

THE WHITE HOUSE

WASHINGTON

July 27, 1994

MEMORANDUM FOR THE NATIONAL SCIENCE AND TECHNOLOGY COUNCIL

FROM: JOHN H. GIBBONS 
ASSISTANT TO THE PRESIDENT FOR SCIENCE AND TECHNOLOGY

SUBJECT: NATIONAL SCIENCE AND TECHNOLOGY COUNCIL (NSTC) QUARTERLY
STATUS REPORT (2ND QUARTER CY 1994)

I am pleased to provide you with a status report on the activities of the National Science and Technology Council (NSTC).

NSTC Meeting

On June 29, President Clinton convened the inaugural meeting of the NSTC. With the Vice President, members of his Cabinet, agency heads, and senior White House officials, the President reviewed the Administration's overall science and technology policy goals and the role of the NSTC in achieving those goals, as well as discussion of specific high priority science and technology (S&T) initiatives. A summary of the meeting proceedings is attached (Attachment 1).

There were several actions assigned during the meeting. First, to develop a set of S&T talking points and themes for NSTC members to convey this new approach in S&T policy and administration to the American public in various venues (speeches, testimony, editorial board meetings, etc.). I will convene a small group in August to develop a draft strategy and talking points that we will share with the full NSTC for review and comment. Second, to identify a mechanism to share key speeches of the NSTC members with the membership as a whole. I have asked Ms. Angela Phillips Diaz, NSTC Executive Secretary, to work with your office to serve as the central repository and distributor of these speeches for the NSTC. Third, to investigate the possibility of establishing an NSTC Internet connection to facilitate communication among the Council members. We have been working with your offices to establish an NSTC link on the Internet as part of the OSTP NPR information highway test bed project. We will keep you informed as this initiative progresses and welcome any additional thoughts or suggestions.

NSTC Membership

On May 16, President Clinton designated the Director of Central Intelligence and the Director of the National Institutes of Health as members of the NSTC. This brings the total NSTC membership to 23.

NSTC Presidential Decision Directives

On May 10, the White House announced two Clinton Administration decisions which were the direct result of NSTC deliberations. First, the decision to converge into a single national system the planned polar-orbiting environmental satellite systems of the Department of Defense and the Department of Commerce's National Oceanic and Atmospheric Administration with participation by the National Aeronautics and Space Administration. This decision implements a recommendation contained in the National Performance Review. And second, the Presidential decision to continue the Landsat remote sensing satellite program and to restructure Federal agency responsibilities for acquiring and operating the next satellite, Landsat-7. This decision insures the continuity and

availability of Landsat-type data which serves a broad range of users in the U.S. and abroad, including the agricultural community, global change researchers, state and local governments, commercial users, and the military.

NSTC Presidential Review Directive

The NSTC is conducting an interagency review of the Federal government's three largest laboratory systems – Defense, Energy, and NASA. The purpose of the review is to evaluate and develop recommendations for ways to improve the efficiency and effectiveness of the Federal R&D investment in these laboratory systems. The overall charge, areas to be considered in the review, and issues for consideration are outlined in NSTC PRD-1 dated May 5. (Attachment 2) The NSTC interagency working group is responsible for preparing an interim report by September 15 which provides options/recommendations on issues that need to be resolved in time to affect the FY 1996 budget.

NSTC Deputies Decisions

On June 27, an NSTC Deputies group discussed the NSTC PDD on National Space Transportation Policy. This directive establishes national policy, guidelines, and implementing actions for the conduct of national space transportation programs that will sustain and revitalize U.S. space transportation capabilities. The PDD has been transmitted to the NSTC principals for agency concurrence.

NSTC FY 1996 R&D Priorities

On May 12, Leon Panetta and I issued a budget guidance memo to heads of agencies and departments that highlights important FY 1996 R&D policies, goals, priorities, and evaluation criteria that were developed through the NSTC process. This reflects an unprecedented approach to providing strategic guidance for the Federal S&T enterprise.

NSTC Publications

- *Our Changing Planet: The U.S. Global Change Research Program* April 1994
- *HPCC FY 1995 Implementation Plan* April 1994
- *High Performance Computing and Communications: Technology for the National Information Infrastructure* April 1994

Upcoming NSTC Committee Sponsored Forums

- Transportation October 1994
- Health, Safety, and Food November 1994

President's Committee of Advisors for Science and Technology (PCAST)

With the vetting process nearly complete, the formal announcement of the PCAST membership is anticipated for early August.

ATTACHMENT

NATIONAL SCIENCE AND TECHNOLOGY COUNCIL JUNE 29, 1994

Meeting Summary

The first meeting of the National Science and Technology Council (NSTC) was chaired by the President with representation from all NSTC members. (Attachment 1)

In his opening remarks, the President charged the NSTC with responsibility for establishing clear national goals for Federal science and technology investments and for developing and implementing science, space, and technology policies and programs that contribute to those goals. He cited the need to invest in fundamental science and generic technologies (such as advanced manufacturing and biotechnology) that will help our industries to compete effectively in world markets. At the same time, he emphasized the need to lead the world in international S&T cooperation, such as on the Space Station. S&T programs like this allow us to build bridges between societies and nations as we deal with the challenges facing the post-Cold War global community.

The President established the following goals for the Council members:

- As a top priority, Departments and Agencies, individually and collectively through the NSTC, should continue to work to reprioritize science and technology investments to match national goals.
- The NSTC should serve as a focus for establishing a closer and more productive relationship in the area of science and technology between the Federal Government and industry, State and local governments, universities, and other private sector institutions.
- All NSTC members should work to establish a broad base of understanding and support among the American people and the Congress for critical S&T investments.
- The NSTC should seek to advance national interests through international science and technology cooperation.

Following the President's remarks, the Council members offered their views and insights regarding the NSTC, interagency collaboration, and specific initiatives being pursued.

Highlights included:

- the importance of a steadiness of funding in science and technology
- the centrality of fundamental research to the needs of our society
- commitment to dual use research and technology
- emphasis on partnerships, e.g. between public and private sectors
- commitment to increasing research in civilian technology
- commitment to balancing civilian and defense research
- reaffirmation of expectation that agency budgets will reflect May 6 budget guidance
- interagency cooperation is essential to accomplishing new missions
- the need for a well articulated S&T strategy that all NSTC members can espouse
- the particular importance of environmental technologies
- the need to communicate more clearly the benefits of government S&T policy
- the need to emphasize the intimate link between education and research
- the need to demonstrate concrete, visible, early results, e.g. new technologies

Vice President Gore reviewed the Administration's S&T accomplishments, commending the group for the strength and leadership the NSTC has already exhibited. For example:

- The NSTC oversaw the successful redesign of the Space Station and its support in Congress.
- The NSTC process produced an agreement on convergence of DOD's and NOAA's polar-orbiting meteorological satellite systems (following many years of unsuccessful efforts), ultimately at savings of a billion dollars or more.
- The NSTC has succeeded in expanding the high performance computing program (HPCC) to support and enable development of the National Information Infrastructure.

Business taken up during the Council meeting included:

- Approval of the Administration's science policy statement, Science in the National Interest. This report is the product of an extensive NSTC study, combined with a broad-gauged Forum with stakeholders, in cooperation with the National Academy of Sciences and others. The outcome presents policy objectives for the Nation's research enterprise.
- Approval of NSTC's Technology for a Sustainable Future: A Framework for Action to initiate a national dialogue, with a White House conference planned for the fall. Similar to "Science in the National Interest", this paper is the result of in-house (multi-agency) analysis complemented by a Forum held in cooperation with the Academy of Science and other groups.
- Discussion of progress on NSTC's review of the Federal laboratories. A presidential directive issued in May requires an integrated review of the DOD, DOE, and NASA laboratories.

ATTACHMENT

NATIONAL SCIENCE AND TECHNOLOGY COUNCIL

JUNE 29, 1994

ATTENDEES

The President of the United States
The Vice President of the United States
The Secretary of Health and Human Services
The Secretary of Transportation
The Secretary of Energy
The Secretary of Education
The Assistant to the President for Domestic Policy
The Director of the Office of Management and Budget
The Director of the Central Intelligence Agency
The Chair of the Council of Economic Advisors
The Assistant to the President for Economic Policy
The Administrator of the National Aeronautics and Space Administration
The Director of the National Science Foundation
The Assistant to the President for Science and Technology
The Administrator of the Environmental Protection Agency
The Deputy Assistant to the President for National Security
The Deputy Secretary of the Department of Defense
The Deputy Secretary of the Department of Commerce
The Deputy Secretary of the Department of Labor
The Deputy Secretary of the Department of Agriculture
The Under Secretary of State for Global Affairs
The Assistant Secretary for Water and Science of the Department of Interior
The Deputy Director for the National Institutes of Health
The Deputy Director for the Arms Control and Disarmament Agency

PRESIDENTIAL REVIEW DIRECTIVE/NSTC-1

TO: THE VICE PRESIDENT
The SECRETARY OF STATE
THE SECRETARY OF DEFENSE
THE SECRETARY OF INTERIOR
THE SECRETARY OF AGRICULTURE
THE SECRETARY OF COMMERCE
THE SECRETARY OF LABOR
THE SECRETARY OF HEALTH AND HUMAN SERVICES
THE SECRETARY OF TRANSPORTATION
THE SECRETARY OF ENERGY
THE SECRETARY OF EDUCATION
THE DIRECTOR OF THE OFFICE OF MANAGEMENT AND BUDGET
THE DIRECTOR OF CENTRAL INTELLIGENCE
THE NATIONAL SECURITY ADVISOR
THE ASSISTANT TO THE PRESIDENT OF ECONOMIC POLICY
THE ASSISTANT TO THE PRESIDENT FOR DOMESTIC POLICY
THE CHAIR OF THE COUNCIL OF ECONOMIC ADVISORS
THE DIRECTOR OF THE ARMS CONTROL AND DISARMAMENT
AGENCY
THE ASSISTANT TO THE PRESIDENT FOR SCIENCE AND
TECHNOLOGY
THE ADMINISTRATOR OF THE NATIONAL AERONAUTICS AND
SPACE ADMINISTRATION
THE ADMINISTRATOR OF THE ENVIRONMENTAL PROTECTION
AGENCY
THE DIRECTOR OF NATIONAL SCIENCE FOUNDATION
THE DIRECTOR OF THE NATIONAL INSTITUTES OF HEALTH

SUBJECT: Interagency Federal Laboratory Review

A central objective of this Administration's science and technology policies is to review all federal support for research and development (R&D) to ensure that programs reflect the Administration's priorities and effectively serve evolving national needs. The National Science and Technology Council (NSTC) is responsible for coordinating the entire range of Federal science and technology investments. One part of the government's research enterprise that requires careful attention is its laboratories, which account for one-third of the Federal Government's R&D budget of about \$70 billion.

