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Report to the Chairman, Committee on Governmental Affairs, U.S. Senate

April 1991

ENVIRONMENTAL PROTECTION

Solving NASA's Current Problems Requires Agencywide Emphasis

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GAO

United States
General Accounting Office
Washington, D.C. 20548

National Security and
International Affairs Division

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April 5, 1991

The Honorable John Glenn
Chairman, Committee on
Governmental Affairs
United States Senate

Dear Mr. Chairman:

We reviewed the National Aeronautics and Space Administration's (NASA) environmental protection program. Specifically, we determined the extent of NASA's known hazardous waste contamination and the effectiveness of the program's management.

Unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days after its issue date. At this time we will send copies to the NASA Administrator and appropriate congressional committees. We will also make copies available to others.

Please contact me on (202) 275-5140 if you or your staff have any questions concerning the report. The major contributors to this report are listed in appendix II.

Sincerely yours,

Mark E. Gebicke

Mark E. Gebicke
Director, NASA Issues

NASA has not adequately implemented its policy to prevent, control, and abate environmental pollution. NASA has delegated responsibility for implementing its environmental pollution policy to its centers without establishing an agencywide strategy and an effective monitoring and management system. Without an implementation strategy, the quality and success of the centers' programs vary considerably in terms of the level of emphasis placed on environmental issues and the staffing and financial resources committed to the programs. Similarly, without effective headquarters management, NASA is unaware of serious noncompliance problems, does not ensure that problems identified at one center are investigated at other centers with similar facilities, and does not ensure that centers perform periodic environmental compliance audits. Thus, program office and Facilities Engineering staff need to work together more closely to effectively monitor centers' activities.

Principal Findings

NASA Faces Many Environmental Problems, but Cleanup Cost Is Unknown

At the five centers GAO visited, the extent of contamination and regulatory noncompliance varied, as did the types of corrective actions being taken or planned. While some actions, such as upgrading of hazardous material storage areas, are relatively minor, others represent significant contamination cleanups. The worst problems are candidates for the EPA's Superfund list of sites considered to present the most serious threats to public health and the environment.

NASA has prioritized its projects to correct the most serious problems first. Where corrective action has been slow, however, state regulatory agencies have taken enforcement actions. For example, the Marshall Space Flight Center stored electroplating wastes in an industrial waste treatment basin and two lagoons. Because the Center failed to periodically sample and analyze the groundwater surrounding the site, Alabama environmental authorities issued a July 1990 order requiring Marshall to submit a groundwater assessment plan.

NASA plans to spend about $32 million to $50 million a year for the next 5 years to address environmental projects and activities. However, this cost covers only the projects funded from one appropriation. Environmental projects are also funded from other appropriations, at the center directors' discretion, which do not specifically identify those project

had been contaminated when mercury in the tunnel's pressure gauges spilled. Although the program office responsible for the research centers informed them about Lewis' problem, it did not require those centers to determine if they were similarly contaminated. The Ames Research Center, for instance, did not begin testing for mercury contamination until January 1991, because of other priorities and limited resources.

Environmental Audits: Current Problems and a Potential Solution

NASA requires environmental compliance audits at centers every 5 years. EPA believes that environmental auditing, if properly conducted, can improve a facility's compliance with environmental requirements. However, the Director, EPA Office of Federal Facility Enforcement, questioned the effectiveness of auditing only every 5 years and suggested intervals of no more than 3 years. Also, center environmental coordinators were concerned about the quality and attention to detail of contractors' audits, preferring contractor-supported audit teams that include NASA headquarters and center environmental experts.

Recommendations

GAO recommends that the NASA Administrator take the following actions:

- Develop an agencywide strategy, including center-based, measurable goals, on implementing the environmental pollution prevention, abatement, and control policy.
- Establish standards on center environmental staff levels and qualifications, organizational authority, and provide for mechanisms to identify funding requirements.
- Develop criteria and guidelines for center reporting of imminent or actual noncompliance with environmental regulations, new state and local regulatory requirements being proposed or issued, and other items as appropriate.
- Require that problems identified at one center be addressed at other centers with similar facilities or functions.
- Establish an environmental audit program to evaluate, at least every 3 years, the centers' regulatory compliance and management systems for ensuring compliance.

Agency Comments

As requested, GAO did not ask NASA to comment officially on a draft of this report. However, the views of responsible officials were sought during the course of GAO's work and are included in the report where appropriate.

Abbreviations

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DOD	Department of Defense
EPA	Environmental Protection Agency
GAO	General Accounting Office
NASA	National Aeronautics and Space Administration
PCB	polychlorinated biphenyl
RCRA	Resource Conservation and Recovery Act

of their responsibilities under RCRA. In particular, while NASA headquarters had emphasized RCRA to its field activities, three NASA facilities had violations because local officials had not understood RCRA's applicability to their operations, or because they lacked knowledge of RCRA requirements.

Organizational Structure and Responsibilities

NASA Management Instruction 8800.13 states that NASA's policy is to prevent, control, and abate environmental pollution in accordance with applicable laws and consistent with NASA statutory authority. To implement this policy, NASA assigned responsibilities to the headquarters Facilities Engineering Office, three headquarters program offices, and the nine centers. While the headquarters offices primarily provide oversight and coordination, the centers are responsible for the day-to-day compliance with NASA's environmental policy.

In 1985, the Facilities Engineering Office became the focal point for agencywide matters on environmental compliance and protection. In an August 1987 letter to headquarters program offices and the centers, the Facilities Engineering Office stated that its responsibilities included (1) coordinating funding for environmental studies, (2) preparing the environmental restoration fund budget submission, and (3) managing agencywide efforts to comply with significant environmental regulations. As environmental compliance requirements became stricter and regulatory agencies increased oversight, NASA created the Environmental Management Branch within Facilities Engineering. In June 1990, the Branch was established in an attempt to centralize the management of environmental activities and to increase the environmental program's visibility. Branch personnel provide expertise to the centers and program offices.

Also at headquarters, the program offices are responsible for the overall planning and direction of operations and resources at the centers. These offices exercise their oversight primarily through the budget process. Following are the program offices and the centers for which they are responsible:

- Office of Aeronautics and Exploration Technology
  - Ames Research Center
  - Langley Research Center
  - Lewis Research Center

reported in the Pollution Abatement Plans are funded from both headquarters and center funds. It should be noted that the plans are planning documents, not funding requests.

Objectives, Scope, and Methodology

We reviewed NASA's environmental protection program at the request of the Chairman, Senate Committee on Governmental Affairs. Our objectives were to (1) determine the extent of environmental problems confronting NASA and the corrective actions being taken or planned and (2) assess NASA's management of its environmental protection program.

