CNRS will also change the way in which it interacts with outside bodies, particularly the universities. Where the previous government tried to use CNRS to spearhead a technological renaissance by promoting the exploitation of research, Feneuille says he is more keen to establish the idea of "partnership" with other organizations. "The principle is that CNRS scientists should work in cooperation with others, such as industrial research groups, but that each partner should be allowed to do what it is best at," he says.

Not surprisingly, the new government's policies have met strong opposition from sectors of the research community that had been well served by its predecessor. Labor unions representing technicians and administrative staff, for example, have already announced plans to fight proposals to cut 900 technical and administrative jobs next year.

More difficult for the government to handle is a deep split within the the ranks of its own supporters. A substantial number of conservative parliamentarians support the views of the militantly anti-Marxist National Interuniversity Union (UNI), which has been demanding much more radical action.

Immediately after Devaquet announced the CNRS reforms last week, the UNI issued a statement expressing its "disappointment" with the measures proposed, and reiterating claims made prior to the elections that "only the breaking up of [the CNRS's] centralized and arthritic structures will inject new life into French research."

The UNI and its supporters have already been making life difficult for Devaquet by claiming that his plans for the reforms of universities do not go far enough in providing higher education institutions with autonomy from the state. A new bill promised for last summer has already been held up for several months as a result.

But, as often happens in France, pragmatism rather than ideology is likely to win the day, at least as far as the organization of science is concerned. Apart from the reductions in support for some areas of applied research, Devaquet's budget plans for 1987 have already been acknowledged by the government's top science advisory committee, the Conseil Supérieur de la Recherche et de la Technologie, as making up for the cuts inflicted shortly after the conservatives came to power in March.

Officials in Paris point out that research was spared the extra cuts demanded of other government agencies in July when it was decided to increase the military budget for 1986. There have been few complaints about that move from the scientific community; and de Gaulle would probably have approved as well. ■ **DAVID DICKSON**

Woburn Case May Spark Explosion of Lawsuits

A suit claiming damages from polluted drinking water has been settled but chemical companies are bracing for similar actions elsewhere alleging a link between toxic chemicals and immune system damage

EIGHT families of Woburn, Massachusetts, filed suit in 1982 against W. R. Grace & Company, Beatrice Foods, and the Unifirst Corporation, saying they would prove beyond a reasonable doubt that the companies had polluted the town's drinking water and given its children leukemia. After a partial trial, one acquittal, and two out-of-court settlements, the charges were dropped in September.

In return, the families reportedly got $8 million from Grace. This was less than the $400 million they sought at first, according to a Grace spokesman. But it was a lot, perhaps the largest per capita settlement of any environmental injury claim.

Thus ended the Woburn case. The promised debate on new theories of chemical damage to the immune system and the associated risk of cancer never came off. But this is not the end of the Woburn story.

Some lawyers foresee a wave of new lawsuits sweeping the nation based on the "Woburn strategy," an approach that links many kinds of illness to immune system injury and ties immune injury to pollution.

"If I were a plaintiff's lawyer, I'd love this argument too," says Donald Evans, deputy general counsel of the Chemical Manufacturers Association. "Whatever disease your client has, you relate it to chemicals." Evans finds it "a tough issue to deal with legally" because "it puts you on the defensive and is difficult to disprove."

Anthony Roisman, executive director of Trial Attorneys for Public Justice in Washington, D.C., and a consultant to the Woburn families, said the $8-million settlement was important because, "The message goes out: you can succeed in these cases. Go ahead and try." Although Woburn sets no legal precedent, Roisman says, its public relations value, together with a recent federal court decision involving the Velsicol Chemical Company, creates "a very important milestone" in toxic chemical law.

Judge C. Odell Horton of the federal district court for western Tennessee decided against Velsicol in a major case on 1 August. Horton gave some residents of Hardeman County $12.7 million in compensation for the pollution of their water by Velsicol. The company admitted that it had caused the pollution, but not the liver and kidney problems or the cancer it was being sued over. Most important, Roisman says, the judge decided to earmark $875,000 specifically for people who said their immune systems were damaged by drinking chemical-laden water. In making the award, Horton cited the plaintiffs' expert witness, Allan Levin, a San Francisco doctor. Levin, a self-designated "clinical ecologist," is one of a handful of experts who have testified in court that exposure to common industrial chemicals damages the immune system.