The three largest Federal laboratory systems, those of the Department of Defense, the Department of Energy, and the National Aeronautics and Space Administration, were funded at \$18 billion in FY 1993 — nearly three-quarters of the combined budgets for all federally owned or operated laboratories. These three laboratory systems are rich in human talent and facilities, have many responsibilities in common, and — with the end of the Cold War and changes in national priorities — must all reexamine their roles and missions.

Since decisions made about the future of these laboratories have major implications for the nation's entire research enterprise, an integrated, interagency review of options is necessary. DOD and DOE are conducting reviews of their major laboratories, and NASA has recently performed a roles and missions review for its Centers as well as taking part in an interagency National Facilities Study. The NSTC will conduct an interagency review, providing guidance to, building upon, and integrating the individual agency reviews.

While the DOD, DOE and NASA laboratory systems are the focus of this review, programs in other Federal laboratory systems that overlap those of the three systems under review shall be considered as necessary and appropriate. Other laboratory systems may be given focused attention in subsequent interagency reviews.

The purpose of the review is to evaluate and develop recommendations for ways to improve the efficiency and effectiveness of the Federal R&D investment in the Federal Government's three largest laboratory systems. The review shall define and assess a clear set of options and develop recommendations to achieve this purpose.

Areas of National Need to be Considered in the Review

The review will consider evolving national needs in categories listed below, and will evaluate the effectiveness and comparative advantages of the laboratories under review in responding to these needs. The categories of national need to be considered are:

1. Fundamental science, including scientific issues that arise in connection with other strategic areas, such as national security, energy supply and use, and space exploration.
2. National security, including advanced conventional weapons systems; stewardship of the nuclear weapons stockpile; nonproliferation of weapons of mass destruction and advanced conventional weapons and their delivery systems; verification of multilateral and regional arms control and nonproliferation agreements; and intelligence collection and analysis.
3. Technologies and activities that contribute to the competitive performance of U.S. industry and the Nation's economic growth, such as manufacturing process technologies (both generic and industry-specific), energy technologies, computer and information technologies, transportation and communication infrastructure, medical and biotechnologies, education and training technologies, and the effective diffusion of these technologies throughout U.S. industry.

4. Environmental protection and cleanup technologies including research and development for remediation and restoration, end-of-pipe controls, pollution avoidance and prevention, response to human health and ecological risks and to global environmental threats, and the science underlying these environmental issues.

5. Space exploration, both with and without human presence, and civilian space and aeronautical research and development.

Other key areas of national need, such as education, training and public literacy and health research and development, may be considered in the context of one or more of the five areas listed above, as appropriate.

Issues to Consider in the Review

The NSTC will assure that relevant important issues are raised in each of the laboratory reviews conducted by individual agencies. These may include the following.

- o Comparative advantage, or special capabilities, including physical infrastructure, of the laboratory system under review in meeting each of the national needs outlined above. These capabilities shall be compared, insofar as possible, with capabilities of other research institutions, such as other Federal laboratories, universities, contract laboratories, and industrial laboratories.
- o Methods agencies use for selecting their research laboratories versus other research institutions for performing R&D activities (e.g., peer review of proposals for fundamental scientific research).
- o Missions appropriate for the laboratory systems under review, and for individual laboratories within the systems, in the context of evolving national needs in the post-Cold War era.
- o Methods agencies use for selecting research areas for their laboratories and the process for re-orienting the research to meet changing national needs.
- o Mechanisms for evaluating the quality and performance of major programs in laboratory systems or at individual laboratories, measured against world standards.
- o Redundancies and possibilities for restructuring, consolidation or closure, redirection, or reassignment to other agencies of laboratories in the systems under review.
- o Alternative management and funding options for the laboratory systems, and/or individual laboratories, to enhance quality, cost-effectiveness, and increased responsiveness to national needs; alternatives may include privatization of laboratories or programs within laboratories.

- o Relations between parent agencies and laboratory systems, with attention to layers and detail of management that may put unnecessary cost and quality burdens on the laboratories.
- o The process agencies use for performing work at their laboratories for other agencies and for non-government entities, and opportunities for lowering barriers to inter-laboratory and interagency cooperation.

In addition, the NSTC may provide guidance to laboratory reviews conducted by DOD, DOE, and NASA on issues to raise in each of the five areas of national need, as appropriate and necessary.

In its interagency Federal Laboratory Review, the NSTC shall address any issues that cannot be easily accommodated in, or may be inappropriate for, individual agency reviews. The NSTC review shall also ensure that interests of all agencies, including those not conducting the individual reviews, are adequately represented, and that such agencies may participate in the review.

External Advice

The NSTC may seek advice from members of the President's Committee of Advisors on Science and Technology and other appropriate representatives of industry, academia, the nonprofit private sector, and state and local government in preparing its reports of the Federal Laboratory Review.

Resources

Agencies shall provide NSTC with the resources needed to prepare guidance for individual agency reviews and for the NSTC's Federal Laboratory Review.

Timing

The NSTC shall prepare an interim report of the Federal Laboratory Review by September 15, 1994. The interim report will provide options/recommendations on issues that need to be resolved in time to affect the FY 1996 budget.

The NSTC shall complete a final report of the Federal Laboratory Review, including options/recommendations, by April 15, 1995. Any difference in view among agencies should be noted.



John H. Gibbons
Assistant to the President for Science
and Technology

May 5, 1994
Date

National Science and Technology Council
Committee on Environment and Natural Resources
Subcommittee on Toxic Substances and Hazardous and Solid Waste

Full Subcommittee Meeting
August 25, 1994
2:00 p.m. to 4:00 p.m.
EPA Washington Information Center
Room 1 North
Conference Call Number (202) 260-3808

Agenda

Welcome and Review of Agenda

Status Report

Steve Lingle

- Where we are
- Information Handouts
- Calendar

Discuss Development of Implementation Plan

Discuss Revised R&D Strategy (8/18/94 draft)
- External Peer Review schedule

Adjourn

Handouts -

Proposed Subcommittee Schedule through October 1
R&D Strategy (8/18/94 draft)
Memo from Gibbons (8/19/94) - Administration Position on NIE
Memo from Rivlin (8/5/94) - FY 1996 R&D Data Collection and Review
Memo from Gibbons (7/27/94) - NSTC Quarterly Status Report (2nd QTR CY 1994)

Next Full Subcommittee meeting will be held on September 29, 1994, from 2:00 p.m. to 4:00 p.m. at EPA, Washington Information Center (WIC) Room 2 South. Conference call number is (202) 260-3819.

CENR Subcommittee on Toxic Substances and
Hazardous and Solid Waste

PROPOSED SCHEDULE

	Mail R&D Strategy out for external review
9/9	First draft of implementation plan reports due from writing team chairs (Chairs will fax copies of reports to each other)
9/13	Meeting of writing team chairs EPA, 635 West Tower
9/19	Revised draft implementation plan reports due from writing team chairs
9/20	FY 95 and 96 focused and contributing budget matrices and FY 1996 program changes due to CENR
9/20-23	EPA to integrate implementation plan reports into one document
9/23	Subcommittee summary on agencies response to FY 96 budget guidance due to CENR
9/26	EPA to distribute draft implementation plan to agencies
10/1	CENR summary on agencies response to FY 96 budget guidance due to NSTC/OMB
10/1	Subcommittee strategy and implementation plan due to CENR
10/17	CENR draft strategy and implementation plan due to NSTC
12/15	CENR plans due to NSTC

DRAFT

DRAFT 8/18/94

COMMITTEE ON ENVIRONMENT AND NATURAL RESOURCES SUBCOMMITTEE ON TOXIC SUBSTANCES AND HAZARDOUS AND SOLID WASTE RESEARCH AND DEVELOPMENT STRATEGY

STRATEGY FRAMEWORK

Research and development (R&D) supporting the goals (identified in Section 1.0 below) for toxic materials* includes a very wide span of work in many scientific and social disciplines. To assist thinking about R&D priorities for combining and coordinating Federal agency efforts, this strategy discusses both risk assessment and risk management in separate sections. Risk assessment topics are organized according to the "paradigm" first put forward in the National Academy of Sciences 1983 report, Risk Assessment in the Federal Government: Managing the Process. Risk management topics are organized according to both the scientific and technological aspects and the social and economic aspects of decision-making.

The risk assessment paradigm is a framework for organizing analyses of pertinent data in a way that emphasizes the interdisciplinary nature of the work. The four elements of the framework are: (1) hazard identification; (2) dose response assessment (note that we refer to elements 1 and 2 as "hazard assessment" in this strategy); (3) exposure assessment; and (4) risk characterization. Within these elements the following questions are addressed with respect to a toxic material: Does the material cause adverse effects in biological systems? Under what conditions of dose might the effects occur and to what degree? What are the actual exposures? What are the nature, magnitude, and extent of risk associated with actual exposure, and what are the uncertainties of the analysis given available data and the current understanding of the phenomena involved? The risk characterization is the transition between risk assessment and risk management; it presents the risk assessment results of most interest to a decision maker (or member of the public) who is considering whether a prevention or control action is needed. Risk management decisions rely on analyses supporting consideration of available prevention and control technologies and consideration of the social and economic choices inherent in decision options.

