



**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
WASHINGTON D.C. 20460**

**OFFICE OF THE ADMINISTRATOR  
SCIENCE ADVISORY BOARD**

**March 13, 2007**

**EPA-SAB-07-004**

The Honorable Stephen L. Johnson  
Administrator  
U.S. Environmental Protection Agency  
1200 Pennsylvania Avenue, N.W.  
Washington, D.C. 20460

Subject: Comments on EPA's Strategic Research Directions and Research  
Budget for FY 2008, An Advisory Report of the U.S. Environmental  
Protection Agency Science Advisory Board

Dear Administrator Johnson:

For many years the EPA Science Advisory Board (SAB) has performed detailed annual reviews of the Agency's Research and Development (R&D) budget request. This year, ORD requested that the Board provide advice on the strategic directions (over the next five years) of its major research programs. For its part, the Board asked ORD to address its current and planned research program in four key cross-program environmental challenge areas. These included: (1) the impacts of climate change; (2) sensitive populations (both human and ecological); (3) the environmental consequences of urban sprawl; and (4) large-scale natural and man-made environmental disasters.

The SAB findings and recommendations are detailed in this report. Overall, the SAB believes that EPA scientists are doing an outstanding job of sustaining a high quality program of research in the face of severe budget constraints that appear to have caused EPA's research planning to become more reactive and less strategic. With few important exceptions (e.g. nanotechnology, sustainability research), the resulting research funding decisions appear to be incremental rather than strategic, causing research programs to focus more on yesterday's issues and less on new and emerging environmental problems.

Further, while the Agency was able to identify its longer term strategic directions for many specific program areas, and also identified a variety of lines of research relevant to the four cross-program issues identified by the Board, cross-program strategic planning is still very limited. EPA urgently needs to develop a higher-level research planning effort that can consider and adjust the balance and focus among major program areas and increase coordination and collaboration across program areas.

With respect to the FY 2008 President's budget, the SAB has grave concerns about the decreased trend in the funding of ecosystems research, decreased funding of STAR extramural and fellowship programs, and the elimination of the economics and decision sciences research program within ORD. The SAB is concerned that continuing intentions to decrease EPA's support of research will erode staff morale and ultimately, if it has not already done so, harm EPA's ability to maintain national leadership in environmental science and engineering.

The SAB looks forward to receiving your response concerning this year's advisory on FY 2008 research budget request and to its continuing interactions with ORD on EPA's future research needs and priorities.

Sincerely,

*/Signed/*

Dr. M. Granger Morgan  
Chair  
Science Advisory Board

## NOTICE

This report has been written as part of the activities of the EPA Science Advisory Board (SAB), a public advisory group providing extramural scientific information and advice to the Administrator and other officials of the Environmental Protection Agency. The SAB is structured to provide balanced, expert assessment of scientific matters related to problems facing the Agency. This report has not been reviewed for approval by the Agency and, hence, the contents of this report do not necessarily represent the views and policies of the Environmental Protection Agency, nor of other agencies in the Executive Branch of the Federal government, nor does mention of trade names of commercial products constitute a recommendation for use. Reports of the SAB are posted on the EPA website at <http://www.epa.gov/sab>.

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\*Members attending the February 22-23, 2007 meeting during which the EPA strategic research directions and FY 2008 research budget were discussed.

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## 1. GENERAL COMMENTS

The mission of the Environmental Protection Agency is to protect human health and the environment. To do that in an effective and efficient way requires a deep understanding of environmental science and technology. However, between 2004 and the proposed 2008 budget, the overall support for Research and Development at EPA has declined by 25% in inflation adjusted terms.<sup>1</sup>

For many years the EPA Science Advisory Board (SAB) has performed detailed reviews of the Agency's Research and Development (R&D) budget. However, the SAB has seen little noticeable effect from its annual plea to redress what it sees as the continuing erosion of the ability to grow the knowledge base at EPA. This year, therefore, the SAB decided to take a different approach.

