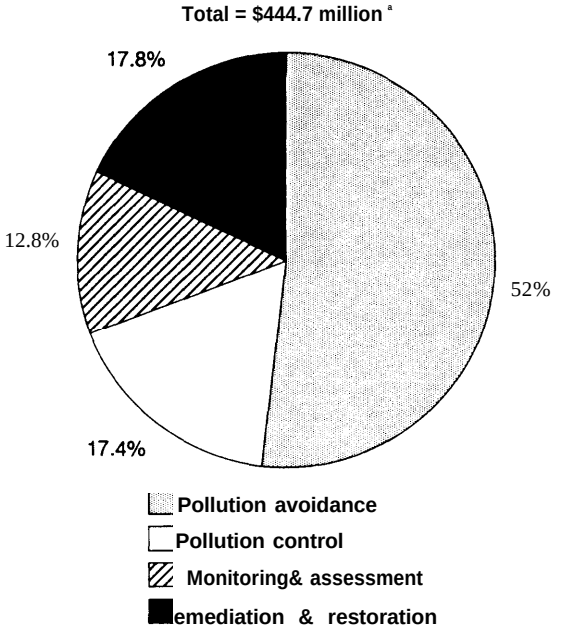
Department of Defense 4

Like the Department of Energy, the Department of Defense (DoD) has major environmental responsibilities, and a multibillion dollar environmental budget. The most publicized DoD environmental chore is to clean up or manage contamination in and around military facilities, here and abroad, arising from military operations.[1] Estimates of the overall bill for cleanup and related activities range into the tens of billions of dollars over the next few decades. About 95 Defense installations are listed as EPA Superfund sites. Cleanup activities are undertaken on 1,700 defense installations around the world, as well as at numerous Defense bases proposed for closure and transfer out of DoD management. Studies are being conducted at many other potentially contaminated sites to determine cleanup needs.

While less publicized, DoD spends as much or more each year to bring its ongoing operations into compliance with U.S. environmental standards as it does on cleanup. For example, it needs to find substitutes for ozone depleting substances currently in use. Finally, DoD is a major land management agency, with approximately 25 million acres under its jurisdiction; management of these lands in an environmentally responsible fashion is a continuing DoD resource management issue: for example, the agency conducts training activities in the field while simultaneously needing to protect threatened and endangered species.

[1] This report does not discuss environmental challenges associated with dismantling nuclear weapons and managing nuclear materials. For discussion of this issue, see Office of Technology Assessment, *Dismantling the Bomb and Managing the Nuclear Materials*, OTA-O-572, (Washington, DC: U.S. Government Printing Office, September 1993).

FIGURE 4-1: Allocation of DoD Environmental Technology R&D and Scaleup by Category, FY 1994 (in percent)



● Total is based on data displayed in table 2-1 in chapter 2.
SOURCE: National Science and Technology Council, unpublished data, Apr. 6, 1994.

Cleanup operations and compliance activities consumed most of the nearly $4.6 billion DoD spent on environmental activities in FY 1994.[2] Environmental costs are mounting. DoD estimates that it could need $25 billion for environmental activities from FY 1995 through FY 1999.[3] The need for more cost effective ways to address environmental issues seems clear.

DoD's environmental technology activities support its environmental program, and include remediation, pollution avoidance, pollution control, and monitoring and assessment (see figure 4-l). As shown in table 4-1, DoD spent about $400 million in FY 1994 on environmental technology development activities. (Not all of DoD's spending for such activities as pollution prevention and energy conservation are encompassed in this figure). These expenditures could produce technologies or approaches that reduce compliance costs or otherwise produce savings compared with conventional approaches. A recent report by a Defense Science Board task force on environmental security identified seven steps that could help DoD achieve environmental goals at a time of significant constraints on environmental budgets, including:

- prioritizing environmental investments through comparative risk reduction,
- implementing pollution prevention actions,
- evaluating and deploying new commercial technology more rapidly for DoD use,
- investing in early development and deployment of emerging technology aimed at unique defense requirements,
- improving environmental management efficiency and effectiveness through use of benchmarking and metrics,
- adjusting environmental legislation consistent with risk reduction priorities, and
- maintaining stable funding for environmental activities over the next five years.[4]