* Throughout this document, the term "toxic materials" should be read to include the range of environmental toxicants including toxic releases to all media, new and existing chemicals, pesticides, biotechnology products, ionizing and nonionizing radiation, oil and chemical spills, and solid, hazardous, radioactive, and mixed wastes.

This strategy discusses risk assessment and risk management in sections, each of which explains the current state of understanding and R&D priorities. Within risk assessment there are three sections: (1) health and ecological effects and their dose response relationships (hazard assessment); (2) exposure assessment; and (3) risk characterization. Health and ecological risk issues are discussed together to highlight the issues they share. Risk management has two sections: (1) scientific and technological aspects and (2) social and economic aspects of decision-making.

1.0 VISION AND GOALS

Environmental Vision: To understand, prevent, and reduce human and ecological exposure to toxic materials and their adverse human health, ecological, and social and economic consequences. Actions will be guided by principles such as sustainable development, community involvement, environmental justice, wise ecosystem management, and the risk of alternatives.

- Protection: Protect human health and the environment from adverse effects associated with exposure to toxic materials;
- Assessments: Ensure appropriate priorities and levels of protection through the use of scientifically sound assessments of risk and cost/benefit;
- Innovative Environmental Technologies: Develop and apply safer, faster, better, and more cost-effective technologies for reducing and monitoring exposures of humans and the environment to toxic materials;
- Pollution Prevention: Promote pollution prevention as a primary guiding principle for protecting the environment. Use regulatory and nonregulatory tools to instill a prevention-based ethic in all sectors of society;
- Sustainable Development: Demonstrate that a clean environment and economic growth can be mutually supporting. Achieve both environmental protection and economic growth through government and private sector collaboration;
- Communication and Community Involvement: Ensure that all stakeholders have access to reliable information about sources and levels of pollution in their communities and promote stakeholder involvement in all aspects of the environmental decision-making process;

- Environmental Justice: Assure that the benefits of environmental protection can be shared by everyone in the society and that no specific group is more at risk due to environmental factors beyond their control;
- Emergency Response/Accidental Releases: Prevent and respond to oil and other hazardous substances spills and chemical accidents so as to minimize environmental injury and protect public safety and ecological integrity; and
- Federal Facilities: Cost-effectively cleanup or contain toxic contamination at Federal sites which pose a risk to human health and the environment. Assure Federal facilities are in compliance with all environmental laws and regulations.

2.0 POLICY-RELEVANT QUESTIONS

The research priorities presented in this strategy directly support the development of policies for managing risks from toxic materials. Risk assessment as a whole is central to policy formation. But science cannot always provide clear, complete, and unambiguous answers for policy formation. Some of the more difficult policy issues that are impacted by the research priorities in this strategy are listed below:

- How to use risk assessment for public policy decisions?
- How to deal with uncertainty in risk assessment?
- How do we improve risk communication and public involvement in decision-making?
- How to use cost/benefit and comparative risk analyses in making risk management decisions?
- How to weigh health risks and risks to ecological systems for different endpoints in making risk management decisions?
- How to incorporate environmental justice concerns in risk management?
- How to use federal government resources to promote development and application of environmental technologies?

3.0 SCIENTIFIC AND TECHNOLOGICAL GOALS

- To advance the science of risk assessment, including:
 - (1) understanding the effects of exposures to toxic materials on human health and ecological systems, including the toxicological mechanisms that produce

those effects;

(2) processes for predicting and measuring exposure to humans and ecological systems, and the processes leading to those exposures; and

(3) estimating risk and characterizing and communicating those estimates. ;

- To demonstrate and evaluate more cost-effective, innovative technologies for pollution prevention, control of toxic wastes and emissions, site characterization, and remediation;
- To collect data and develop evaluative methodologies for the social and economic consequences of pollution; and
- To disseminate and coherently explain risk/benefit information, so the public can participate in a meaningful way in environmental decision-making.

4.0 RISK ASSESSMENT

4.1 HAZARD ASSESSMENT

Conceptual Framework. There are several basic similarities between understanding the hazard of toxic materials to human health and ecological systems. The same fundamental scientific principles of chemistry and cellular biology apply across species when evaluating chemical dose. Differences between responses exist primarily due to the presence or absence of particular physiological or biochemical processes that are related to the mode of action of toxic chemicals. Human health is focused on one species of concern (human beings) with many endpoints related to the risk to individuals. Research often cannot be conducted on the species of concern but must be extrapolated from data on laboratory animals. Ecological hazard research is directed towards many species with endpoints that are related to the risk to populations and communities of populations. In many cases research can be carried out directly on species of concern but then must be extrapolated to many other species that may have fundamentally different physiological processes. Thus, intra-specific variability within the human and inter-specific variability among non-human species within a family or taxa must be understood to develop effective policies on reducing risks from toxic materials.

4.1.1 Hazards to Human Health

Characterizing and assessing the effects of toxic materials on human health requires an understanding of how toxic materials affect human health and what effects are most important to the

well-being of individuals and populations. In addition, there are differences in the responses and exposure of individuals and groups of individuals that must be identified and understood in order to develop appropriate protection strategies. Toxic materials, however, are only one set of potential stressors on human populations. The effects due to toxic materials must be considered in conjunction with other factors, such as nutritional status and behavior patterns, that can work singly or in combination to produce adverse health conditions.

Current State of Understanding. Past efforts in the hazard identification of toxic materials have focused on cancer as the main endpoint of concern with other endpoints (e.g., neurological, reproductive, and developmental effects) receiving less attention. Efforts to establish dose-response relationships for carcinogens have largely been of a curve-fitting nature that make linear low dose estimates of response at lower exposures. Dose-response analysis has not been done for noncancer endpoints; the approach has generally been to identify a "No Observed Adverse Effect Level" and/or a "Lowest Observed Adverse Effect Level." Uncertainty factors are then used to establish a level below which effects would not be expected to occur in humans. There has been a paucity of data with which to develop biologically-based dose-response models.

Much of the information on toxic materials has come from animal testing. This testing has generally been on individual chemicals, and little is known about the hazards of chemical mixtures. Differences between animals and humans with respect to metabolism, absorption, excretion, and sensitivity have made the extrapolation of effects seen in animals to the human situation problematic both qualitatively and quantitatively. It has also been difficult to extrapolate the results of lifetime animal studies or long-term occupational studies to environmental exposures lasting much shorter periods of time (e.g., childhood exposures for children living near Superfund sites).

Research Priorities. In recent years, there has been a growing emphasis on improving the biological rationale for quantitative risk assessment, as opposed to the simple curve fitting of data in the observable range with extrapolation to lower exposures. For carcinogenicity, low-dose linear modeling is currently considered a default approach in the absence of biological data but tends to be more the rule than the exception. For some carcinogens, this may be a reasonable procedure, but for other carcinogens, improved biological data could suggest a better and very different approach. For noncarcinogens, improved biological information is key to developing first generation dose-response models. There have been some inroads in biologically-based dose-response modeling, but it is clear that the information needed for this approach is very much in a developmental stage, and much more work needs to be done.

Similarly, emphasis has focused on improving the pharmacokinetic data for the extrapolation of dose-response effects seen in animals to humans, but again, in general, more data need to be developed before such information can be used with any confidence. There has also, in recent years, been more emphasis on noncancer endpoints such as developmental toxicity, reproductive toxicity, immunotoxicity, and neurotoxicity. The potential of these effects to have large social or public health implications is recognized, and work in these areas should be expanded, particularly for those toxic materials that have already demonstrated evidence of having significant public health impact (e.g., lead poisoning, pesticides and children, environmental hormones). Information on mode of action and pharmacokinetics is integral here also.

There is very little information available on the variation in susceptibility to chemicals across individuals. Differences in existing disease (e.g., diabetes, immunologic disease, emphysema, etc.), genetic variability, and socioeconomic conditions among individuals could produce considerable variation in response to toxic materials. Estimates of low-dose effects are currently made for the general population, but sensitive subpopulations could demonstrate much greater dose-response. Improved understanding of the variation in response to toxic materials would reduce the uncertainty of risk estimation and allow for a better evaluation of the "conservativeness" of existing approaches.

Much more information is needed to understand the effects of short term exposure that the risk assessor must often address. Most of the population is not exposed to toxic materials from any one source for their entire lifetime because of changes in address or changes in habits/lifestyles or introduction/reduction of pollution sources throughout life. Most of the health effects studies from which we draw our information on toxic materials, however, are lifetime animal studies or long-term human studies.

A related issue is that very little is known regarding the effects of toxic materials vis-a-vis age of exposure. For example, does a toxic material have a disproportionately greater effect during a particular time period of an individual's life (e.g., a young child vs. a middle-aged adult)? Current estimates of risk for short-term exposures have generally attempted to "pro-rate" the response from a lifetime exposure study to the period of the short-term exposure (e.g., response in a lifetime animal study prorated to 5/70 if we are concerned about 5 years of childhood exposure and assume a 70-year lifetime). There are reasons to believe that toxic materials may have greater effects at certain chronological ages than at others. A focus on the effects of shorter term exposures at different chronological ages would be more relevant to the environmental situation.

The strategic research needed to develop effective U.S. policies for the protection of human health from toxic materials includes the following:

- Improved understanding of the biological basis for toxicity;
- Improved knowledge of the range and distribution of individual susceptibility to toxic materials;
- Effects of short term exposures to toxic materials at different chronological ages of life;
- Increased data base on the noncancer effects of toxic materials; and
- Better understanding of the pharmacokinetic and metabolic differences between animals and humans.