We performed our work at NASA headquarters in Washington, D.C., and at the following five centers:

- Ames Research Center, Moffett Field, California;
- Goddard Space Flight Center's Wallops Flight Facility, Wallops Island, Virginia;
- Johnson Space Center, Houston, Texas;
- Marshall Space Flight Center, Huntsville, Alabama; and
- Lewis Research Center, Cleveland, Ohio.

These centers were judgmentally selected from NASA's nine centers to include at least one from each program office and to provide for geographic dispersion in our work. We limited the number of centers visited because at the time of our review, NASA's Inspector General was conducting environmental management audits at four centers.

To determine the extent of environmental problems, we interviewed officials from the Facilities Engineering Office, program offices, and selected centers and obtained documents, where possible, describing efforts to identify problems. With these individuals, we also discussed

- the centers' environmental compliance status,
- the cost of compliance and restoration projects, and
- existing headquarters and center organizational support for monitoring the actions of field environmental activities.

To gain an overall view of NASA's environmental protection program, we obtained the following from headquarters:

- management instructions, policies, and other guidance;

NASA Is Facing Various Environmental Problems and Unknown Cleanup Costs

Over the years, NASA has encountered various environmental problems, such as groundwater and soil contamination, and noncompliance with EPA, state, and local regulations. These problems, identified through internal and external assessments, have resulted in costly compliance and correction projects whose costs are shared by NASA headquarters and centers. NASA headquarters, for example, estimates it needs $32 million to $50 million a year over the next 5 years to address environmental projects and activities. However, this cost covers only the projects funded from the Construction of Facilities appropriation; it does not include projects funded from the centers' other appropriations. Furthermore, for many cleanup projects not yet approved, it is unclear what clean up will be done, and how much the clean up will cost until required studies are completed.

Origin of Environmental Problems

NASA and its contractors have traced current environmental problems to maintenance, industrial, and research processes and to practices of previous military owners of some NASA centers.

From 1985 to 1990, NASA contractors conducted numerous reviews required by CERCLA at NASA centers and satellite installations. These contractors found that NASA had contaminated its facilities, surrounding soil, and groundwater through spills, inadequate or improper storage and disposal of waste. EPA and state inspections, conducted during this period, found similar problems.

In some instances, contamination was caused by actions that were considered standard practices at the time. For example, EPA has ordered NASA's White Sands Test Facility to investigate the magnitude of freon and trichloroethylene contamination of the groundwater. According to an EPA project manager, White Sands stored wastewaters containing these substances in an unlined surface impoundment,[1] a practice considered normal at that time. Today, surface impoundments must be lined to prevent seepage.

NASA's assessments also found that some contamination had been caused by prior owners, especially military owners of NASA facilities. For example, the Santa Susana Field Laboratory (a Marshall Space Flight Center satellite installation located in Ventura County, California), the

[1] A natural topographic depression, man-made excavation, or diked area formed primarily of earthen materials, which is designed to hold an accumulation of liquid wastes. Examples include holding pits, ponds, and lagoons.

In some cases, the contaminated site may pose a sufficient hazard to human health and the environment to be a candidate for EPA's National Priority List of Superfund sites. CERCLA created the Superfund program, which is managed by EPA, to clean up the most dangerous abandoned hazardous waste sites and authorized EPA to compel responsible parties to clean up those sites. According to NASA officials, the following sites may be included in the Superfund list.

- Water supply wells in the vicinity of the Jet Propulsion Laboratory are contaminated with trichloroethylene and other solvents.
- A fire-training pit at the Wallops Flight Facility where waste fuel was discharged onto the ground, ignited, and then extinguished during training exercises.
- The Ames Research Center's Dryden Flight Research Facility, which is being evaluated because it is a tenant of Edwards Air Force Base, itself a Superfund site.

Appendix I provides further examples of environmental problems, potential corrective actions, and, where available, NASA's estimated costs.

Problems Requiring Regulatory Enforcement Action

If a facility does not promptly and properly correct environmental problems identified in warning letters and violation notices, EPA or state regulators may take enforcement action. Whether by an agreement or an order, the enforcement document requires the facility to take certain actions by specific dates to attain compliance. Of the centers we visited, the Wallops Flight Facility and the Marshall Space Flight Center were recently ordered to comply with environmental requirements.

Until 1989, the Marshall Space Flight Center stored electroplating wastes in an industrial waste treatment basin and two lagoons. Wastes from an industrial sewer and laboratory were also stored in the basin. The Center proposed closing the basin and lagoons in 1984 and, as part of the closure process, was required to sample the groundwater surrounding the site. The Alabama Department of Environmental Management requested that the Center periodically assess groundwater quality because of the concentration of hazardous waste and its components in the groundwater. Because the Center failed to obtain additional groundwater samples, in July 1990, the state ordered that the testing be conducted.

- NASA cannot rely on when other responsible parties will provide their share of cleanup costs;
- the time and methods needed to complete some complex projects, and the resulting cost, are difficult to estimate, and remedial investigation/feasibility studies and similar studies must be completed before costs can be accurately assessed; and
- environmental regulations can change at any time, which would require new or revised projects.