As DoD is one of the largest funders of environmental technology R&D, questions about how to optimize returns from this public investment have arisen. DoD's environmental technology activities cross the spectrum from basic research,

[2] According to the U.S. General Accounting Office, DoD, in FY 1994, spent $1.965 billion for defense environmental restoration account activities; $160 million for base realignment and closure activities; and $2,482 billion for compliance, conservation, protection, and prevention. Testimony of David R. Warren, "Environmental Protection: Challenges in Defense Environmental Program Management," before the Subcommittee on Military Readiness and Military Installations and Facilities, Committee on National Security, House of Representatives, U.S. Congress, Washington, DC, Mar. 24, 1995, p. 4.

[3] As cited in Ibid.

[4] Department of Defense, Office of Under Secretary of Defense, Acquisition and Technology "Report of the Defense Science Board Task Force on Environmental Security," Washington, DC, Apr. 22, 1995, p. ES2.

TABLE 4-1: Department of Defense Environmental Technology RDDT&E Programs ($ millions)

	FY 1994 (actual)	FY 1995[a] (estimate)	FY 1996[a] proposal Clinton Administration
Army	91.3	79.5	32.9
Navy	76.0	60.8	76,8
Air Force	10.5	6.1	11.3
Defense-wide:	68.1[b]	38.5	24.1
Advanced Research Projects Agency	—	43,9	14.9
Environmental Security Technology Certification Program	154.1	55.1	58.4
Strategic Environmental Research & Development Program			
Total	400.0	283.9	218.4

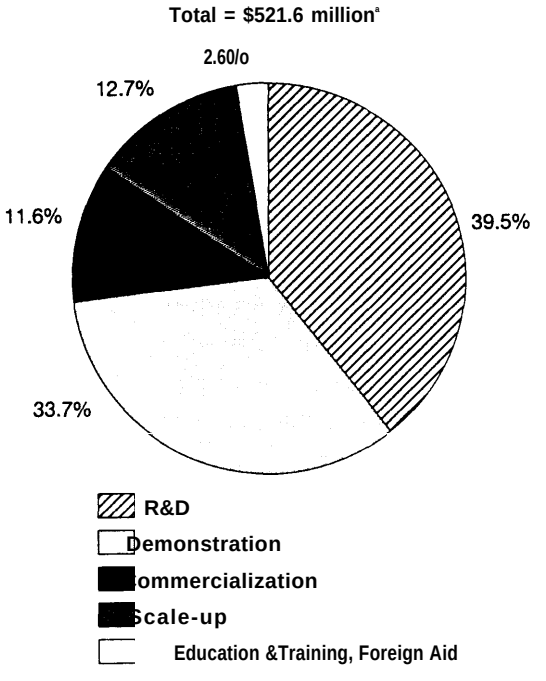
Key: RDDT&E=research, development, demonstration, test, and evaluation.
[a]Figures cited above may differ from other estimates, such as in table 2-1 in chapter 2, due to differences in methodologies, definitions, or programs covered in data collection.
[b]Figure does not include $10 million in unreleased funds.

SOURCE: Department of Defense, 1995.

through development, demonstration, testing, and evaluation, to validation, deployment, and transfer. (See figure 4-2). Some of the technologies it develops could be useful to other federal agencies, state governments. and/or the private sector; while, at the same time, many environmental technologies developed elsewhere could be used effectively by DoD. Establishing effective means for technology cooperation and transfer among different components of DoD itself, between DoD and other federal agencies; and between DoD and nonfederal entities is thus an important need. Several programs and mechanisms, both inside and outside of DoD. have been set up to facilitate cooperation among these parties.

Selected aspects of DoD's environmental technology programs are briefly discussed below. Most of the discussion focuses on priority setting for environmental technology through reorganization and development of an environmental technology strategy. Also discussed are the Environmental Security Technology Certification Program, the Strategic Environmental Research and Development Program (SERDP), and various Advanced Research Projects Agency (ARPA) activities. The focus is on Defense-wide activities; the individual services also have their own activities, but these are not discussed here.