4.1.2 Ecological Hazards

Characterizing and assessing the hazard of toxic materials to ecological systems requires an understanding of existing chemical impacts and an ability to predict future impacts in support of management decisions to protect, preserve, and restore sustainable populations of aquatic life, plants, and wildlife. To conduct these assessments, the capability must be developed to diagnose causes of degradation, predict changes in responses that would result from potential management options, and prevent effects by predicting the potential hazard from future human activities. Because toxic materials are just one category of environmental stressors, it is important to conduct evaluations of chemical hazard in the context of existing and changing contributing factors, such as habitat quality, and potential stressors, such as global warming and increasing UVA/UVB radiation.

Current State of Understanding. During the past 30 years, research on the hazards of toxic materials has primarily focused on the development of empirical toxicological data with greater emphasis placed on aquatic rather than terrestrial systems. These data reflect the first generation of approaches that effectively contributed to the assessment of adverse impacts resulting from overt toxic effects (e.g., lethality and growth effects) caused by exposure to environmental chemicals. With some exceptions, extrapolations of toxic effects across species and endpoints were based on the empirical evaluation of existing data. For example, water quality criteria for the protection of aquatic life are based on the assumption that the variety of tested species are representative of the vast array of untested aquatic species. Comparable data for the protection of plant and wildlife species are very limited especially with regard to

endangered species. It is clear that empirically-derived hazard data cannot be developed for each combination of chemical and species.

In the past few years there has been an increasing emphasis on the development of new approaches using a mechanistic basis of extrapolating across species and chemicals. For example, understanding relationships between mechanisms of toxic responses and chemical structure have made possible the prediction of potency for untested chemicals that are based on modes of action. Although these newer models have proven effective for predicting the acute toxicity of many xenobiotics, there remain significant uncertainties in predicting metabolic activation and chemical reactivity, which are the processes that underlie the chronic toxicity of the most potent environmental chemicals. There has also been increasing concern that the first generation of approaches are not adequate for assessing the chronic effects of persistent bioaccumulative chemicals such as dioxins, furans, and those compounds suspected of acting as endocrine disruptors. In the context of extrapolating across species, the recent development of physiologically-based toxicokinetic (PB-TK) models for aquatic organisms reflects an important step towards a predictive capability. Initial linkage of PB-TK models with mechanistic research provides a rational approach to identifying critical toxicokinetic and toxicodynamic processes that underlie the differences in responses of species to chemicals.

Research Priorities. Although ongoing research is making important advances, there remains significant uncertainties in predicting hazard to toxic materials, including dose-response relationships and species susceptibility. These uncertainties are especially noteworthy in the context of chronic endpoints, such as reproduction and development and for those potent chemicals with complex modes of toxic action. In addition, it is essential that data and models be developed that will allow the prediction of ecologically relevant endpoints that can be used to predict the sustainability of sensitive populations of aquatic life and wildlife. For example, endocrine disruptors are generally thought to have receptor-based mechanisms that affect reproductive success and, therefore, population dynamics. Thus, in addition to life-cycle studies, research on these chemicals must be conducted at the organ, cellular, and subcellular level to identify toxic mechanisms and receptors. This information is necessary to quantitatively predict responses for untested chemicals and establish the critical physiological and biochemical properties that underlie differences between species.

Because of the need to extend the understanding of toxic responses across many species (including those threatened and endangered), the ability to extrapolate from tested species to untested ones must be improved. This improvement in extrapolation requires information on the physiological and

biochemical similarities and differences between species in the context of the underlying toxicokinetic and dynamic processes. This knowledge coupled with the development of PB-TK and biologically-based dose-response models will assist in predicting dose-to-target organs and the resultant effects when empirical data is not available. The ability to predict of dose-response relationships in conjunction with exposure predictions is necessary to be able to predict the load reduction of chemicals to ecosystems necessary to protect or restore populations. Identification of populations of organisms at significant risk would assist in setting priorities for the establishment of physiological and biochemical data.

The assessment of chemical impacts in natural systems typically involves complex mixtures. Although advances have been made in developing a mechanistically-sound basis to interpret and predict acute toxicity, there are very limited data and techniques available for addressing the chronic effects of mixtures. Mixtures of persistent bioaccumulative chemicals are of particular concern.

Throughout all these efforts, approaches are needed that minimize the use of animals in ecotoxicological research through the development of scientifically-defensible alternative methods such as advanced computer models.

The effects of chemicals on survival, growth, reproduction, and development of organisms can be an important component in protecting sustainable populations of aquatic life and wildlife. The development of tools that predict population dynamics in the face of natural forcing functions (e.g., temperature, rainfall, light intensity), chemical stressors, physical modifications and biological interactions is needed to integrate the vast array of information that is becoming available.

Research on ecotoxicological effects has been based on testing programs involving dozens of important fish, mammal, and bird species. The testing approach, even if funding expanded ten-fold, simply cannot provide hazard assessment information for the hundreds of chemicals and relevant species. Federally funded research over the past several decades has demonstrated that the only realistic option for information needs is to refine advanced animal extrapolation models which permit a minimum toxicological data set to predict effects for many other species. Developing species-to-species extrapolation methods for fish, wildlife and birds is not only more cost-effective than expanding animal testing programs, this strategic approach is the only one to protect endangered species which cannot be tested.

A second strategic choice in research is to focus on the effects of reactive chemicals and persistent bioaccumulative chemicals thought to have receptor-based mechanisms of activity.

These chemicals have the potential for greatest hazard, as well as greatest uncertainty with respect to current predictive power. This research should focus on the fundamental scientific mechanisms that control and influence the ability of organisms to sustain populations. The selection of chemicals and organisms to be tested should be strategically based on the need for data to develop robust predictions from information on chemical structure and extrapolations to untested species. This will require the identification of sensitive populations or populations at greatest risk and the development of a database of relevant physiological and biochemical characteristics of those species. Models of population dynamics are needed that incorporate the relative impacts of multiple stressors on populations and that predict the response to management activities to protect or restore these populations.

In summary, the priorities for research on the ecological effects of toxic materials are as follows:

- Develop biologically-based methods for extrapolating effects between species;
- Focus on effects of reactive chemicals and persistent bioaccumulative chemicals;
- Identify populations at greatest risk;
- Develop data base of relevant physiological and biochemical characteristics of organisms for extrapolation of effects; and
- Develop predictive models of population dynamics for selected ecological or societal species of interest.

4.2 EXPOSURE

Conceptual Framework. Most aspects of the science of risk assessment can be grouped under the general topics of either exposure or hazard. Progress in one area has motivated progress in the other, resulting in a leap-frogging development where the science lead alternates between exposure and hazard. In many respects, the exposure field currently lags behind hazard, and research is needed to bring it up to par with the state-of-the-art in the hazard area.

The same basic scientific principles generally apply in assessing human and ecological exposure to environmental contaminants. Both types of assessments must consider the activity patterns of the organism of concern and the different ways that contact can occur with contaminants. Both types of assessments are also aimed at evaluating various indicators of impact. Most human assessments focus on endpoints, such as body

burdens or health effects. Ecological assessments can also look at health effects in animals or alternative indicators of ecological impact, such as species diversity or population trends.

The following discussion analyzes the knowledge gaps in the exposure area and proposes areas of research to address them in the future. The overall goal of this research is to generate the basic information that risk managers need to identify and analyze opportunities for reducing exposure to environmental contaminants and associated risks. A dual track strategy is proposed to develop the needed exposure related information:

- One approach is to focus on sources of environmental contaminants and work prospectively along the pathways of transport and dispersal.
- The second approach is to start with human body burdens (or other direct measures of exposure) or analogous ecological endpoints and work retrospectively through the process of bioaccumulation and uptake.

At some point these two lines of inquiry should meet to give us a much more complete understanding of the process and properties of exposure. The key elements of these two tracks are presented in the table below.

Dual Track Strategy for Exposure Assessment Research

Prospective Approach	Retrospective Approach
Gather data on release rates of contaminants from sources.	Gather data on levels of contaminants in humans/wildlife and data on indicators of ecological hazard such as species diversity, population trends, etc.
Gather data on levels of contaminants in media potentially impacted by sources.	Gather data on the levels of contaminants in media contacting humans or animals.
Develop fate models to predict media levels based on source releases.	Gather data on rates which receptors contact environmental media and develop models to predict uptake in organisms from food, air, etc.

Dual Track Strategy for Exposure Assessment Research (table continued)

Use media data to validate and improve fate models.	Use media data to validate and improve uptake models.
Extend models to cover bioaccumulation through the food chain and attempt source-to-receptor validation.	Link uptake models to food chain models and attempt source-to-receptor validation. Evaluate geographic trends in data on body burdens and sources to see if links can be made.

4.2.1 Human Exposure

The exposure assessment element of the risk assessment paradigm asks the questions: "How many people are exposed? What are the routes and pathways of exposure? What is extent, duration and magnitude of exposure? What is the distribution of exposure levels in the population? Are any segments of the population highly exposed?"

Current State of Understanding. Procedures have been reasonably well developed to provide point estimates of mean exposure levels. Basic data on human behavior exist and simple fate models are generally capable of predicting environmental concentrations, although with varying degrees of capabilities. There is, however, great uncertainty in many of these predictions.

Research Priorities. Further information is needed to improve exposure assessment in a number of ways. The strategy for gathering this information should follow the parallel tracks identified above. The "prospective track" would include the following efforts:

- More data are needed on contaminant release rates from sources and contaminant levels in the environment media impacted by sources. These data can be used to identify geographic and temporal trends. Geographic trends can be useful for identifying sources and mechanisms of impact. Temporal trends can be used to help evaluate effectiveness of regulatory programs; and
- Validation work is needed to test the effectiveness of existing fate models and guide further development efforts.