The court in Massachusetts never got into medical issues. The litigants quit after the first part of a planned three-part trial; parts two and three would have dealt with medical testimony on cancer and birth defects. The Unifirst Corporation, a dry cleaning company, bailed out before the trial began, giving the Woburn families $1 million. This financed the continued litigation against Beatrice Foods and Grace.

These two companies owned land near public wells "G" and "H" in Woburn, both of which were contaminated with solvents. Phase one of the trial attempted to track the path of the chemicals as they traveled underground in East Woburn. Because Beatrice inherited the problem when it bought property in 1978 and claimed to know nothing about it until after the wells were closed in 1979, the jury absolved it of negligence.

Grace conceded that its employees had "sporadically" dumped an unknown quantity of trichloroethylene (TCE) and buried drums of the chemical on its property half a mile from the town wells. But the company insisted that many others in Woburn had dumped the same chemicals. The offending molecules in Woburn's water, Grace argued, did not come from its property, but from somewhere else nearby, perhaps from the polluted Aberjona River.

Company experts estimated that much of

the TCE dumped by Grace had evaporated. The remainder that went deep underground, they said, could not have traveled half a mile through dense soil to wells G and H. Even if some TCE had gone into the ground water, Grace said, it could not have migrated to the wells in time to have "substantially" contaminated them. The jury rejected this argument and found that TCE could have made its way from Grace's property to the drinking water, and that Grace should have prevented it from doing so.

The trial lasted 2 months and ended as it had begun, in confusion. Responding to compound questions put by the judge, the jury found that Beatrice was not at fault, but that Grace was. The key question asked of the jury was to give the earliest date on which each company was negligent and had contributed "substantially" to the chemical pollution of Woburn's water. The answer in Grace's case was September 1973. Having obtained this answer, the judge decided that it made no sense and said that his questions were badly worded. He agreed with attorneys for Grace that the jury had not understood the hydrogeologic testimony. On 17 September he ordered the entire trial redone from the start. This grim prospect may have goaded the parties to settle, which they did on 22 September.

Grace says it spent $7 million defending itself. When it was over, board chairman Peter Grace said, "We have better things to spend our money on than lawyers." The plaintiffs, who said they spent more than $2 million, claimed vindication.

By the end, the charges had narrowed to one: that Grace had polluted city water with TCE, a solvent used to clean greasy machinery. TCE, according to the congressional Office of Technology Assessment, is a common contaminant of ground water throughout the United States. The first reading of TCE in one of the Woburn wells, taken in 1979, was 267 parts per billion (ppb). It triggered an immediate decision to close the well. The concentration in Woburn's tap water was never measured, but the highest well water reading ever taken (in 1981) was 400 ppb. The Woburn families claimed that chronic exposure to trace amounts of the chemical had caused stillbirths, birth defects, leukemia, and other problems.

State and federal agencies did not support this claim nor did they pinpoint any cause of the health problems. In a paper issued in March, the Centers for Disease Control (CDC) noted that Woburn has been a hub of odiferous industry for more than 100 years. Woburn's first chemical plant went up in the 1850's; the town was the center of arsenical pesticide manufacture until 1915; and an animal glue factory shut down only in 1970. A more recent investigation 2 miles from the Grace and Beatrice properties uncovered a lagoon holding old lead and arsenic wastes and a pit filled with slaughterhouse debris. As far as is known, however, these dumps did not pollute the drinking water.

In the late 1960's, some residents complained that the water had a "sulfurous" or chemical odor, but were reassured by city officials that nothing was wrong. In the late 1970's, a group of citizens led by Anne Anderson, whose son had leukemia, began to fear that Woburn was in the grips of a cancer epidemic. For other reasons in 1979, the state tested wells G and H and found them to contain TCE, tetrachloroethylene, benzene, and chloroform.