FIGURE 4-2: DoD Environmental Technology Budget by Function, FY 1994[a]



[a]Total is based on data displayed in table 2-1 in chapter 2

SOURCE National Science and Technology Council, unpublished data, Apr. 6, 1994

BOX 4-1: Selected DoD Environmental Security Functions

Assistant Deputy Under Secretary of Defense (Environmental Technology): Identifies requirements, sets priorities, oversees demonstrated and validated technology and technology transfer to DoD users.

Assistant Deputy Under Secretary of Defense (Cleanup): Carries out an environmental restoration program at DoD facilities; guides DoD cleanup efforts, including cleanup and remediation of asbestos, lead-based paint, and radon at DoD installations.

Director (Environmental Quality-Compliance): Works on compliance with statutory and regulatory requirements for all environmental security functions.

Director *(Environmental Quality-Conservation):* Provides planning, management, protection, preservation, conservation (including energy), and impact analysis for air, land, and water resources for which DoD is steward or a user, including DoD construction, installation maintenance and repair, and installations operations and management.

Director (Environmental Quality-Pollution Prevention): Develops pollution prevention policy, establishes requirements, and monitors source reduction and other practices that reduce or eliminate the creation of pollutants.

SOURCE: Office of Technology Assessment, 1995: adapted from Information provided by DoD and information contained in U.S. General Accounting Office, New *Environmental Security Faces Barriers,* GAO/NSlAD-94-142 (Washington, DC: U.S. Government Printing Office, September 1994)

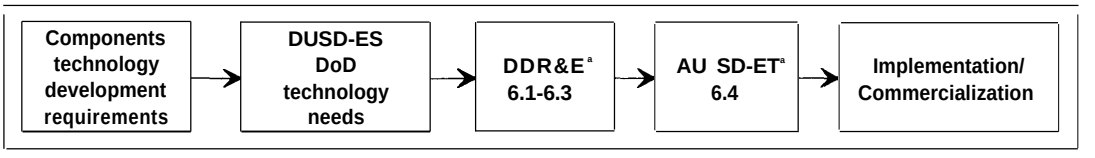
ORGANIZATION FOR ENVIRONMENTAL TECHNOLOGY

At the department level, environmental technology responsibilities are shared by the Deputy Under Secretary for Environmental Security (DUSD-ES) and the Director of Defense Research and Engineering (DDR&E). The DUSD-ES, a new position set up in early 1993, contains offices organized in five mission areas: cleanup, compliance, conservation, pollution prevention, and technology. (See box 4-1). The technology function is considered a crosscutting issue pertinent to the other four missions. A process has been developed to identify and set priorities for environmental technology among Defense users. The process is intended to focus environmental technology research, development, testing and evaluation (RDT&E) on top priority environmental requirements within DoD, and to provide a means to track progress in meeting those requirements.

As shown in figure 4-3, DDR&E oversees basic research, exploratory development, and advanced development (the so called 6.1, 6.2, and 6.3 activities). DUSD-ES is responsible for establishing user-based requirements, oversees demonstration and validation (6.4 activity), and the transfer of environmental technology.

A Defense Environmental Security Council and committee structure has been set up to assist the DUSD-ES. The Council participates in the Defense Performance Review, Secretary of Defense decisions on roles, missions, and functions, and base realignment and closure actions. Environmental matters in the military services are under the Assistant Secretary for Installations, Logistics, and Environment.

FIGURE 4-3: Environmental RDT&E Process Relationships



[a]In DoD budget terms, category 6 I refers to research into basic and applied sciences; 6.2 refers to exploratory development Of practical applications of the research; 6.3A refers to building of prototypes to demonstrate the principal of applications; 6.3B and 6.4 entail development of specific systems linked closely to procurement.

KEY: ADUSD-ET=Assistant Deputy Under Secretary of Defense for Environmental Technology, DDR&E=Director of Defense Research and Engineering; DUSD-ES=Deputy Undersecretary of Defense for Environmental Security.