The "retrospective track" would include the following efforts:

- More data are needed on contaminant levels in

receptors. This would include surveys of contaminant levels in human tissues and other direct measures of exposure. This information is the ultimate proof of exposure and best guide to setting priorities for assessment efforts. Such data can be analyzed for geographic and temporal trends to help evaluate sources of exposure and effectiveness of control programs;

- More data are needed on human activity patterns to help develop distributions of exposure factors, such as food ingestion rates, time spent in various settings, etc.;
- Better procedures are needed for assessing dermal exposure, especially to contaminants in soil. Experimental protocols need to be developed and validated to determine dermal absorption properties of chemicals in various matrices; and
- Better procedures are needed to assess complex exposure scenarios involving multiple sources/chemicals and multiple pathways of exposure. This would include developing procedures using biomarkers and other direct measurement techniques for assessing exposure. Direct measurement techniques include use of various types of monitors, such as personal air samplers, to measure exposure as it occurs. These approaches are well suited to assessing complex exposures involving intricate behavior patterns and spatially variable contaminant levels.

4.2.2 Ecological Exposure

The exposure of non-human receptors to chemicals can only be managed practically with a knowledge of adverse effect thresholds and a firm understanding of the behavior of chemicals in the environment once they are released. Assessments have traditionally been made through extensive measurements of chemical concentrations, which becomes more difficult at the watershed or regional ecological scales. Rather, exposure assessment is more cost-effective when based on transport and fate models which strategically define needs for measured data and simulate ecological exposure on a larger scale. Exposure assessment relies, therefore, on the science of transport and fate models and on methods for detecting chemicals.

Current State of Understanding. Generic transport and fate models are already widely available. While such models can be tailored to be used for small, site-specific problems, use at a higher scale, like watersheds, is limited by the complexity of the natural processes that must be linked together for large system models. The primary uncertainty of extrapolating laboratory hazard data to ecosystems in the field is the

uncertainty about the actual chemical dose received by individuals.

Modern computing has removed many intractable hurdles in the science of modeling chemical behavior in the environment. While models are available to simulate transport of chemicals in the atmosphere, surface water, and groundwater, most models are limited in their ability to accurately simulate the impact chaotic weather events have on exposure, as well as the risk reduction which accompanies chemical and biochemical transformations. Models of resuspension of contaminated sediments, which controls long-term risks of persistent chemicals, are in their infancy. Models of bioavailability are still in the conceptual stage even though the physical and chemical interactions that influence bioavailability are known. Soil/air interactions are largely unknown. Degradation models are seldom reliable, especially for industrial chemicals.

Reducing the uncertainty of exposure assessment will be accomplished by improving methods for measuring toxic forms of chemicals and developing more realistic information on the processes that control chemical transport and fate. Such information lags far behind the engineering of the computer frameworks for the models. Studies of fundamental ecosystem processes need to be designed in the context of the risk paradigm and with a new perspective from the modeling frameworks already developed. For example, current progress in exposure assessment has shown that most transport occurs during storm events. While sediment chemistry is becoming understood, sediment physics with respect to the energy of resuspension is a critical knowledge gap. Metal speciation has been modeled from a chemistry perspective, but not in the context of bioavailability or toxicity. Persistence and natural assimilation capacity of ecosystems for toxic materials are essential to making strategic choices in risk reduction and pollution prevention. In addition, biomarkers and other more diagnostic methods of measuring exposure are needed.

Research Priorities. Exposure assessment research will focus on three major areas:

- Abiotic processes that control the transport, persistence, and bioavailability of chemicals in soils, natural waters, and sediments;
- Bioaccumulation and metabolic processes that control biodegradability of chemicals in microbial populations in soils, natural waters and sediments; and
- More diagnostic methods and biomarkers for defining the route of exposure and exposure history.

4.3 RISK CHARACTERIZATION

Conceptual Framework. Risk characterization is the part of risk assessment which develops the risk estimates and explains these estimates in terms useful to risk managers. Risk characterization specifically includes 3 aspects which provide perspective to the risk manager: (1) integration of the other parts of the assessment to reach an estimate of risk; (2) an evaluation of the confidence of that estimate; and (3) communication of these results and their implications in terms useful to the risk manager.

Integration. First, the risk characterization integrates the individual characterizations of hazard, dose-response, and exposure to synthesize the estimate of potential risk. The risk characterization "tells the story" of who or what is at risk and why.

In developing the hazard identification, dose-response, and exposure portions of the risk assessment, the assessor makes many judgments concerning the relevance and appropriateness of data and methodology. The risk characterization examines these judgments, their implications, and the compatibility of the judgments across the parts of the assessment. The risk characterization also explains the constraints of available data and the state of knowledge about the phenomena studied in making the judgments, including:

- The qualitative, weight-of-evidence conclusions about the likelihood that the toxicant may pose a specific hazard (or hazards) to humans or other life, the nature and severity of the observed effects, and by what route(s) these effects are seen to occur. These judgments affect both the dose-response and exposure assessments;
- For ecological and human noncancer effects, a discussion of the dose-response behavior of the critical effect(s), data such as the shapes and slopes of the dose-response curves for the various other toxic endpoints, and how this information was used to determine the appropriate dose-response assessment technique; and
- The estimates of the magnitude of the exposure, the route, duration, and pattern of the exposure, relevant toxicokinetics, and the number and characteristics of the populations exposed. This information must be compatible with both the hazard identification and dose-response assessments.

The presentation of the integrated results of the assessment draws from and highlights key points of the individual characterizations of hazard, dose-response, and exposure analysis.

Evaluation. Second, the risk characterization provides an evaluation of the overall quality of the assessment and the degree of confidence the authors have in the estimates of risk and the conclusions drawn.

The risk characterization summarizes the data brought together in the analysis and the reasoning upon which the assessment is based. The description also conveys the major strengths and weaknesses of the assessment that arise from data availability and the current limits of understanding of toxicity mechanisms.

Confidence in the results of a risk assessment is consequently a function of confidence in the results of analysis of each element: hazard, dose-response, and exposure. Within each of these analyses, the important uncertainties and interpretation of data are explained so that the risk manager is given a clear picture of the scientific consensus (or differences of opinion) about significant aspects of the assessment. For example, whenever more than one view of dose-response assessment is supported by the data, and choosing between them is difficult, the views are presented and discussed together. If one has been selected over another, the rationale is given; if not, then both are presented as plausible alternatives.

If a quantitative uncertainty analysis is appropriate, it is summarized in the risk characterization; in any case a qualitative discussion of important uncertainties is appropriate. If other prior assessments have been done on the substance or an analogous substance and have relevant similarities or differences, these too need to be described.

Communication. Third, the risk characterization communicates the results of the assessment to the risk manager and others. The risk manager uses the results of the risk assessment along with technological factors, socioeconomic considerations, and other factors in reaching a decision about what risk management action need be taken, if any. The results of the assessment must be explained in terms useful for these purposes.

Often, it is helpful to describe risks in several different ways, such as average risk, median risk, highest risk within a population, risk by source, risk by species, risk by media, etc. These descriptions are usually tailored to the needs of the risk manager and may require extensive statistical effort to develop. Nonetheless, the effectiveness of this final step in the risk

assessment process may mean the difference between useful information and a wasted effort.

Current State of Understanding. Risk characterization has long been overlooked as an area of research, the most common reasoning being that if the other three parts of a risk assessment were done correctly, the risk characterization would follow in a relatively straightforward manner. Experience has shown this to be presumptuous. Much of the criticism of risk assessments can be traced to inadequate risk characterization.

Although we currently do integration of hazard, dose-response, and exposure for carcinogen assessments where simplifying assumptions have been made (dose linearity, simple exposure scenarios, etc.), it is much more difficult to see how these pieces fit together in ecological assessment or in noncancer health assessments. Complications such as mixtures, cumulative risk, short-term *vs.* long-term exposures, and the effects of biological variability have been dealt with in crude ways (or not at all) in assessments. The research necessary to properly integrate the parts of a risk assessment in all but the most simple cases has not been done at all. We are sorely in need of tools to help us understand and explain risks when taking into consideration what most risk managers see as these realities of life.

There has been some recent research into risk-related uncertainty analysis, but it has not yet developed to the point of being second nature to the assessors themselves. Quantitative statistical treatments of uncertainty are well founded and established, but the application and adaptation of these techniques to risk assessment still needs some research. Presentation of the qualitative aspects of risk assessment uncertainty has not been well studied or developed. Before risk characterization can routinely present the confidence of the assessment to the risk manager, research must be done and methods established for both the qualitative and quantitative aspects of uncertainty.

Communication of the risk results to the risk manager requires both statistical and sociological research. We have only a vague idea currently about what specific information would be most useful for risk managers and how to develop it. There is a recent groundswell in the risk assessment field toward the use of Monte Carlo and other probabilistic tools, but these tools are currently poorly understood by both risk managers and risk assessors in general. Research is needed to develop both the statistical basis for presentation of results and the ability to clearly and concisely express results in terms needed by the users of the assessments.

Research Priorities. In order to make risk characterization

the effective tool that it needs to be, direct attention needs to be paid to the research necessary to develop the science:

- Methodological research is needed on how hazard, dose-response, and exposure can be integrated in more complex cases (ecological assessments, mixtures, cumulative exposures, etc.);
- Methods for both the qualitative and quantitative aspects of uncertainty analysis must be specifically applied to risk assessment, and the resulting methodology made a routine part of risk characterization; and
- A specific effort is needed to improve the way risk assessment is communicated to the public and the risk manager, including development of statistical and communications tools.