Mark Morelli

The defendant. *W. R. Grace's Cryovac plant, half a mile from the town wells, was blamed for leaking TCE into the water. Grace spent $7 million arguing to the contrary.*

CDC came to investigate and, working with the state health department, reached a preliminary conclusion in 1981. CDC said there was an epidemic: Woburn's childhood leukemia rate was two to three times the national average. But it did not think water pollution was the cause.

The CDC report left the public uneasy because it confirmed the problem but did not come up with a solution. At this point, the Harvard School of Public Health stepped in. Two faculty members, Marvin Zelen, chairman of the biostatistics department, and biostatistician Stephen Lagakos, obtained an analysis of Woburn's water flows during the critical years when wells G and H were operating (1964–1979). They used it to construct a map of exposure to TCE-laden water. Meanwhile, 300 Woburn volunteers, including families later involved in the lawsuit, collected health data on 5000 households. Zelen and Lagakos made a statistical match of the data in 1984 and found a significant correlation between households receiving a high share of water from wells G and H and the incidence of sudden infant death, stillbirths, birth defects, and childhood leukemia. They did not state, but clearly implied that the former caused the latter.

The Harvard study has many critics. For example, epidemiologist Brian McMahon, also of Harvard's School of Public Health, penned a strong attack in the September *Journal of the American Statistical Association*. He wrote that the pollutants were present in such low concentrations that it would require "a major revision of our ideas about chemical carcinogenesis to believe that they are indeed causally associated" with the leukemia in Woburn. McMahon pointed out that only half of the excess childhood leukemia cases can be linked with well water, even if the study is correct. This, he said, makes "less attractive" the idea that water pollution can be blamed for any of the excess leukemia cases. He mentioned other flaws, including a potential bias in the method of collecting health data. McMahon also thought the analysis was almost too sophisticated for the quality of the data, creating a numerical complexity that might generate spurious correlations.

Lagakos agreed that there is always some uncertainty in a study of this kind. But the charge of bias in the health data is unfair, he said in a telephone interview. Those who collected the data did not know which houses received the bad water. In fact, Lagakos said, the study is quite strong because it found an association between wells and diseases at distant sites. The pattern was consistent, following a unique geographical and temporal ebb and flow as the water was

turned on and off over a period of 15 years. Furthermore, Zelen, Lagakos, and coauthor B. J. Wessen wrote that they tested the data for evidence of "recall bias" and found none. Responding to doubts about the effects of Woburn's chemicals at low exposures, they said that because there are no data on this point, it would be foolish to assume the chemicals do not cause cancer.

Had the Woburn trial continued, phase two would have examined the question of cancer causation. Grace intended to argue that there is no evidence that exposure to TCE causes leukemia in humans. However, studies of TCE conducted for the National Cancer Institute and the National Toxicology Program have produced cancer of the liver, kidney, and other organs in laboratory rats and mice, leading the Environmental Protection Agency to label it a "probable carcinogen."

Industry officials counter by citing a review of the literature published in 1985 by Renate Kimbrough of CDC. She found fault with both of these TCE studies. The carcinogen that affects rodents appears to be a metabolite of TCE, Kimbrough said in a telephone interview, and it may be present only when the chemical is ingested at high doses. In her view, it is unclear whether or not the carcinogen is produced at low exposures, and she thinks it may not be produced at all in humans. She added: "As far as I know, there is no evidence in the literature of TCE's effect on the immune system."

Roisman said the attorneys for the Woburn families intended to brush aside the animal data with a new strategy, the same one used against Velsicol in Tennessee. "We approached it like a bus accident," he says. "When your client is hit by a bus, you don't go out and do an epidemiological study to see how many people hit by buses end up with broken legs. . . . You don't go out and check to see what happened in studies of animals hit by buses. You take your client to the doctor and say, 'Tell me what's wrong with this person.' " The doctor's answer provides the medical evidence of injury that justifies the suit, he says. "There's no argument about causation."

One of the leading medical witnesses for the Woburn families would have been David Ozonoff, director of the environmental health division at Boston University's School of Public Health. He coordinated a $60,000 study that compared immune system patterns in the blood of 22 clients with patterns from 47 other people in Boston.