Environmental Program Costs Not Identified as Such

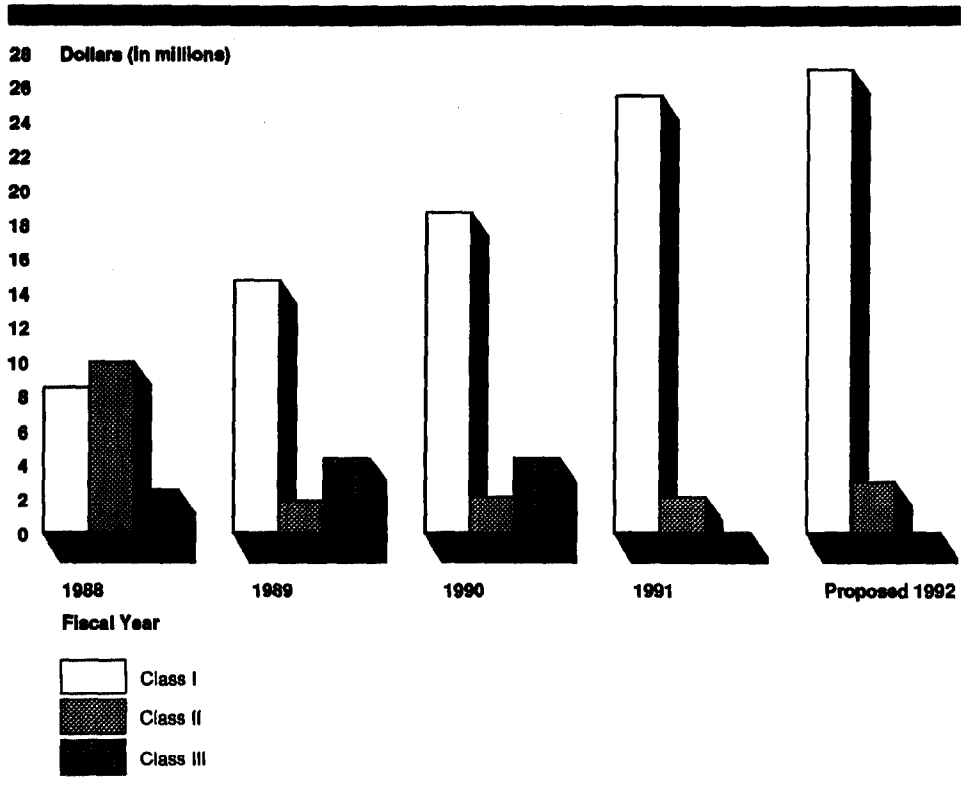
The centers fund projects from various appropriations, including Construction of Facilities, Research and Development, and Research and Program Management. In some cases, such programs as the space shuttle also fund environmental projects. NASA's budget submissions to the Congress identify amounts to be spent from the Construction of Facilities appropriation for environmental projects—first approved as a separate line-item in its fiscal year 1988 budget request. NASA budgeted $23.9 million for environmental projects for fiscal year 1988 and $32 million for fiscal year 1991, although these amounts do not include all the money spent agencywide to prevent, control, and abate environmental pollution. For fiscal years 1988-90, for example, NASA budgeted about $80 million from the Construction of Facilities appropriation account, while the total amount that NASA reported that it planned to spend in its Pollution Abatement Plan was $108 million. Projects funded from appropriations other than the Construction of Facilities account made up the difference.

Although the Pollution Abatement Plan provides a more complete picture of environmental project costs, it does not include all costs of the environmental program. According to NASA officials, some expenses not included are salaries of environmental staff, hazardous waste disposal cost, contract services for hazardous waste handling and laboratory analysis, and small projects that are completed quickly.

Sharing the Cost With Responsible Parties

NASA expects to receive some DOD funds for its share of contamination at some installations. However, NASA officials said they cannot rely on DOD contributions in the budget development process. DOD contributions to site cleanup costs are long-term negotiated items, with funds not immediately available for NASA's cleanup work. Because DOD must also go through a budget prioritization process, any DOD apportionment of costs will not necessarily be available for use when NASA must accomplish the work.

Figure 2.1: Construction of Facilities Budget for Environmental Projects by Class



Source: NASA

Space Flight Center when it was seeking someone to evaluate its environmental program.

At the Lewis Research Center, where a lack of management attention has caused costly environmental damage, recent improvements have been made. However, before 1989, senior management assigned a low priority to the environmental program. Staff were not trained to manage the environmental function and did not notify senior management of environmental concerns, including hazardous substance spills that were not immediately cleaned up. Additionally, the Center lacked adequate safeguards to prevent illegal dumping of hazardous wastes.

After the Center received negative media attention in 1989, senior managers took decisive steps to improve the environmental program. Managers reorganized the environmental function to provide greater authority and visibility, employed highly qualified individuals, and included environmental protection responsibilities in senior managers' performance plans. The Center also began periodic, unannounced visits to evaluate compliance with environmental regulations.

Insufficient Resources and Training at Some Centers

Some environmental offices, as discussed below, were not given sufficient management attention or resources to ensure effective performance of environmental responsibilities. As a result, environmental problems that could have been prevented or corrected may have occurred or continued.

Ames Research Center

The environmental coordinator at the Ames Research Center was the only full-time civil servant assigned environmental responsibilities. The coordinator served multiple roles: regulatory specialist, hazardous waste program manager, and chemical spill response coordinator. The coordinator told us that as a result of these many responsibilities, she had insufficient time to make compliance inspections of the Center's on-site hazardous waste generating activities and commercial off-site treatment, storage, and disposal facilities.

At the time of our visit, Ames was in violation of several county requirements relating to such matters as container management, labeling of hazardous wastes, training, and fire and spill control equipment. The environmental coordinator had issued letters to responsible managers to correct these deficiencies but, because of time constraints, had been unable to verify that the facilities had complied.

Marshall Space Flight Center

In 1988 and 1989, Marshall's Internal Control Office and a committee on environmental activities cited a need for more Center involvement in environmental management. The groups also identified the need for Center guidance and instructions on implementing aspects of the environmental program.

In May 1990, the Marshall director approved the establishment of an environmental office. At the time of our visit in July 1990, the Center employed two environmental engineers and by December 1990, hired two more. However, as of February 1991, the Center had not issued management instructions on an environmental management program, a waste minimization policy, and spill prevention procedures.

Furthermore, the Center's environmental coordinator told us that insufficient resources had hampered the office's ability to identify environmental problems. However, even when environmental problems were identified, the Center was slow to take action. For example, a 1989 EPA-sponsored assessment of previously unregulated releases to air, soil, and groundwater identified over 50 areas for which further action, such as testing for environmental damages, were suggested. According to the environmental coordinator, no action has been taken, except at one site, because the EPA assessment was in draft format. Only one of these potentially contaminated sites is included in the Center's 5-year pollution abatement plan, used to project future needs.

Comprehensive Headquarters Oversight Needed

Because of inadequate monitoring, NASA headquarters is not sufficiently informed to ensure that the centers comply with environmental laws and regulations. NASA Instruction 8800.13 requires headquarters program offices to ensure the overview and management of centers' implementation of NASA environmental requirements funded from non-Construction of Facilities sources. The instruction also requires that the Facilities Engineering Office ensure the overview and management of Construction of Facilities-funded environmental activities, with program offices' review. The instruction also requires Facilities Engineering to support and guide program offices and centers in interpreting NASA's environmental policy.

To improve monitoring, NASA needs a better and more comprehensive strategy for implementing its environmental policy than delegating environmental responsibility to centers without establishing specific and

Headquarters officials believe that program office and Facilities Engineering staff need to work together more closely to effectively monitor centers' activities. This is considered essential because program office staff, who can require centers to conduct specific activities, lack environmental expertise, while Facilities Engineering staff, who possess the expertise, lack the authority to ensure centers' compliance with policies and regulations.

Compliance Not Enforced by Headquarters Program Managers

Headquarters program managers often did not exercise their authority to enforce the centers' compliance with environmental regulations and headquarters directives. Although they shared information about environmental problems experienced among their centers, they did not ensure that the centers used this information to identify potential contamination or to better manage their environmental programs.