5.0 RISK MANAGEMENT

Conceptual Framework. Global population growth and economic development present major new challenges to our ability to maintain, and hopefully to improve, the quality of the environment and protection of human health. Current projections are that by the year 2050, world population will roughly double, and world economic output will increase five fold. This will lead to production and consumption patterns that can greatly increase both the quantities of wastes and the levels of toxic materials released to the environment. (It is a simple fact that when we extract resources from our natural environment for productive use, they must ultimately be returned as wastes, often in more toxic forms as a result of chemical or physical processing.)

This expected growth also poses economic and social challenges. The costs of conventional pollution control divert financial resources from more economically productive uses. Consequently, it is essential that we:

- Base management of wastes and toxic materials on high quality risk assessments, and set priorities based on risk, and
- Greatly improve the effectiveness and efficiencies of this management through emphasis on pollution avoidance (or prevention) and through development and use of innovative, cost effective technologies to monitor, control, or remediate toxic materials in the environment.

This strategy for risk management R&D first considers the scientific and technological aspects of this issue and then the social and economic aspects. The scientific and technological aspects and the socioeconomic aspects are linked in several ways, including through broad goals of "sustainable development" and "environmental justice." Sustainable development has been defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." The term is also commonly understood to refer to simultaneous achievement of a clean environment and economic growth. Environmental justice means that the risks associated with toxic materials and wastes should be managed equitably across all sectors of society.

5.1 SCIENTIFIC AND TECHNOLOGICAL ASPECTS

To reduce risks from toxic materials to humans and ecological systems we must either reduce exposure or reduce the level of toxicity. For many years the primary emphasis was placed on reducing exposure by storing or "disposing" of wastes through burying in landfills, placement in abandoned salt mines, injection into deep wells below the potable water table, or like methods. Leaving toxic contamination in place and restricting access or limiting possible future land uses is another approach that has been used.

Many of these methods are not viewed as effective in the long-term and are often seen as simply shifting exposure to future generations. However, these methods continue to be appropriate for circumstances where they provide an appropriate level of risk reduction (especially when combined with the best available containment technologies), and where other methods may be too costly or technically impractical. This may include, for example, application to wastes of lower toxicity, very large volume wastes, or wastes with radioactive properties. It also includes containing spills and reducing exposure in the work place. Although these approaches are not the primary focus of future R&D that is described in this strategy, some continued research is appropriate to ensure that effective containment methods are available and to assess the effectiveness and associated risks of the best methods available.

Much of the emphasis of the last several years has shifted to treatment methods to reduce mobility of toxic contaminants (and consequently exposure) or to permanently reduce levels of toxicity. In the waste management arena, this has been a requirement of laws such as the Comprehensive Environmental Response, Compensation, and Liability Act (Superfund) and the Resource Conservation and Recovery Act (RCRA). Innovative technologies that provide greater permanent risk reduction at lower cost have become the emphasis of Federal R&D efforts. The need for continued and expanded R&D in this area is reflected in

the priorities presented in this strategy.

The other major new direction in managing risks from toxic materials is to eliminate or reduce both exposure and toxicity through pollution prevention. Prevention can include use of less toxic inputs, use of less energy or raw materials, or use of more efficient, cleaner processes or better product design. The research priorities in this strategy reflect pollution prevention as the preferred risk management approach.

The discussion of R&D priorities that follows is organized by categories of technological approaches commonly associated with managing toxic materials. These are the same approaches used in the recent National Science and Technology Council publication, Technology for a Sustainable Future. This hierarchy of approaches includes pollution prevention, control, and remediation. Accident prevention and response is addressed as a separate area and monitoring R&D needs are incorporated into each of the other areas.

5.1.1 Pollution Prevention

Pollution prevention is the preferred approach for managing risks from toxic materials. Generally, it achieves the greatest levels of risk reduction and does so more efficiently than any other approach. Often prevention has economic benefits as well as environmental benefits. Considering world population and economic growth, and the cost of conventional pollution control, pollution prevention is the only way to achieve long-term sustainable development.

Over the next 10-15 years, Federal R&D resources should increasingly be shifted to pollution prevention from areas such as control and remediation. Increased prevention will ultimately reduce needs for managing wastes and cleaning up contaminated sites.

Current State of Understanding (Development). Pollution prevention research is still relatively young relative to other environmental technology areas. Research to date has generally focused on 3 areas: (1) tools and methods for analyzing prevention alternatives; (2) cleaner technologies and processes (including identification of less toxic inputs); and (3) information dissemination. Tools range from practical guides for conducting assessments to sophisticated computer models for process design and toxic materials substitution. Life cycle assessment is perhaps the most fundamental tool. Further research is needed to complete development and refine all of these tools.

Designing cleaner technologies and processes is at the heart of research needs in pollution prevention. Examples of this

research include development of new (cleaner) synthesis pathways for chemicals (such as photochemical or biochemical conversion), identification of less toxic substitutes for organic solvents, and developing less polluting production technologies (such as non-chlorine bleaching of wood pulp). To date several individual technologies or unit operations have been developed, but comprehensive, industry sector-focused R&D is only beginning.

Information dissemination is a critical adjunct to R&D to bring about commercial application. Therefore, it must be included in the national research agenda. Much has been done, but more innovative and effective approaches are needed. They range from establishing better integrated networks of technical assistance providers to utilizing electronic data transfer more effectively.

Federal vs. Private Sector Role. Industry has a central role in prevention R&D because it deals with issues integral to the design and operation of industrial processes. Federal R&D efforts in pollution prevention should emphasize partnerships with industry through research consortia and cooperative R&D agreements. Government cannot redesign industrial processes, but it can be an effective partner because of its financial resources, expertise of its scientists, and ability to act as a convener of industry and other stakeholders.

Another important role for government is to assist smaller companies who individually or collectively do not have the resources or expertise to develop or adopt pollution prevention approaches. This may involve both joint R&D and technical assistance. Federal agencies are not usually a direct provider of technical assistance, but may establish or support delivery of assistance by others and may support information networks and clearinghouses.

Federal R&D can also effectively address cross-cutting issues that affect many different industries, such as reduction of solvent use and development of risk assessment tools and models.

Research Priorities.

R&D Partnerships

- Form partnerships with industry, academia, and government to develop a new generation of cleaner industrial technologies and processes, focusing on specific industry sectors. Initial sector priorities are: paper, iron and steel, chemicals, petroleum refining, automobile assembly, electronics, metal finishing, and printing.

Technical Assistance

- Develop a national system of technical assistance delivery focused on small manufacturers and businesses to provide information on pollution prevention approaches, techniques, and technologies. The delivery system should incorporate existing and developing institutions, such as the Manufacturing Technology Centers developed by the Dept. of Commerce, the Small Business Development Centers of the Small Business Administration, and state prevention assistance programs. The system should be supported by R&D to develop high quality technical information and guidance and should link pollution prevention with environmental compliance requirements. National, integrated, on-line information systems should be established to link the providers with each other and the users.

Cross-cutting Tools and Information

- Develop and validate tools, such as life cycle analysis (LCA), and computerized process design models for use by industry in incorporating pollution prevention into products and processes; and
- Develop information on the characteristics, performance, and environmental and health effects of solvent alternatives and other toxic material substitutes and incorporate into national data bases.

5.1.2 Control Research

End-of-pipe or end-of-stack control technologies have become the mainstay of pollution control over the last 20-30 years as Federal laws and regulations have specified acceptable emission levels based on use of "best available control technology." This regulatory "lock-in" of existing technology has had a chilling effect on development and use of more innovative technologies that could achieve an equal or greater reduction in risk for less cost. In addition, many conventional control technologies have not permanently reduced toxicity, but have often shifted toxic materials from one media to another.

Over time, pollution prevention will reduce the need for end-of-pipe controls, so that research in this area should decline in the long-term in favor of prevention R&D. This must be phased, however, because existing and new regulatory requirements still rely heavily on these control technologies. New innovative technologies and practices are needed over the next several years to lower compliance costs and improve risk reduction associated with pollution control. (In addition, more flexible regulatory approaches must be put in place to encourage

use of these innovative methods.)

Current State of Understanding (Development). Although a wide range of control technologies exist, many are not cost-effective, and may not reduce risks adequately. A striking example of this is treatment of hazardous wastes, where incineration is still the norm as "best available technology." Yet, incineration is expensive and is under attack as potentially causing significant risks to human health as a result of emissions of toxic "products of incomplete combustion". Another example, current drinking water treatment, depends heavily on chlorination and filtration to remove contaminants. Chlorination produces disinfection byproducts that are themselves toxic, and current filtration methods do not remove some biological contaminants effectively. Furthermore, drinking water distribution systems can release toxic metals if proper pH controls are not maintained. Conventional treatment technologies for air emissions and wastewater often shift pollutants from one media to another with little toxicity reduction.

R&D has focused largely in the past on point source releases, but better integrated risk reduction can be achieved by focusing on whole watersheds or ecosystems. Monitoring has also been neglected, particularly development of continuous emission monitors and in-process monitors of specific toxic materials such as metals and dioxins.

These examples suggest a need for innovation across all media to improve control for toxic materials. This need is further driven by new regulatory requirements that are evolving. Suggested research priorities reflect areas believed to offer the greatest potential for further risk reduction.

Federal vs. Private Role. The private sector is the source of most of the control technologies currently in use, although Federal research has also been very instrumental in advancing the state-of-the-art. The Federal role in future control technologies R&D should be to both enhance private sector development and to fill gaps not addressed by the private sector or others. The Federal laboratories have extensive expertise and can work in partnership with private developers under Cooperative R&D Agreements authorized by the Federal Technology Transfer Act. Federal agencies can also support demonstrations at Federal facilities and can test and evaluate technologies to verify their performance. These activities must be coupled with other policy approaches that provide incentives and opportunities for development and commercialization by the private sector.

Research Priorities.

