pollution problem is, the greater the number of factors in the formula.

The degree of purification required is determined by the specific purpose for which the treated water will be used. At some locations the irrigation water used for non-edible crops, for golf courses, and for parks is municipal waste effluent that has been conventionally treated and then chlorinated; many of the organic and all of the inorganic impurities are not removed. To produce water for industrial reuse, the treatment sequence might have to remove scale-forming and corrosive components. To reuse wastewaters recreationally, treatment must include steps to disinfect, remove algae nutrients, and to eliminate distasteful conditions such as color, odor, and foaming. To renovate a wastewater so that