For example, in April 1989, the Lewis Research Center's Environmental Pollution Control Board was told that a wind tunnel had been contaminated when mercury in the tunnel's pressure gauges spilled. Although the program office responsible for the research centers that use such tunnels informed its centers about Lewis' problem, it did not require those centers to conduct a comprehensive center-wide mercury evaluation to determine if they were similarly contaminated. The Ames Research Center, for instance, did not begin testing for mercury contamination until January 1991, because of other priorities and limited resources.

In another case, the Facilities Engineering Office tried to minimize NASA's potential liability for cleaning up off-site commercial treatment, storage, and disposal facilities. The Office proposed in October 1988, and issued in September 1989, a policy requiring centers to annually audit all off-site facilities they use. However, one center visited did not conduct such audits and two centers only audited some facilities they use, even though their environmental coordinators believed that the audits were necessary. For example, in a January 1990 memo, a Goddard Space Flight Center official stated that the Center would not audit its off-site facilities because headquarters did not provide the necessary resources and because using available resources would dilute higher priority efforts. The responsible program offices took no actions to enforce compliance.

Conclusions

A lack of emphasis on environmental issues by some center directors and a lack of comprehensive oversight by headquarters has hampered implementation of NASA's policy on preventing, abating, and controlling environmental pollution. As a result, NASA may be permitting environmental problems to occur or continue at some centers, with the potential for additional cleanup costs.

Although some centers have improved their environmental programs in recent years, the quality and success of the programs vary considerably among centers. Several centers still lack adequate resources or trained personnel to carry out NASA's environmental policy.

Further, headquarters is not adequately overseeing and managing environmental activities to ensure that the centers

- comply with all relevant environmental laws and regulations;
- effectively use information about the problems encountered at other centers with similar facilities or functions; and
- conduct required inspections of off-site facilities used to treat, store, and dispose of hazardous wastes.

In addition, more frequent and more detailed environmental audits could assist the centers in identifying potential problems before they require cleanup or enforcement action.

Recommendations

We recommend that the NASA Administrator take the following actions:

- Develop an agencywide strategy, including center-based, measurable goals, on implementing the environmental pollution prevention, abatement, and control policy.
- Establish standards on center environmental staff levels, qualifications, and organizational authority, and provide for mechanisms to identify funding requirements.
- Develop criteria and guidelines for center reporting of imminent or actual noncompliance with environmental regulations, new state and local regulatory requirements being proposed or issued, and other items as appropriate.
- Require that problems identified at one center be addressed at other centers with similar facilities or functions.
- Establish an environmental audit program to evaluate, at least every 3 years, the centers' regulatory compliance and management systems

Goddard Space Flight Center

Goddard's Greenbelt, Maryland Facility

- Asbestos removal: Flaking asbestos must be removed from various buildings at an estimated cost of $650,000.
- Underground storage tanks: Underground storage tanks will be replaced with above-ground tanks, if possible, or with a Resource Conservation and Recovery Act (RCRA) underground storage tank system. The estimated cost is $1.3 million.

Goddard's Wallops Flight Facility, Wallops Island, Virginia

- Aviation storage tanks: Underground storage tanks built by the Navy in 1943 as a fueling station and storage area and later used by Wallops have petroleum-related groundwater contamination. The Center plans to take measures to protect nearby drinking water well fields at an estimated cost of $4 million.
- Scrapyard: In the 1970s, polychlorinated biphenyl (PCB) transformers, along with excess metal wastes and batteries, were dumped in a scrapyard. When testing the site, Wallops discovered that PCB-contaminated oil from the transformers had contaminated the soil. This project cost has not been determined.
- Sewage treatment plant contamination: During a December 1989 RCRA inspection, Virginia inspectors concluded that Wallops was operating a hazardous waste treatment, storage, and disposal facility without a permit. The facility discharged waste from the electroplating and etching operation to the sanitary sewer system. Thus, the state contends that this discharge contaminated the sewage treatment plant and wastewater treatment holding sites. The cleanup cost has not been determined.

Jet Propulsion Laboratory, Pasadena, California

- Cleanup of groundwater contamination: Previous sampling and testing of groundwater from City of Pasadena water supply wells in the vicinity of the Laboratory have confirmed the presence of trichloroethylene and other solvents in excess of federal and state standards. This project provides for the design and initiation of construction of a treatment facility to remove the volatile organic compounds from municipal water supplies. The estimated cost of this project is $4 million.
- Hazardous substance underground storage tanks: This project will provide funds for storage tank testing, soil testing, replacement of leaking

capping the landfill and installing a stormwater drainage system and monitoring system at an estimated cost of $7.6 million.

Langley Research Center, Hampton, Virginia

- Remediation of Tabbs Creek: The creek has polychlorinated terphenyl residues. This project will clean up these residues and possible PCBs as determined by a site study and risk analysis. The estimated cleanup cost is $4 million.
- Underground storage tank spill and leak prevention: Existing tanks do not conform to the leak detection specifications required by 1993. This project will provide corrosion protection, spillage, overfill prevention, and leak detection devices on underground storage tanks at an estimated cost of $2.5 million.
- Construction debris landfill: This project will provide clean up and remediation of an abandoned construction debris landfill, recently identified by a site inspection. Results were submitted to EPA and the State of Virginia, but EPA has not decided on the level of cleanup. The estimated cost is $1 million.

Lewis Research Center, Cleveland, Ohio

- Remediation of South 40 area: The Center is investigating if landfilling and storage of drums, batteries, and PCB transformers in this area have contaminated the soil and groundwater. Mercury contamination has already been confirmed and cleanup is estimated at $3.2 million.
- Underground storage tanks: This project will remove, replace, or protect, as necessary, 42 underground storage tanks at Lewis and the Plumbrook Station to meet federal, state, and local regulatory requirements. The estimated cleanup cost is $4.8 million.

Marshall Space Flight Center, Huntsville, Alabama

- Driller's mud disposal site: Significant quantities of sodium dichromate solution and barium sulfate-based driller's mud were discharged at this site. One assessment concluded that a high potential exists for release of contaminants to soils and groundwater. The Center plans to excavate 1,500 cubic yards of contaminated materials and then fill and cap the excavated area at an estimated cost of $1 million.
- Industrial waste treatment basin: The Center stored electroplating wastes in an industrial waste treatment basin and two lagoons. NASA proposed closing the basin and lagoons in September 1984, with a closure completion date set for August 1986. However, the Alabama Department of Environmental Management noted significant differences among groundwater samples from different wells. In September 1988, the state cited the Center for failure to obtain additional groundwater

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Executive Summary

Purpose

The National Aeronautics and Space Administration (NASA) produces tons of hazardous wastes annually through its scientific research and development and routine operations and maintenance activities. Improper management of these wastes may have caused and may continue to cause environmental pollution problems that must be corrected to prevent shutdown of some facilities by the Environmental Protection Agency (EPA) or state environmental authorities. Since 1988, NASA has planned to spend more than $100 million on projects and studies to comply with environmental requirements.