The SAB again offers commentary about some specifics of the Agency's research budget, however, the SAB has focused much of its attention on a longer term more strategic look, attempting to assess how well the EPA's current research program is likely to prepare the Agency to address four key environmental challenges over the coming decades. While the Agency will face many challenges, the four chosen by the SAB for its focus, and which the SAB asked EPA to address, are:

- a) Climate change, including both impacts (for example on: natural ecosystems; water, coastal regions through sea level rise; air quality) as well as key issues such as terrestrial and deep geological sequestration that may arise as a result of future efforts in abatement.
- b) Sensitive populations, both human and ecological.
- c) Urban sprawl and the associated consequences for land use, stresses on ecosystems, stresses on sensitive populations, water contamination, air quality, loss of open space, and related issues.
- d) Environmental disasters, both those that may arise as a result of natural causes (such as hurricanes, ice storms, drought, earthquakes and volcanism) as well as terrorist induced events.

The full text of our request to Dr. George Gray, Assistant Administrator for Research and Development, is in Appendix A to this advisory report.

Agency staff made a serious attempt to respond to this request, revealing a mixed picture. While the agency can identify a variety of lines of research relevant to each problem, it

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<sup>1</sup> As reported by the AAAS R&D Budget and Policy Program at <http://www.aaas.org/spp/rd/cht9508b.pdf>.

is very clear that there has been far too little cross-EPA or interagency research planning on these topics. Specifically:

- a) Research related to climate change was identified to us as the most coherently planned. While there is clear coherence within the domains of climate change impacts on air and water, there are large and important issues not being addressed. For example, while the Department of Energy is performing research on deep geological sequestration of CO<sub>2</sub>, the EPA is not looking carefully at whether this research will provide the necessary basis for future science-based regulation. Similarly, land use, soil and water issues that may arise in connection with bio-mass energy production are not being seriously studied, nor, to our knowledge, are these and several similar issues being addressed elsewhere across the Federal system.
- b) The Agency has ongoing, though shrinking, programs to study certain human populations that are sensitive to some important environmental stressors. However, studies of sensitive ecosystems are very limited, as are studies of human populations which are dependent upon those ecosystems.
- c) While there is considerable research directed at cleaning up legacy problems in land contamination (some of which remain very important), there is not yet a coherent program to systematically understand and redress the environmental problems arising from such land-use issues as shifting population distributions, urban sprawl, and development pressures on already vulnerable low-lying coastal areas that will become even more stressed in the future as a result of sea level rise and other impacts of climate change.
- d) While there is limited work drawing lessons from Hurricane Katrina, we found no systematic research program to anticipate and mitigate possible future environmental disasters. Indeed the proposed budget would totally eliminate Central Basin (Mississippi-Missouri River) monitoring, and cut EPA's already under-funded wetlands program. While the EPA has only partial regulatory and management responsibility for dealing with natural or terrorist-induced environmental disasters, this is no justification for devoting so little attention to this critical topic.

From this look at a sample of four important environmental problems, we draw the following general conclusions:

- a) The Agency's research programs have long faced greater demands than they have had money, time, or attention to address; the planning process has fallen into a reactive mode that is too often playing catch up.
- b) With a few important exceptions, the Agency's funding decisions in R&D appear to be incremental rather than strategic, leaving allocations within and across major program areas rather stable. In many cases there is an overemphasis on yesterday's problems and insufficient attention to new and emerging problems.

- c) On the positive side, the introduction of a new system of National Program Directors, with wide-ranging responsibility to set priorities within specific program areas (such as air, water, or human health), and across Centers and Laboratories, holds the promise of improved balance and a more strategic design of research plans *within* existing program areas.
- d) The agency urgently needs to develop a higher level research planning effort that can:
  - i) consider and adjust the balance and focus among major program areas and increase coordination and collaborations across program areas (i.e. begin to break down the "stovepipes" within which many of these program have been operating);
  - ii) be better coordinated with, and build upon, the research programs of other Federal agencies;
  - iii) benchmark EPA's research with other cutting edge programs in environmental research around the world; and
  - iv) restore our national leadership in environmental science and engineering so as to assure our international competitiveness and provide the knowledge and technology that Americans will needs in the 21<sup>st</sup> Century.
- e) However, effective high level research planning is unlikely to occur in the face of a continually eroding research budget, when so much attention must be directed at simply holding things together.