SOURCE: Office of the Deputy Under Secretary of Defense for Environmental Security, Department of Defense, *DoD Environment/ Technology Requirements Strategy,* Washington, DC, Mar. 15, 1995.

The U.S. General Accounting Office (GAO) recently reviewed DoD's environmental security strategy[5] and its environmental security program. GAO anticipated some difficulties in overcoming several long-standing barriers, including: 1) limited cooperation between DoD and other agencies, 2) constraints in implementing environmental regulations, and 3) inconsistent environmental funding methods.

Priority Setting

DoD has developed a process to identify environmental technology needs to meet its overall goals of cleanup, compliance, conservation, and pollution prevention. A *DoD Environmental Technology Requirements Strategy*[6], issued in May 1995, discusses the process DoD is using to match technology investments with these DoD environmental priorities. The goals for technology research, development, testing and evaluation are identified under four broad environmental quality goals:

Cleanup technology: increase the effectiveness of cleanup efforts while "reducing the time and costs to assess, characterize, and treat DoD contaminants."

Compliance technology: support efforts to ensure that "all applicable environmental laws, rules, and regulations as put forth by appropriate regulatory entities are met." Examples include technologies for environmental monitoring, waste treatment, recycling and disposal, marine risk assessment, and environmental management.

Conservation technology: use new and innovative technology to decrease environmental risk and future environmental costs in use and management of cultural, biological, and natural resources under DoD's jurisdiction.

Pollution prevention technology: seek out cost-effective, in-process methodologies to meet long-term DoD environmental obligations. Examples include design of less polluting manufacturing or maintenance practices, substitutions, and use of life cycle assessments. DoD is placing increased emphasis on source reduction and other pollution prevention approaches, as discussed in box 4-2.

DoD is in the process of aligning environmental technology R&D with standard DoD acquisi-

[5]U.S. General Accounting Office, *New Environmental Security Strategy Faces Barriers.* GAO/NSIAD-94-142 (Washington, DC: U.S. General Accounting Office September 1994).

[6]Office of the Deputy Under Secretary of Defense for Environmental Security, U.S. Department of Defense, *DoD Environmental Technology Requirements Strategy,* Washington, DC, Mar. 15, 1995.

BOX 4-2: DoD Pollution Prevention Policy and Activities

in December 1993, DoD issued a policy statement committing the department to adherence with the 1990 Pollution Prevention Act (Public Law 101-508), as required of all federal agencies by Executive Order 12856. The 1990 Act establishes a preference for preventing or reducing pollution at the source when feasible, and sets up a hierarchy among other options (recycling, treatment and disposal in order of desirability).

DoD policy states that "the solution to long-term cleanup and compliance is the development and acquisition of environmentally sound defense systems. This is based on the belief that pollution prevention will limit the extensive cleanup and compliance costs and reduce risks to military and civilian personnel, the public, and the environment".

Pollution prevention activities are underway in a broad range of DoD areas, including acquisition and procurement practices, development of innovative technology, and through creation of better chemical management and accounting systems.

As mentioned, pollution prevention is one of four goals in DoD's environmental technology strategy. Some of DoD's technology goals for pollution prevention could have applications outside of DoD, including in industry, such as:

- Development of less-polluting and less-toxic methods for surface cleaning and decreasing of weapons systems, ships, aircraft, and components.
- Improving processes and developing new formulations to reduce hazardous materials and volatile organic compounds (VOCs) in painting and coating, stripping, and ordnance manufacturing and *use.*
- Development of safe and affordable alternatives to ozone-depleting substances used in climate control and refrigeration, solvents in manufacturing and maintenance operations, and firefighting agents for facilities, weapons systems, ships and aircraft.
- Reductions in DoD use of 17 **toxic** chemicals through use of alternative substances and processes;
- Development of predictive models to aid in environmental risk and life cycle cost assessments;
- Reduction in DoD's greenhouse gas emissions, and expansion of DoD's use of renewable energy sources and substitutes.