Concerned about the potential impact on the environment and the government's cleanup costs, the Chairman, Senate Committee on Governmental Affairs, asked GAO to

- determine the extent of environmental problems confronting NASA and the corrective actions being taken or planned and
- assess NASA's management of its environmental protection program.

Background

Several laws, as well as EPA, state, and local regulations, govern federal agencies' management and disposal of hazardous wastes and the cleanup of contamination. In accordance with these requirements, NASA's policy is to prevent, control, and abate environmental pollution.

To carry out its policy, NASA uses a decentralized management approach. Its nine center directors are responsible for day-to-day compliance with environmental laws. At the headquarters level, program offices are responsible for overseeing and ensuring the management of environmental protection actions at the centers they monitor, and the Facilities Engineering Office is the focal point for environmental compliance and protection matters.

Results in Brief

Through its internal assessments and inspections by environmental regulators, NASA identified various environmental problems at its centers, including leaking underground storage tanks, exposed asbestos, and mercury spills. These problems have been traced to maintenance, industrial, and research processes and to the practices of previous military owners of some NASA centers. To correct the problems and to comply with environmental regulations, NASA has undertaken or planned many costly projects. However, the total costs of these projects are unknown, partially because environmental costs are not always specifically identified in the budget. Also, for many contaminated sites, it is unclear what cleanup will be done until required studies are completed.

costs. In addition, NASA is uncertain whether the amounts it has budgeted for environmental projects will be sufficient because the scope of some complex projects is difficult to determine and because environmental requirements are becoming more stringent. However, NASA headquarters officials believe the budget requests represent the best assessment of funds needed to meet the most urgent requirements known or anticipated at the time the budget is prepared.

Centers' Emphasis on Environmental Issues Varies

Of the five centers visited, two gave environmental issues high priority and provided their environmental offices with sufficient resources to carry out NASA's policy. The other three centers' environmental offices lacked sufficient, adequately trained staff and resources to monitor operations and effectively carry out their responsibilities.

For example, the environmental coordinator at the Ames Research Center was the only full-time civil servant assigned environmental responsibilities. The coordinator served as a regulatory specialist, hazardous waste program manager, and chemical spill response coordinator. Thus, she did not have the time to inspect commercial off-site treatment, storage, and disposal facilities used by the Center. NASA requires these inspections to limit the agency's potential liability.

Some centers were aware of deficiencies in their environmental programs and had recently made improvements. For example, the Wallops Flight Facility, associated with the Goddard Space Flight Center, created an environmental office in 1990 and hired additional staff.

Headquarters Oversight and Management Need to Be Strengthened

Although headquarters is to ensure that the centers carry out their environmental responsibilities, it was at times unaware of problems experienced by the centers and did not exercise its authority to require the centers to conduct needed environmental activities. Program office staff, who can require centers to conduct specific activities, lack environmental expertise, while Facilities Engineering staff, who possess the expertise, lack the authority to ensure centers' compliance with policies and regulations.

Headquarters program managers shared some information about environmental problems experienced among their centers, but they did not ensure that the centers used this information to identify potential contamination. For example, in April 1989, the Lewis Research Center's Environmental Pollution Control Board was told that its wind tunnel

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Introduction

In carrying out its scientific research and development mission, the National Aeronautics and Space Administration (NASA) generates, stores, and disposes of tons of hazardous wastes, such as solvents, acids, and heavy metals (e.g., mercury). Exposure to some of these wastes in large doses can pose immediate health threats, long-term illness, or even death. When no longer needed, these wastes are treated, stored, or disposed of—often at commercial off-site facilities. NASA must ensure that its facilities comply with environmental requirements or face possible shutdown by Environmental Protection Agency (EPA) or state environmental authorities.

While NASA headquarters is responsible for overseeing facilities, its nine centers manage and control their own activities, including environmental protection, within broad NASA directives and budgetary guidelines and constraints. These centers have different missions, such as developing space-based shuttle payloads and space shuttle launches and providing aeronautical and aerospace testing capabilities.

Federal Agency Environmental Requirements

To regulate the management and disposal of hazardous wastes and the cleanup of contamination, the Congress has passed several major environmental statutes, such as the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Federal facilities are subject not only to federal but also to state and local environmental standards. In addition, Executive Order 12088, dated October 13, 1978, requires the heads of executive agencies to ensure that all necessary actions are taken to prevent, control, and abate environmental pollution at facilities under their control.

Prior GAO Reports on NASA's Compliance With Environmental Regulations

In previous reports,[1] we assessed civilian agencies', including NASA's, compliance with RCRA and CERCLA requirements. In 1984, we reported that NASA was unaware of a CERCLA requirement to notify EPA of facilities where hazardous substances had been stored, treated, or disposed of. In 1987, we reported that NASA had physically inspected its facilities to locate hazardous waste sites and, as of September 1986, regarded its site discovery efforts as complete. Another report in 1986 found that federal agencies had been slow in developing an awareness and understanding

[1]Status of Civilian Federal Agencies' Efforts to Address Hazardous Waste Problems on Their Lands (GAO/RCED-84-188,Sept. 28, 1984); Superfund: Civilian Federal Agencies Slow to Clean Up Hazardous Waste (GAO/RCED-87-153, July 24, 1987); and Hazardous Waste: Federal Civil Agencies Slow to Comply With Regulatory Requirements (GAO/RCED-86-76, May 6, 1986).

- Office of Space Science and Applications
  - Goddard Space Flight Center
  - Jet Propulsion Laboratory
- Office of Space Flight
  - Johnson Space Center
  - Kennedy Space Center
  - Marshall Space Flight Center
  - Stennis Space Center

Center directors are responsible for implementing NASA's environmental policy. They therefore must plan, design, construct, manage, operate, and maintain facilities according to applicable environmental regulations and provide timely responses and appropriate remedial actions to address environmental compliance requirements. The directors execute the agency's technical and administrative programs within budgetary guidelines and generally allocate budgeted resources among various center functions as they deem appropriate.

