The identification of pollutants, the source of pollutants, and the fate-persistence of pollutants in the water environment require the application and development of scientific and technical instrumentation, relationships, methods, analyses, and techniques.

The criteria for measuring the quality of water for various uses and the relationships between those criteria and effects on water use have to be established (Water quality requirements—Subprogram 18—Figure 1). It would be most desirable to have data on the effects of different concentrations of pollutants (or deleterious results produced by pollutants) related to the time of exposure. This concept can be reviewed by examination of Figure 2. The complete set of data would result in a series of curves indicating biological, economic, and aesthetic effects on a short or long term basis. The complexities associated with biological and ecological systems, the synergistic and antagonistic relationships among pollutants, and quantification of aesthetic factors all may be found in this area of research.

The development of treatment processes and pollution control techniques and the determination of the capital and operating costs associated with those systems is another major area for Research and Development and Demonstration. The results of this effort may be illustrated by a series of curves—Figure 3, which would prevent the costs of reducing the concentration of any pollutant (having an initial concentration of C_1, C_2, C_3, etc.) to any desired residual level. The total pollutional load from any pollutant may be obtained by relating concentration to flow or volume of wastes.

The scientific and technical data and information which could be presented in a form as illustrated by Figures 2 and 3, would enable the water quality control administrator to know the costs of achieving or protecting any water use. The gathering of that data and information has top priority in the research and development effort of FWPCA. Considerably more data than currently available are needed.

We have had no experience to date in the enforcement of violations of established water quality standards for interstate waters. The standards submissions, including their plans of implementation and enforcement, of 15 States have been approved and are Federally enforceable. The range of expert scientific and technical competence recruited to assist in the development of water quality standards, as represented most notably by the 84 scientists and water authorities comprising the National Technical Advisory Committee to the Federal Water Pollution Control Administration on Water Quality Criteria, provides substantial weight and support, technical and legal, to the established standards if challenged in this regard.

ADVANCED WASTE TREATMENT—RECENT PROGRESS AND STATUS

Research and development on advanced waste treatment (AWT) technology was begun, on a very modest scale, in 1961. The objective of this program is to develop and demonstrate the technology necessary to achieve, at minimum cost, any level of waste treatment which may be required to meet pollution control needs. The methods being developed range across the spectrum of physical, chemical, and biological separation techniques. They range from the mundane (filtration and sedimentation), through the novel (biological denitrification), to the exotic (reverse osmosis). Techniques are under study to improve the performance of primary treatment, to upgrade and extend the capability of secondary treatment, and to extend the purification train on to tertiary treatment.

The pollutants to be removed or destroyed in waste treatment may be generally categorized as:

(1) suspended and colloidal solids
(2) dissolved biodegradable organics
(3) dissolved refractory organics
(4) nutrients
(5) inorganic salts
(6) microorganisms

Many processes are, of course, capable of treating wastes in more than one category; others may be effective for only one type. Likewise, pollution control