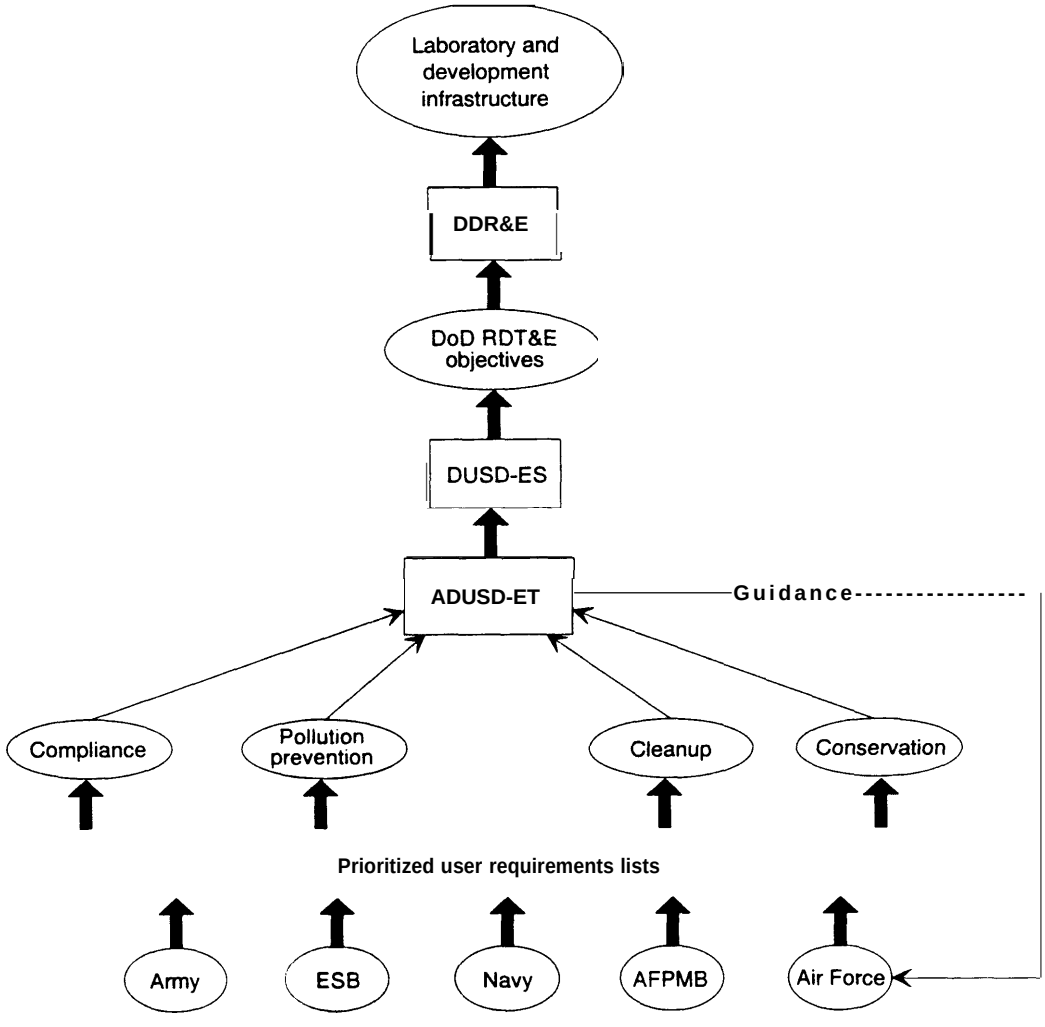
The status of DoD's pollution prevention efforts were recently reviewed by the U.S. General Accounting Office.[1] GAO **noted that** DoD has set up a DoD-wide system to obtain information on toxic chemicals; but the agency expressed uncertainty about whether DoD would meet the July 1995 deadline for this effort. It concluded that current information was inadequate to determine the extent to which toxic chemical use had been reduced. GAO noted that more research, development, testing, and evaluation would be needed to "identify potential substitute processes and materials. "It also noted that the military services believe that the estimate of $2 billion needed to meet pollution prevention needs from FY 1994 through FY 1999 could be underestimated.

SOURCE: Office of Technology Assessment, 1995.