Funding for Environmental Projects

NASA environmental projects are funded from various appropriations that do not specifically identify the funds allocated to those projects. However, NASA's budget submissions to the Congress set forth amounts to be allocated from the Construction of Facilities appropriation for environmental compliance and restoration project funding. Headquarters allocates funds from the Construction of Facilities appropriation account to the centers for specific environmental projects. At the center directors' discretion, funds from other appropriations may also be used for environmental projects. The centers' appropriations therefore do not pinpoint the costs of environmental projects.

Another source for identifying the potential cost of environmental projects is through NASA's Pollution Abatement Plans. Federal agencies prepare these plans for the Office of Management and Budget to ensure their continuing compliance with new regulatory requirements or to correct problems or violations identified by EPA or the states. At NASA, each center reports to the Facilities Engineering Office the environmental projects that it plans to undertake for the next 5 years. The Office then submits the agency's overall plan and estimated costs to the Office of Management and Budget through EPA. If approved, NASA projects

- NASA's 5-year Pollution Abatement Plans for its centers and satellite installations and budget submissions for the Construction of Facilities appropriation; and
- environmental audits, preliminary assessments, and site inspections.

Additionally, at the program offices, we reviewed correspondence files to determine problems experienced by the centers and satellite installations that we did not visit. We also determined how the program offices prioritize environmental projects and how they monitor and manage operations at the centers they oversee.

To determine the status of environmental activities at the centers, we reviewed studies, budget data, inspection files, and management instructions and guidance. We also toured the facilities to observe hazardous waste-generating activities and storage areas, as well as contaminated sites. However, our work at the Lewis Research Center, whose Office of Inspector General was in the process of reviewing its environmental management program, consisted of a briefing by center management on environmental problems and the corrective actions taken, and a tour of the facility.

We also interviewed EPA officials to discuss federal facility requirements and the relative status of NASA's environmental activities compared with those of other federal agencies.

We conducted our work from July 1990 to February 1991 in accordance with generally accepted government auditing standards. We discussed our findings with NASA officials and incorporated their comments where appropriate. As requested, however, we did not obtain official comments on this report.

Jet Propulsion Laboratory, and the Wallops Flight Facility, all formerly owned by the Department of Defense (DOD), are experiencing groundwater contamination that appears to have resulted from activities conducted under DOD ownership. Given that DOD is one of the federal government's most serious polluters[2] and that 5 NASA centers and 10 satellite installations have been previously owned by DOD or have had tenant relationships with DOD, further pollution attributable to DOD may still be found on NASA property.

Types and Extent of Environmental Problems

While the extent of contamination and regulatory noncompliance varied among the centers visited, all had problems and had taken or planned corrective actions. Some of these actions are needed to meet regulatory deadlines, and others are needed to clean up contamination that poses significant risk to human health and the environment. NASA has set priorities according to such risks and is correcting its most serious problems first. Where corrective action has been slow, however, state regulatory agencies have taken enforcement actions.

Environmental Project Priorities

Environmental projects are scheduled for implementation according to a three-tiered classification defined by EPA. The highest priority, Class I, includes projects for facilities that are out of regulatory compliance. Class II projects are needed at facilities that are not yet out of compliance but need to meet an upcoming compliance deadline. Class III projects include those which are needed and are important to environmental quality, but are not directly related to a compliance issue. Following are examples of environmental projects, by class, submitted by some of the centers:

- Class I: Storm drains flowing into San Francisco Bay have contaminated the bay with toxins, and wildlife has died in the marshlands. The Ames Research Center plans to install an oil/water separation system to remove toxins from the storm drains.
- Class II: The Marshall Space Flight Center has planned a multiyear program to replace 44 underground tanks used to store petroleum products and hazardous substances. Regulations require all such tanks to meet new standards.
- Class III: The Johnson Space Center repaired its underground sewer system to prevent leaks.

[2]Federal Liabilities Under Hazardous Waste Laws, Congressional Budget Office, May 1990.

Similarly, in August 1989, the Virginia Department of Waste Management ordered the Wallops Flight Facility to (1) comply with state regulations when shipping hazardous wastes and (2) develop a contingency plan, a waste analysis plan, and a written inspection schedule. However, a December 1989 state inspection, which cited 41 violations,[3] found that Wallops was still not complying with various hazardous waste management regulations and had not developed a detailed contingency plan. Furthermore, the state cited Wallops for disposing of hazardous electroplating and etching wastes improperly and without a permit at an on-site location. Wallops environmental staff told us they had not acquired the necessary permit because they were unaware that the wastewater from the operation was considered hazardous.

State environmental authorities considered these violations of such a serious nature that they referred the matter to the state Environmental Enforcement Section. According to a headquarters program office manager, the sewage treatment plant that receives electroplating and etching wastewaters was subject to closure as an illegal operation. According to the Chief of the Enforcement Section, as of February 1991, state and Wallops officials were still negotiating actions Wallops must take to correct these violations.

Potential NASA Responsibility for Problems at Off-Site Waste Facilities

Because agencies retain liability for their wastes regardless of where they are disposed, NASA may be liable for cleanup costs at commercial waste disposal facilities it has used. EPA had inquired about all five centers' transactions with contaminated commercial sites. In one case, EPA linked NASA to a low-level radioactive disposal site, Maxey Flats in Morehead, Kentucky. Of 652 potentially responsible parties, NASA was ranked as the 18th largest waste contributor, accounting for 1.3 percent of the wastes.

Cost of Compliance and Restoration Activities

The total cost of NASA's compliance and restoration activities is unknown partially because funds for environmental projects, activities, and staffing are not fully identified in the budget or in NASA's Pollution Abatement Plans. Also, NASA does not know whether the amounts it has budgeted to clean up identified problems will be sufficient because

[3]The state issued violations to Wallop's main base and island complex separately, because it considered them separate facilities requiring different hazardous waste generator identification numbers. Thus, several of the violations were repeated.

To date, DOD has not transferred funds to NASA for its share of cleanup costs at any NASA facility. However, according to a NASA headquarters official, the Army's Corps of Engineers installed some wells at the Jet Propulsion Laboratory to monitor groundwater and provide background data in support of an on-going investigation.

Estimating Future Costs

NASA does not know how much future cleanups will cost for those environmental problems it has already identified. For some projects, such as upgrading hazardous material storage areas, the costs can be accurately estimated because the scope can be easily defined and the work can be completed within a short period. For complex projects, however, the scope and corrective actions depend on results of remedial investigations and feasibility studies, making it difficult to predict how long cleanup will take and what it will cost.