In addition to this general assessment, the SAB also reviewed the Agency's existing program structure, in each case asking: 1) Is the balance within the program appropriate? Are the most critical scientific questions receiving a high priority? Have adequate financial resources been allocated to address them? Are there important questions that have been left out? 2) Is the Agency, and particularly the Office of Research and Development (ORD), being sufficiently proactive in designing research programs that will adequately meet the Agency's likely future needs?

The Agency scientific and technical staff and managers are doing a remarkable job of sustaining high quality research in the face of a continuing erosion of financial support. However, in our examination of existing research program areas, we found three developments to be especially troubling.

The decline in funding for ecosystem research has continued (see Figure 1). One consequence of these cuts is that the Agency is largely abandoning past efforts to monitor the status of key ecosystems (e.g. terminating a long-term program tracking the impacts and benefits of reduced acid deposition on streams and

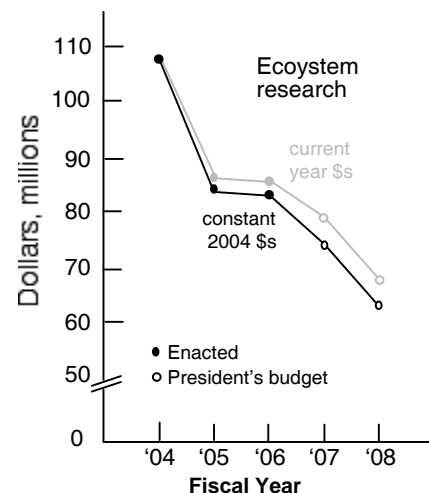


Figure 1: Recent history of EPA ecosystem research funding. Adjustment to constant dollars done with the NASA Gross Domestic Product Deflator /Inflation Calculator available at <http://cost.jsc.nasa.gov/inflateGDP.html>

lakes in the mid-Atlantic and North East). The Agency has expressed a commitment to estimate the economic value of "ecosystem services." However, as explained below, many of the financial and human resources needed to do this well, have been eliminated.

In order to assess ecosystem services it is essential to collect the data needed to assess the health of ecosystems over time and to develop a basic scientific understanding of the complex interactions within ecosystems. For example, as climate changes, not all species will be able to respond in the same way so entire coherent ecosystems will not be able to gradually move north (or up mountains). Instead, separate species will, or will not, be able to move, new pests will emerge, etc. The current EPA ecosystem research program will not provide the science needed to understand, predict, and plan for these changes, their consequences or how they might be mitigated. As a result, EPA will fail the country in this vital mission.

One argument that has been used to justify the ongoing cuts in support for ecosystem research has been that this program has not been able to quantify the benefits that it is producing. At the same time there is a proposal to eliminate the ORD program in Economics and Decision Sciences Research. It appears seriously misguided to raise the bar for comprehensive cost-effective or benefit-cost justification for environmental science research, while simultaneously shrinking the resources devoted to the types of research needed to assess the net social benefits of the outcomes of environmental science research.