Municipal systems

- Develop and evaluate methods to significantly reduce risks to human health from drinking water associated with:
 - lead and copper, by developing techniques to control corrosion;
 - disinfection byproducts, by developing techniques to remove precursors and by evaluating alternative (non-chlorine) disinfectants;
 - disease agents such as cryptosporidium, through improved filtration or other control techniques;
- Develop, demonstrate, and commercialize innovative, low cost, and low maintenance technologies for use by small communities and developing countries in treating their wastewater and drinking water; and
- Develop, demonstrate, and test approaches to address non-point source releases of toxic materials, including storm water runoff and combined sewer overflow.

Geographical Systems

- Develop practical and scientifically valid tools and approaches to manage watersheds, including the impacts of sewage sludge, storm water discharges, non-point source pollution, toxic chemicals, and contaminated sediments.

Industrial systems

- Develop new or improved continuous monitors and instrumentation for in-process control, emissions/effluent monitoring, and combustion systems. Research should focus on high risk toxic materials, including heavy metals and dioxin; and
- Develop cost-effective controls for treatment of toxic wastes formed during chemical synthesis, manufacturing processes, and mineral extraction. Priority should be on high toxicity, hard-to-treat wastes.

5.1.3 Remediation and Restoration

Mismanagement of toxic materials in the past has left a legacy of contaminated soils, sediments, and groundwater.

Consequently, while this strategy emphasizes a shift in emphasis to prevention R&D, increased emphasis must also be placed for the next several years on R&D related to controlling the risks from these past problems.

The current and projected costs to remediate the vast number of contaminated sites in the U.S. are enormous. These costs, as well as the risk these sites pose to human health and the environment, can be reduced through deployment of innovative technologies that will provide more cost-effective identification, prioritization, monitoring, and cleanup.

Current State of Understanding (Development). Risks to humans from toxic materials in contaminated sites derive from contaminated groundwater and airborne dust and from direct exposure to contaminated soils. For many sites, radioactivity and explosion or fire are also major risks. Most of these sites also release toxic materials to various ecosystems through direct contact, leaching, or runoff.

Groundwater contamination at these sites has been the most difficult technical issue in cleanup and represents a large part of cleanup costs. Although groundwater contamination has not been deemed to be one of the higher relative environmental human health risks in scientific studies, it is perceived by the public as a major health risk and can present high risks at specific sites. It is also a concern because it degrades a natural resource and reduces its future uses.

A recent National Academy of Sciences study found that groundwater cleanup is both expensive (estimates of up to \$1 trillion over the next 30 years) and that existing technologies are generally not capable of effectively addressing the problem. (Dense non-aqueous phase liquids (DNAPLs), for example, are not readily removed by existing treatment methods.) The study recommends a major national R&D effort to develop more cost-effective groundwater cleanup technologies.

Another problem associated with many sites where a cost-effective technical solution is not within reach is mixed radioactive and chemical wastes. Many contaminated Federal sites cannot be effectively remediated until technologies are developed and demonstrated to address this problem. Federal R&D is particularly important in this area because of a lack of private sector focus.

One of the principal ways to reduce both costs and risks during remediation is to treat contaminated soils in place (in-situ) without excavation. Methods for in-situ treatment are a major focus of current R&D efforts and should remain a priority into the future. In recent years, advances have been made in technologies such as bioremediation and soil vapor extraction,

but further development of these and other technologies is needed.

When wastes or sediments are excavated for treatment, cost can be reduced through improved techniques to separate the contaminants from the soil prior to treatment. Soil washing and solvent extraction are examples of technologies in this area that require further development or testing.

One of the highest costs in site remediation is site characterization and monitoring. Innovative methods that are non-intrusive, provide real time results, and improve detection capability need further development or field testing.

Federal vs. Private Role. The Federal role in remediation research, as in prevention and control, is to support and enhance private sector development and commercialization. In large part the same roles described there are relevant here. A critical link between R&D and commercialization in each of these areas is the demonstration, evaluation, and verification of cost and performance of innovative technologies. For remediation technologies, in particular, the Federal agencies, in cooperation with States, are in a position to provide Federal facilities as testing beds for innovative technologies and can directly support or conduct demonstrations and evaluations at these facilities.

Research Priorities.

- Develop protocols for testing innovative technologies to develop scientifically credible data on cost and performance, and use these protocols to verify performance. (Applies to control and prevention as well.);
- Develop a national Federal test sites program to identify test sites at Federal facilities and to support demonstrations and evaluations at these sites to encourage commercialization and application of innovative cost-effective remediation methods;
- Initiate an expanded effort to develop and test technologies in the following areas:
 - In-situ technologies, such as bioremediation, for remediation of contaminated sites without excavation, transportation, or incineration.
 - Technologies for separating toxic constituents from soils, sediments, and water.
 - Innovative technologies for the special problems posed by radioactive waste, mixed waste, unexploded

ordnances, and chemical munitions.

- Innovative site characterization and monitoring systems to reduce the cost and time of assessing and analyzing contaminated sites.
- Innovative methods for subsurface characterization, monitoring and remediation, with particular emphasis on DNAPLs associated with common chlorinated solvents in groundwater; and
- Improve knowledge of fate and transport phenomena in the subsurface to reduce uncertainty in contaminant transport modeling, improve risk estimates, and optimize remediation techniques, including natural attenuation.

5.1.4 Spills and Accidents Research

Development of the technology for containment and removal of spilled oils has been supported by the government and private industry for a number of years. Recently, as a result of the Comprehensive Environmental Response and Liability Act (CERCLA) and the Oil Pollution Act of 1990, it has become increasingly important to develop suitable control methods for hazardous and toxic material spills. In the longer term, emphasis on prevention should reduce accidental releases. In the immediate future the current levels of R&D should continue.

Research Priorities.

- Develop and evaluate response technologies to mitigate the impacts of inadvertent spills or discharges to the land or water and facilitate the expediency of cleanup efforts;
- Develop better methods to remediate environments impacted by oil spills or chemical releases;
- Develop and evaluate technologies to mitigate underground leaks from pipes and tanks, including improved leak detection, and more cost-effective cleanup. The effectiveness of natural attenuation in managing petroleum plumes is also an R&D priority; and
- Develop more effective measurements of environmental recovery following oil spills or leaks and accidental chemical releases.

DRAFT

5.2 SOCIAL AND ECONOMIC ASPECTS

Management of risks from toxic materials and wastes raises significant economic and social issues. The economic issues have at least two dimensions. One is that the costs of environmental compliance affect the profitability of private companies (and thus economic growth) and can also consume large amounts of public funds. The second is that the innovative technological solutions that can reduce these costs are often not developed or commercialized due to economic constraints such as lack of capital.

Although economic issues per se are not the primary focus of research under this strategy, they have important policy implications and drive the technical research priorities in certain directions. For example, economic considerations suggest that:

- pollution prevention research should be given high priority because of its link to sustainable development
- innovative technologies for control and remediation that can reduce risk at lower cost are essential
- legislation, regulations, and other government policies must provide sufficient flexibility to allow innovation to occur and to allow innovative technologies to be used
- financial support for R&D and commercialization, selectively infused, coupled with removal of other barriers to commercialization such as lack of test sites and performance verification, must be provided
- an effective Federal program to catalyze and enhance environmental technology development can yield important gains in the position of U.S. companies in global markets.

Under these conditions, stringent environmental requirements can actually lead to enhanced competitiveness and economic strength.

Social issues also have at least two dimensions. One concerns informing the public and involving them in decisions about risk management. Meaningful involvement demands that the public have access to reliable and understandable information about sources and levels of toxic materials in their communities, their associated risks; and that they have the opportunity to participate in the decision-making process for managing these risks.

The second critical social dimension is equity. Although existing information is incomplete, it is generally accepted that involuntary risks from toxic materials and their management are not shared equally by all socioeconomic sectors in our society. For example, while the Federal government is aware that dietary risk from pesticides varies across different income, ethnic, and age groups, present survey results cannot provide disaggregated dietary intake estimates for these groups from different commodities. Similarly, there is insufficient information correlating exposure from waste management with different socioeconomic groups. Examples such as these suggest that significant new studies and surveys are needed to effectively carry out a national policy of "environmental justice."

Research Priorities.

- Identify and pilot economic incentives to encourage private sector development and commercialization of innovative risk management technologies;
- Develop analytic tools for integrating environmental and economic decisions;
- Develop standardized methodologies to produce reliable information about the environmental attributes of products so that consumer purchases of goods and services can be made with environmental concern in mind;
- Develop new approaches and tools to provide the public with quality data in a form that allows them to evaluate the role of toxic materials in their community and to participate in the decision-making process;
- Develop techniques to identify and survey "high end" behavior which impacts exposure levels across different socioeconomic groups, e.g., dietary consumption patterns for high pesticide residue commodities; and
- Understand the distribution of exposures to the general population as a baseline for comparing exposure levels in subpopulations (biologically susceptible, socioeconomic subgroups of interest, young, older persons, etc.) in order to identify, evaluate, and correct inequitable environmental risk situations.

DRAFT

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Dana

THE WHITE HOUSE

WASHINGTON

August 19, 1994

MEMORANDUM FOR HEADS OF DEPARTMENTS AND AGENCIES

FROM: John H. Gibbons 
Assistant to the President for Science and Technology

SUBJECT: Administration Position on a National Institute for the Environment

The purpose of this memorandum is to relay to you the current position of the Administration on establishing a National Institute of the Environment (NIE). In short, the Administration does not think creating and funding such a new entity is desirable at this time.

The Administration acknowledges the need for a more effective and coordinated federally funded research and development program to address the critical environmental science and policy needs of the Nation. Further, we recognize that, historically, the federal environmental R&D system has not been well-linked to policy formulation. However, as the President and Vice President said in *Putting People First*: "The answer for every problem cannot always be another program or more money." We think the best way to address the concerns about the federal environmental R&D effort is through the interagency effort mobilized under the President's National Council on Science and Technology and its Committee on Environment and Natural Resources (CENR).