[1]U.S. General Accounting Office, *Pollution Prevention: Status of DoD's Efforts,* GAO/NSIAD-95-13 (Washington, DC U.S. Government Printing Office, November 1994).

tion policy. In the past, unless installation commanders applied operation and maintenance funds for demonstration, testing, and evaluation, environmental technology developed in the laboratory often remained in the laboratory. This may change, in part because the DUSD-ES can support testing and evaluation of environmental technologies through the new Environmental Security Technology Certification Program (ESTCP), discussed below.

FIGURE 4-4: DoD Environmental Technology Planning Process Overview



KEY: ADUSD-ET=Assistant Deputy Under Secretary of Defense for Environmental Technology; AFPMB=Armed Forces Pest Management Board; DDR&E=Director of Defense Research and Engineering; DUSD-ES=Deputy Undersecretary of Defense for Environmental Technology; ESB= Explosives Safety Board.

SOURCE: Office of the Deputy Under Secretary of Defense for Environmental Security, Department of Defense, *DoD Environmental Technology Requirements Strategy,* Washington, DC, Mar 15 1995

Environmental problems of one sort or another occur at most Defense installations. Hence, effective dissemination of information about how to address these problems is critical. In many cases, effective techniques or technologies to address a problem may be available but not known by base commanders. In such cases, a potential exists for duplication of efforts or reliance on more expensive alternatives.

Figure 4-4 shows a simplified schematic of DoD's environmental technology planning process. Each of the services has its own process for identifying a user list of priorities for environmental technology R&D. The lists are analyzed and

prioritized by the office of the Assistant Deputy Under Secretary of Defense for Environmental Technology. The priority list then is used DUSD-ES and the Director of Defense Research and Engineering to match program funding with priority projects, as requested by users.

ENVIRONMENTAL SECURITY TECHNOLOGY CERTIFICATION PROGRAM

It is often difficult for innovative environmental technologies to gain acceptance. Reasons for this include uncertainty about the performance of the new technologies and reluctance of users to invest in approaches that may not pass muster with regulations. This new technology certification program is used to demonstrate and validate the performance of technologies that meet DoD priority needs for cleanup, compliance, and pollution prevention. The objective is to reduce the cost and risk to DoD of meeting its environmental obligations.

Candidate technologies can be federally developed or developed by the private sector. The demonstrations are conducted at DoD sites. The technologies are tested in operational settings to determine their suitability for DoD use in terms of regulatory requirements, end-user needs, and cost effectiveness. Twenty-four demonstrations were initiated in FY 1995. These technologies are expected to yield cost (and/or time) savings for DoD compared to current practice or conventional technology.

Information about ESTCP demonstrations will be publicly available. As a result, technologies that fare well in the certification program may gain broader acceptance elsewhere.

STRATEGIC ENVIRONMENTAL RESEARCH AND DEVELOPMENT PROGRAM

SERDP, set up by Congress in 1990 through Public Law 101-510, supports basic and applied research and development of technology to enhance DoD and Department of Energy (DOE) capabilities to meet their environmental obligations. The program also seeks to foster information and technology exchange among government agencies and the private sector, and to find more cost-effective ways to lower environmental risks through use of existing science and technology. About $154 million was spent on SERDP during FY 1994; the estimate for FY 1995 is $55 million.

The program is conducted by DoD, DOE, and Environmental Protection Agency, with participation by the National Ooceanic and Atmospheric Administration, the National Aeronautics and Space Administration, and some other agencies. Among other things, SERDP can be used to:

- Identify research, technologies, and other information developed by DoD and DOE for national defense purposes that would help government and private sectors in developing technologies for addressing environmental concerns.
- Share DoD and DOE research, technologies, and other information with government and private organizations.
- Furnish government and private organizations with data and enhance data collection and analytical capabilities for conducting environmental research, including global environmental change research.
- wdentify private sector technologies that are useful for DoD and DOE defense activities in addressing environmental requirements.