The study found a significant difference in the client population, Ozonoff said. An index used to measure disease-fighting potential, the ratio of T4 to T8 cells, showed that the client population had an odd distribution of values, including an unusually high ratio of T4 to T8 cells for a few people. The tests also discovered antithyroid antibodies in some clients. Functional tests, in which a viral agent is introduced to serum to stimulate an immune response, indicated no difference between the client and the control groups. "What this means, I really don't know," says Ozonoff, except that he is convinced that the clients exhibited an abnormal pattern. The attorneys planned to use this as evidence of permanent injury to their clients' immune systems.

Levin planned to testify for the Woburn families, making just this point. He would have linked leukemia to immune system injury and to TCE in the water. Levin made a similar presentation in Tennessee, where the levels of pollution were higher and the chemicals (carbon tetrachloride, chloroform, chlorobenzene, and eight others) were more clearly dangerous. In this case the judge relied on Levin's testimony to conclude that the company's conduct had caused chemicals to "invade each particular plaintiff's body." Because the chemicals "were of such a nature as to cause the reported symptoms and cellular damage and adverse biological change (however slight), the court considers that this ingestion, inhalation, or contact caused emotional stress in each plaintiff." Specifically, the plaintiffs feared that they would get liver and kidney cancer, and "fear of developing a disease in the future, such as cancer, is an established item of damages."

Levin and Ozonoff may give testimony similar to that planned for Woburn in other lawsuits pending in the West. One mammoth case in Tucson, Arizona, involves 300 people who demand compensation from Hughes Aircraft. They say that TCE leaking from one of its plants has contaminated the city water, causing tumors, heart disease, liver problems, leukemias, birth defects, and nervous disorders.

In the Woburn trial, Grace intended to counter this thrust with testimony from Robert Waldman, dean of the University of Nebraska medical school, and Fred Rosen, an immunologist at the Harvard Medical School and physician at the Boston Childrens Hospital, and others. Rosen said in a telephone interview that Levin's interpretation of immune data is "ridiculous." His deposition in the Woburn case conveyed the same message, but in more circumspect terms.

Ridiculous or not, the theory is taken seriously by chemical companies and their attorneys. For example, the Monsanto Company has set up a lab in St. Louis to screen its agricultural chemicals for immune system effects. Already, one plaintiff's attorney in Missouri sent a tremor through the court when he used the phrase "chemical AIDS" in describing his clients' injury. The *Toxics Law Reporter* observed recently that "the use of evidence of human immune system effects to prove claims of latent injuries, including leukemia, from exposure to common industrial chemicals in ground water" could portend "an explosion" of such cases.

The Woburn suit is closed, but many feel that the issues it raised are far from settled. They will reappear in at least half a dozen other states where chemicals have been found in the ground water.

Meanwhile, Woburn residents may discover that their own problems are not over. A scientific advisory committee to the state department of public health concluded in June 1985—6 years after the tainted wells were shut—that the puzzle was far from solved. Of the water pollution theory, it said: "the panel weighed the evidence and found itself left with uncertainty." The "raised frequency of childhood leukemia in Woburn has not yet disappeared," the experts noted, and they suggested it would be prudent to investigate an equally plausible theory that the outbreak was caused by a virus. ■ ELIOT MARSHALL

Briefing:

Science Agencies Fare Well in Budget Battles

Congressional inaction on the 1987 federal budget has again left many researchers on the edge of their chairs awaiting news of last-minute decisions by the legislative body. At *Science*'s press time, Congress was still trying to reach agreement on a massive $570-billion spending bill for fiscal year 1987, which began 1 October.

While the funding picture remains uncertain for many basic research and applied science programs, the budgets for the National Institutes of Health (NIH) and the National Science Foundation (NSF) appear set. House and Senate negotiators are expected to accept appropriation conference reports on these agencies. A funding plan for the National Aeronautics and Space Administration (NASA) also appears firm.

NIH's budget is slated to be $6.18 billion, almost $1.2 billion more than the Administration originally proposed. NIH officials say somewhat more than 6200 research grants are likely to be funded—a rise from the 6100 supported in 1986, but about the same number as in 1985.

NASA's budget is expected to increase by