Over the last year, the Administration has made significant progress toward remedying these problems through the activities of the CENR. The chairs and vice chairs of the CENR elevate the level of participation to agency leaders in both the science and policy areas. The Committee is organized around key environmental policy areas (global change, biodiversity and ecosystems, resource use and management, toxic substances and waste, water resources and coastal and marine environments, air quality, and natural disaster reduction). In addition, there are three cross-cutting subcommittees on environmental technology, risk assessment, and socioeconomic research. The CENR has developed a draft strategy for environment and natural resources R&D across all these areas, and will be developing an implementation plan over the coming months. Through this interagency process, existing programs and resources are currently being analyzed to determine gaps and overlaps, as well as to identify near and long-term R&D priorities. The CENR process will significantly enhance the use of merit review and competitive selection in federal research projects.

In a very short time, with exceptional agency cooperation, we have initiated major changes and made much progress. In particular, EPA is currently engaged in a fundamental restructuring of the Agency's R&D program. Such significant changes must be given time to work. The President has endorsed our process and expressed his opinion about the need for an NIE in letters to constituents: "At this time, I do not believe there is a compelling reason to fundamentally restructure the research agencies or to create any new entities given the changes that have already been initiated." I hope you will inform your staff that this is the Administration position on the National Institute for the Environment.

Heads of Departments and Agencies

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EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

THE DIRECTOR

MEMORANDUM FOR THE HEADS OF DEPARTMENTS AND AGENCIES

FROM: Alice M. Rivlin *AMR*
Acting Director

SUBJECT: FY 1996 R&D Data Collection and Review

On May 6, 1994, the agencies were sent a memorandum from OMB (M-94-20) outlining the FY 1996 research and development (R&D) policy principles and priorities. Attached you will find a memo signed by the President's Science Advisor and I providing you with the additional FY 1996 R&D data collection and review information that was mentioned to be forthcoming in the May 6th memorandum. Also attached is a list of NSTC agency representatives. You should address any further questions you might have on this memorandum to your agency's NSTC representative.

Attachments

NATIONAL SCIENCE AND TECHNOLOGY COUNCIL
DEPUTIES GROUP ON FY 1996 R&D PRIORITIES

William M. Wise	Office of the Vice President
Timothy Wirth	Department of State
John Deutch	Department of Defense
Deborah Knopman	Department of the Interior
Richard Rominger	Department of Agriculture
David Barram	Department of Commerce
D. James Baker	National Oceanic and Atmospheric Administration
Robert Portman	Department of Labor
D.A. Henderson	Department of Health and Human Services
Mortimer Downey	Department of Transportation
Charles Curtis	Department of Energy
Madeleine Kunin	Department of Education
Gary Foley	Environmental Protection Agency
John R. Dailey	National Aeronautics and Space Administration
Neal Lane	National Science Foundation
Alice M. Rivlin	Office of Management and Budget
W. Bowman Cutler	National Economic Council
Bruce Reed	Domestic Policy Council
Joseph E. Stiglitz	Council of Economic Advisers
James W. Reed	National Security Council
Harold Varmus	National Institutes of Health
John Holum	Arms Control and Disarmament Agency

THE WHITE HOUSE
WASHINGTON

August 5, 1994

MEMORANDUM FOR THE HEADS OF EXECUTIVE DEPARTMENTS AND
AGENCIES AND THE NATIONAL SCIENCE AND TECHNOLOGY COUNCIL
COMMITTEE CHAIRS

FROM:  Alice Rivlin and Jack Gibbons 

SUBJECT: FY 1996 R&D Data Collection and Review

On May 6, 1994, we sent the agencies a memorandum outlining the FY 1996 research and development (R&D) policy principles and priorities. It is expected that the agency FY 1996 budget requests will support these principles and priorities and do so within the budget totals received from OMB. The purpose of this memo is to provide you with the additional process and reporting information that was mentioned to be forthcoming in the May 6th memorandum.

Since the transmittal of the May 6th memorandum, we have been considering the most effective and least burdensome way of collecting and reviewing the agency's responses to these R&D policy principles and priorities. Outlined below are the roles and expected products from the agencies and the NSTC committees in collecting, analyzing, and reporting FY 1996 R&D data. Several priority areas were selected for formal interagency assessments in FY 1996 (see section 3). Although the other R&D priority areas mentioned in the May 6, 1994 memo are still considered very important and information is being requested for them (see section 4), it was judged that they were not ready for a formal, interagency budget analysis during the development of the FY 1996 budget. The FY 1996 R&D data collection and review process components include:

1. Basic, Applied, and Development R&D Totals. As has been done for many years, agency totals will be collected electronically through OMB Circular A-11 44A R&D Exhibit. Exhibit 44A has been updated this year to include data collection on merit reviewed scientific research with peer review evaluation and competitive selection. This data will be due September 29, 1994. Agency's current Exhibit 44A Point-of-Contacts will be provided with instructions in mid-September on how to input this data electronically into the OMB's MAX computer system.
2. Agency R&D Total by Program/Project. Agency R&D totals will be collected at the program/project level. This data collection will be arranged on an agency-by-agency basis to reflect the most efficient format and structure for collection. OMB staff will

be contacting agency budget offices directly on how to respond to this component. This data will be due September 29, 1994.

3. Priority Assessments and Budget Analysis. The NSTC committees are being asked to provide OMB and OSTP by September 29, 1994 with a 5-10 page summary of the following priority areas:

<u>Priority Area</u>	<u>NSTC Committee</u>
Environment and Natural Resources	Environment and Natural Resources
High Performance Computing and Communications (HPCC)	Information and Communications R&D
Partnership for New Generation Vehicle (PNGV)	Civilian Industrial Technology
National Electronics Manufacturing Initiative	Civilian Industrial Technology
Learning Productivity	Education and Training R&D
Building and Construction	Civilian Industrial Technology
Transportation Physical Infrastructure	Transportation R&D
Peacekeeping, Special Operations, and Low Intensity Conflict	National Security

We request that all agencies provide the Chair of the appropriate NSTC Committee with your agency's contributions to these assessment areas. Agencies must be responsible for ensuring that the budgets proposed to these committees represent the views of the agency's senior management, are consistent with OMB budget guidance, and are highlighted in their agency's budget submittal to OMB on September 9, 1994.

The summary must include a description of each assessment area's budget and describe how important goals and policy issues are addressed, including a strategy to measure the progress and performance of achieving these goals. It should also identify any funding shortfalls associated with important policy issues and provide options on how they can be accommodated within the agency budget totals. The summary should also include a list of agency programs within the assessment area. Two funding options should be provided, one at the total FY 1995 enacted levels or best current estimate of anticipated enacted level (i.e., level funding between FY 1995 and FY 1996), and another at the total FY 1996 agency request levels. It should be clear how these options differ in achieving the overall goals of the assessment area.

Each Committee will transmit to Committee members further instructions that clarify the content, format, process, and internal schedule to meet the September 29, 1994 deadline. Where useful and appropriate, Committees should review agency contributions prior to September 9, 1994 in an effort to determine or influence how responsive agency budgets have been to the these priority areas. Each Committee

should be prepared to develop a short summary of the assessment area suitable for publishing once the President's FY 1996 budget has been transmitted to the Congress.

A Terms of Reference (TOR) has already been transmitted by OMB and OSTP (June 28) for the environmental and natural resources assessment. For the rest of the assessment areas, this memo should be considered the TOR. In addition, an Arctic research TOR was transmitted from OMB and OSTP to the Interagency Arctic Research Policy Committee to fulfill the Arctic research crosscut requirements mandated in the Arctic Research and Policy Act and current policy.

The recently issued (June 24) TOR for the Information Infrastructure Task Force (IITF) asks that R&D activities relevant to the IITF be provided by the NSTC. Likewise, a July 11, 1994 memo from Bill Galston, Gene Sperling, and John Gibbons asks for R&D relevant to learning and technology. Neither of these non-NSTC reviews will duplicate the NSTC assessments, but will incorporate the results of relevant NSTC assessments into their analysis.

4. Other Priority Areas. All NSTC Committees should continue to further examine and refine the definitions and agency contributions to the remaining list of priorities (according to Committee jurisdiction) cited in the May 6th memo. To the extent possible, agency committee representatives should also provide data to the committees in these priority areas. It is intended that this budget data exchange occur at the program-manager-to-program-manager level. Unlike the assessment areas mentioned above, we are not asking for data that has been cleared by agency budget offices. This information will also be incorporated into the Committee Strategic Implementation Plan. In addition, Committees should be prepared to assist OMB and OSTP in resolving R&D funding issues that arise in these areas during the FY 1996 budget process.

In carrying out these data collection and review activities, please keep in mind the following general provisions:

Participation. Agencies conducting R&D are strongly urged to provide the information required for NSTC Committee assessment in a timely manner. The information will provide OMB, OSTP, and the NSTC Committees with the means for understanding the current agency efforts in the assessment areas, aid in developing an integrated interagency program, identify R&D gaps that need funding and areas of duplication to ensure that maximum benefits are realized from Federal investments.

Data Sharing and Confidentiality. FY 1996 budget information is part of the internal deliberative process of the Executive Branch and is therefore confidential and should not be shared with parties outside the Executive Branch prior to submission of the President's FY 1996 Budget to Congress. This does not mean that agencies cannot

share FY 1996 budget information within the NSTC Committees. Indeed, it is critical that they do. Although agency budget requests are still in the development stage, to meet the NSTC timeframe for submitting NSTC Committee R&D Strategy and Implementation Plans, work needs to start immediately.

Definitions. For the purpose of this activity, research will be defined in accordance with OMB's Circular A-11 R&D definitions.

Data Collection. For the purpose of this activity, there will be no double counting between assessment areas in section 3 and to the extent practicable in section 4.