SERDP activities include global environmental change and energy conservation and renewable resources, as well as cleanup, compliance, conservation, and pollution prevention. Table 4-2 shows FY 1993 spending in each of these areas. Most of the SERDP funds are distributed to laboratories at DoD, EPA, and DOE, or other federal laboratories; over half of the funds are eventually expended by private industry or universities. Table 4-3 shows the distribution of these funds by agency.

TABLE 4-2: SERDP FY 1993 Funding Summary ($ millions)

	Congressional Interest	Project	FY 1993 Total
Installation restoration	3.5	32.0	35.5
Compliance	2.3	12.6	15.0
Conservation	0.8	8.1	8.9
Alternate/Clean Energy	0.0	8.1	8.1
Global environmental change	5.0	65.2	70.2
Pollution prevention	0.0	31.6	31.6
Undistributed reductions			10.2
FY 1993 Scientific Advisory Board and Council support			0.5
FY 1993 appropriation total			**180.0**

SOURCE: Strategic Environmental Research Development Program (SERDP), 1994 *Annual Report and five-Year (7994-7998) Strategic Investment Plan,* Arlington, VA, September 1994.

The DoD (Army, Navy, and Air Force) and EPA are cooperating (under SERDP sponsorship and funding) in the National Environmental Technology Demonstration Sites program to develop facilities for testing the performance of environmental technologies. About $19 million in SERDP funds have been committed since FY 1993 for the preparation of five demonstration sites at military installations. The objective of this effort is to permit side-by-side demonstrations and evaluations of innovative technologies under controlled conditions. Priority will be given to technologies developed through SERDP; but some of these sites may be used by ESTCP (described earlier) as well as other government and private sector technology developers.

TABLE 4-3: Distribution of SERDP Funds to Laboratories, FY 1993 ($ millions)

Department of Defense laboratories	
Army	29.7
Air Force	11.3
Navy	45.8
Department of Energy laboratories	17,4
Environmental Protection Agency laboratories	17.1
Other federal recipients	47.9

SOURCE. Strategic Environmental Research Development Program (SERDP), 1994 *Annual Report and Five-Year (1994-1998) Strategic Investment Plan,* Arlington, VA, September 1994

ARPA SUPPORT FOR ENVIRONMENTAL TECHNOLOGY AND ACTIVITIES

The DoD Advanced Research Projects Agency supports advanced basic and applied research and development projects, including prototype projects, pertinent to DoD missions. ARPA does not conduct this R&D itself, but arranges for the work to be performed at military or other government laboratories, by defense industry contractors, or at universities.

ARPA supported about $68 million in environmental technology research and development in FY 1994. This does not include sizable ARPA spending on fuel cell, battery, photovoltaics technologies, and some advanced manufacturing technologies that could have environmental quality benefits. Much of ARPA's environmental work is conducted in partnership with defense industry firms.

ARPA R&D in the pollution prevention area includes ongoing work to reduce the environmental impact of electronics manufacturing. Some of this is carried out through SEMATECH, an R&D consortium with the semiconductor industry, with the aim of reducing reliance on ozone depleting substances in the manufacture of semiconductor chips. ARPA also supports several R&D projects to develop environmentally preferable technolo-

gies for use in the printed wiring board industry, including both drop-in technologies, and breakthrough technologies.

Another pollution prevention thrust at ARPA involves development of environmentally preferable coating or curing technologies that would reduce the environmental impact of metal plating, finishing, and painting.

ARPA support for cleanup or compliance-related R&D includes work on plastics recycling and also hydrothermal oxidation processes as an alternative to incineration. ARPA plans to support in situ bioremediation R&D in FY 1996.

Some ARPA environmental technology activities are carried out through the Technology Reinvestment Program (TRP). TRP is a dual-use technology project managed by ARPA with the participation of several other agencies, including, DOE, NSF, NASA, the Department of Commerce and Department of Transportation. The program emphasizes defense relevant partnerships that involve cost-sharing between participants and the federal government. A major ARPA effort undertaken through TRP involves development of advanced environmental sensors that would permit on-site characterization of contaminants for cleanup and/or process monitoring. Such technologies could appreciably reduce cleanup costs. Several advanced manufacturing projects funded under TRP also could result in cleaner, more energy efficient manufacturing processes.