In its Pollution Abatement Plan, NASA has reported about $34 million and $50 million, respectively for fiscal years 1991 and 1992 environmental projects. Also, NASA headquarters estimates it needs $32 to $50 million annually in its Construction of Facilities budget request over the next 5 years to address environmental projects and activities, but it is uncertain whether this is sufficient. NASA headquarters officials believe the budget requests represent the best assessment of funds needed to meet the most urgent requirements known or anticipated at the time the budget is prepared. However, headquarters and center officials believe that the cost of planned and future compliance and restoration projects will increase because of stricter environmental requirements, such as those restricting the land disposal of hazardous waste.[4] Also, some planned projects that have not yet received EPA or state approval may have to be revised as new regulations are issued.

With the passage of stricter regulatory requirements, the approach of regulatory deadlines, and the approval of cleanup plans, the number of class I projects is expected to increase. Since fiscal year 1988, the Construction of Facilities account for class I projects has steadily increased from $8.5 million to a proposed $27 million in fiscal year 1992. In contrast, funding for class II and III projects decreased from fiscal year 1988 to 1991, with no funding proposed for class III projects in fiscal years 1991 and 1992. (See fig. 2.1.)

[4]The Hazardous and Solid Waste Amendments of 1984 prohibit the continued land disposal of hazardous wastes beyond specified dates unless such wastes are granted variances or are treated to meet EPA standards. Land disposal includes any placement of hazardous wastes in, for example, surface impoundments, landfills, waste piles, and injection wells.

Oversight and Management of Environmental Programs Should Be Strengthened

A lack of emphasis on environmental issues by some center directors and a lack of comprehensive guidance and oversight by NASA headquarters may have contributed to some of the centers' environmental problems discussed in chapter 2. Centers generally focused on cleaning up identified environmental damage rather than preventing and controlling future pollution and the resulting cleanup costs. Although some centers have recently improved their environmental management programs, more needs to be done to ensure that centers carry out NASA's policy to prevent, abate, and control environmental pollution.

Centers' Emphasis on Environmental Programs Is Sometimes Inadequate

NASA Instruction 8800.13 requires center directors to

- prevent, control, and abate environmental pollution at their centers;
- report progress to headquarters in meeting the objectives of centers' Pollution Abatement Plans;
- establish an environmental oversight coordinator with responsibility for prevention, control, and abatement of environmental pollution; and
- establish and maintain internal environmental compliance controls.

However, due to inadequate management emphasis, the environmental organizations at some centers lacked adequate resources, including trained specialists, to monitor operations and effectively carry out their programs. The environmental programs at other centers were more successful, due to either management commitment or recent improvements made as a result of negative publicity.

Management Attention Noted at Some Centers

The Johnson Space Center has made a strong commitment to environmental protection. The Center director established an environmental office in 1985 and has staffed it with four environmental experts with regulatory experience, each with a different area of responsibility, such as hazardous waste. Environmental compliance has received top management attention, including development of instructions on waste disposal, spill prevention and response, and waste minimization. At the time of our visit, the Johnson Space Center had no outstanding violations and only one contaminated site, which it was cleaning up. It was also pursuing an aggressive waste minimization program, as certified by an independent contractor.

NASA's Facilities Engineering Office considers Johnson's environmental program to be one of the agency's best managed. For example, the Office recommended Johnson's environmental coordinator to the Goddard

The environmental coordinator also said she was unable to ensure that sound environmental procedures were practiced at the off-site facilities the Center uses due to limited resources. NASA requires off-site facility inspections to limit the agency's potential liability for cleanup of such facilities. Ames' current environmental support contractor disposes of the vast majority of the center's wastes at its own treatment, storage, and disposal facilities. Therefore, it may not be reasonable to rely on the support contractor to inspect its own facilities.

Goddard Space Flight Center

Goddard's environmental office, responsible for both Goddard's Greenbelt, Maryland, and Wallops Island facilities, was headed by an experienced environmental coordinator. The two additional employees, however, had received little training in environmental requirements. One employee, stationed at Wallops, was trained as a safety engineer, and the other, stationed at Greenbelt, was trained as a fire protection specialist.

At the time of our visit, the Wallops Flight Facility was not complying with various environmental regulations and was facing potentially significant cleanups. As previously discussed, the Virginia Department of Waste Management ordered Wallops to comply with hazardous waste and other regulations. The order also required Wallops to identify staff positions involved in hazardous waste management, develop a written job description for each position, develop a training program for these positions, and submit documentation that training had occurred.

Additional management and compliance problems were found when the Johnson Space Center's environmental coordinator evaluated the Wallops environmental program in March 1990. This evaluation, made at the request of the Goddard Space Flight Center, concluded that Wallops' environmental program was not effectively organized, lacked management directives, and was not in compliance with some basic waste storage and disposal environmental requirements. Of the nine recommendations made by Johnson's environmental coordinator, Wallops agreed with eight and by February 1991 had taken action on seven.

Recent improvements have been made at Goddard. Recognizing that its environmental program needed restructuring and was understaffed, in 1990 the Goddard Center director established an environmental office. That same year, the Center hired an experienced environmental engineer for the Greenbelt facility. Also, at the time of our visit, Wallops was in the process of hiring another environmental engineer.

measurable environmental goals and methods to review the accomplishment of such goals. For example, such a strategy could include specific objectives and goals for each center to

- reduce the amounts of hazardous waste generated through waste minimization, resource recovery, and recycling programs, and
- conduct training activities to ensure that appropriate personnel are proficient in their responsibilities.

Ineffective Headquarters Monitoring

Although headquarters is to ensure that the centers carry out their environmental responsibilities, it has an ineffective system for monitoring the centers' environmental programs. Moreover, monitoring and supporting centers' environmental programs is only one task that headquarters program offices and Facilities Engineering must do. Thus, headquarters was unable to devote much time to monitoring centers' compliance with environmental policies and regulations.

According to the Chief of the Facilities Engineering Office, Environmental Management Branch, headquarters relies on the centers to properly report their environmental problems and does not have a mechanism to ensure that the centers do so. For example, the Assistant Associate Administrator for Facilities Engineering was surprised to learn on August 31, 1989, that the Ames Research Center was expected to sign an EPA order by September 11, 1989, for its contribution to contamination at a Superfund site. Because his office was unaware that negotiations between EPA and other parties had reached this advanced stage and had not been notified of the resulting funding requirements, no funds for this project had been budgeted for fiscal years 1990 or 1991.

To avoid further problems, in June 1990 the Facilities Engineering Office requested that centers inform the Office whenever an environmental regulatory agency issues a violation or begins an enforcement action. EPA recently began sending to the Office a list of NASA facilities that had been issued an EPA or state violation or enforcement action. However, the Chief of the Environmental Management Branch said that this additional information does not guarantee complete, prompt disclosure of the centers' problems because problems could surface after an EPA or state inspection and because the EPA list excludes local inspection results.

Environmental Audits: Current Problems and a Potential Solution

NASA requires environmental compliance audits at centers every 5 years, and it is currently planning its second round of audits. EPA believes that environmental auditing, if properly conducted, can improve a facility's compliance with environmental requirements. However, questions have been raised about the infrequency and quality of the NASA contractor audits.

The Director, EPA Office of Federal Facility Enforcement, said that although EPA did not formally require environmental audits or suggest the frequency of such audits, conducting audits every 5 years was too infrequent to serve as an effective management tool. The Director suggested that NASA audit its large centers every 2 years and its smaller centers every 2 or 3 years. As another option, the U.S. Navy has established a flexible auditing policy that requires more frequent audits where managers believe greater environmental risks exist. Navy policy requires audits no later than 6 months after an activity has been cited for significant environmental violations.

In addition, three of four environmental coordinators we interviewed questioned the quality and attention to detail of contractors' environmental audits. Common criticisms were that contractors reported only what center officials told them and that contractors failed to identify significant compliance problems, such as the need for permits required by federal, state, and local regulatory agencies. Most coordinators agreed that a more successful approach would be to establish contractor-supported audit teams of NASA headquarters and center environmental experts who are more familiar with NASA operations. A successful precedent to this approach was demonstrated in March 1990, when the Johnson Space Center environmental coordinator evaluated the Wallops Flight Facility's program at the request of Goddard Space Flight Center management.

A common concern of headquarters and center officials was that environmental compliance problems discovered through environmental audits might lead to the demands that problems be immediately corrected without due regard to other concerns, costs, or budget priorities. For its part, EPA has taken steps to encourage environmental auditing in light of these concerns. It has pledged its assistance in finding cost-effective solutions to agency environmental problems and has stated that it will refrain from routinely requesting internal audit reports.

for ensuring compliance. Audits should be conducted by headquarters and field officials and supported by contractors.

Examples of Environmental Problems

This appendix presents examples of environmental problems identified and potential corrective actions for the National Aeronautics and Space Administration's (NASA) nine centers and some of the centers' satellite installations. NASA's estimated costs for the projects are included where available.

Ames Research Center, Moffett Field, California

- Superfund site: The Environmental Protection Agency (EPA) identified the Center as contributing to a contaminated groundwater plume flowing north to the San Francisco Bay under the Center. EPA directed the Center to negotiate a joint responsibility agreement with the companies primarily responsible for the Superfund site, because petroleum from the Center's leaking underground storage tanks will eventually join the plume. The Center's estimated cleanup cost is $1 million.
- Underground air storage facility: The Center has an abandoned underground air storage facility, made up of 50 storage tanks, which previously stored highly pressurized air used in wind tunnel testing. These tanks extend approximately 1,200 feet into the ground and penetrate four aquifers. While the deeper aquifer is a source of drinking water for the Bay area, the shallow aquifers are contaminated with petroleum products and solvents. One of these high pressure tanks has ruptured and caused groundwater to spurt from the deeper aquifer to the surface. The Center fears that ruptured tanks may eventually provide conduits between the aquifers and contaminate the drinking water supply. The Center plans to keep the aquifers separated by permanently sealing the air tanks. The estimated cost is $1.3 million, but because the Center is unsure whether the proposed method will work, it has reserved an additional $560,000 for an alternate method.
- Aircraft ramp: The soil and groundwater north of the aircraft ramp are contaminated with solvents and fuel components. The Center plans to excavate contaminated soil or treat it, at an estimated cost of $1.2 million.
- Storm drain compliance: Storm drains flowing into the San Francisco Bay have contaminated the bay with toxins and wildlife has died in the marshlands. To comply with state and local laws, the Center plans to spend about $1.7 million to enhance wastewater treatment by installing an oil/water separation system, connecting drains and overflow lines to the sanitary sewer system, and relocating the existing main storm drain channel.

tanks, installation of monitoring systems, tank removal, and excavation and disposal of contaminated soil. The estimated cost is $2.5 million.

Johnson Space Center, Houston, Texas

- Thermochemical test area: The Center's monitoring wells have detected freon contamination in the subsurface of this area, requiring cleanup. Additionally, a 1990 state inspection identified concerns with the Center's system for collecting stormwater/process water from the test area. As a result, the Center plans to assess the contamination, remediate the area, and install an above-ground tank system to collect potentially contaminated runoff. The total estimated cost for these projects is $2.9 million.

Johnson's NASA Industrial Plant, Downey, California

- Chemical storage building: Hazardous chemicals that support shuttle production are stored throughout the facility in storage areas that do not meet Occupational Safety and Health Administration or 1988 fire codes or military temperature and humidity control specifications. The planned project will construct a centrally controlled storage building to comply with these specifications at an estimated cost of $505,000.

Johnson's White Sands Test Facility, Las Cruces, New Mexico

- Fuel scrubber and oxidizer fume exhaust systems: This project is required to comply with RCRA, the Clean Air Act, and Occupational Safety and Health Administration regulations. The estimated cost to replace overloaded and wornout equipment is $1.1 million.
- Groundwater and soil contamination: EPA ordered White Sands to assess the extent of contamination and associated public health risks resulting from improper releases of freon and trichloroethylene. The estimated cost is $33.1 million, including $18.1 million for the assessment and $15 million for corrective actions, if necessary.

Kennedy Space Center, Florida

- Flight crew rescue training area: A survey identified contaminated groundwater consisting of several volatile organic compounds, including trichloroethylene. A study will further define the level and extent of contamination, as required by Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), at an estimated cost of $550,000.
- Schwartz Road landfill: As of November 1989, the landfill was projected to have another 2 years of capacity. If the landfill is not expanded, it will have to be closed to comply with federal regulations. This involves

samples from downgradient wells, where a significant difference occurred. In July 1990, the state ordered the Center to submit a comprehensive groundwater quality assessment plan. The estimated cost for this plan has not yet been determined.

Marshall's Santa Susana Field Laboratory, Ventura County, California

- Groundwater contamination: NASA used this facility to test rocket engines, and waste fuel residuals from the engines contaminated the groundwater with trichloroethylene. This project will define and design treatment strategies and treat groundwater to meet a federal and state compliance schedule. The estimated cost of the project is $30 million.
- Container storage area: The current facility is undersized, uncovered, and cannot properly segregate wastes by characteristics. This project to expand and upgrade the storage facilities will ensure RCRA compliance and reduce the generation of hazardous waste. EPA has issued a noncompliance warning letter. The estimated project cost is $360,000.

Stennis Space Center, Mississippi

- Hazardous material handling facility: Present facilities are inadequate for future growth. A new facility will be designed for handling the increased quantities of hazardous materials. The estimated cost is $310,000.

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