Economics and Decision Science resources at the Agency were small to start with (about \$2.5 million). This budget has been reduced to about \$1 million, as staff from the program in ORD, are relocated to the National Center for Environmental Economics (NCEE) within the

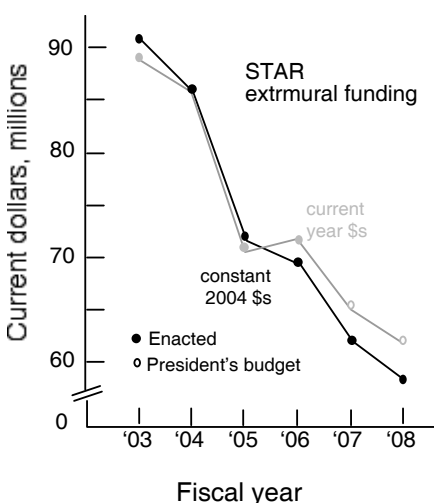


Figure 2: Recent funding history of the EPA STAR extramural program. Adjustment to constant dollars done with the NASA Gross Domestic Product Deflator /Inflation Calculator available at <http://cost.jsc.nasa.gov/inflateGDP.html>

Office of Policy, Economics and Innovation (OPEI). In jeopardy are the already very limited resources for extramural research. Also threatened will be Agency's tradition of partnering with other institutions to co-sponsor (at roughly \$10-20,000 each) its series of recurring research workshops and conferences. These events have long been a key forum in which to identify and explore the frontiers of environmental economics research. The transition to the NCEE also appears to almost completely eliminate other social sciences disciplines, so that the representation of essential human behavior disciplines (such as psychology, sociology, and anthropology) is decreased to near zero.

An equally disturbing trend is the continuing decline in financial support for extramural research through the STAR program. Figure 2 shows this trend. A number of EPA research programs that could greatly benefit from contributions from extramural research conducted through the STAR program, are not participating.

An especially troubling part of this downward trend is the erosion of the STAR Graduate Fellowship program, down from \$9.7-million in FY 2003 to a proposed \$5.9-million in 2008. This program has been critically important in educating the next generation of environmental scientists and engineers who will be needed by EPA, the States and the private sector. It has played a vital role in supporting interdisciplinary study of environmental problems. There are several changes that we found to be very positive. The current focus and modest growth in support for the program in nano-technology are both good developments, because understanding the fate and transport of nano-materials is likely to be increasingly important to the Agency in the future. It is also time to begin a modest program of research to identify possible strategies for regulation, because the classic "toxicological testing" approach is unlikely to be viable if it is applied unchanged to nano-technology evaluations.

Although very small, the new Sustainability Research Strategy and associated Multi-year Plan could provide a valuable integrating framework for EPA core and problem-driven research. These efforts support the transition from the traditional single-media approach of environmental protection to a more systems-based and fully integrative process based on life-cycle principles. ORD's sustainability research program should be developed in a way that enables the Agency to address the most challenging and multifaceted environmental issues, such as urban sprawl, climate change, the environmental consequences of biofuels production, and ecosystem degradation in interdisciplinary ways that can provide cost-effective options for reducing a range of environmental impacts. In addition to the modest progress in nano-technology and sustainability, there are other fine research programs and activities within ORD.

The SAB is concerned that, as the overall level of financial support for research in the Agency continues to decline, despite the growing number of difficult and complex environmental challenges, two dynamics will further erode the EPA's research capabilities:

- a) Staff morale will suffer, resulting in an accelerated loss of outstanding people, and it will be increasingly difficult to recruit new young scientists and engineers, who will see options for more rewarding careers elsewhere.
- b) As budgets shrink, and the agency struggles to keep staffing size reasonably stable, a higher proportion of funds will go to salaries, and less to the other costs of research (laboratories, field studies, computers, research travel for collaboration and discussion of findings at professional conferences, etc.).

Agency scientists are doing an outstanding job of nurturing and sustaining a high quality program of research in the face of very serious constraints. They must be provided far better budgetary support if they are to lead and catalyze our efforts to develop the knowledge and approaches necessary to protect the nation's human health and the environment in the face of hazards that increasingly exhibit integrated characteristics resulting from man-made behavior and natural processes.

As the House Committee on Science and Technology confers on these matters with its colleagues on the Appropriations Committee, we urge particular attention to the following needs to:

- a) Reverse the downward trend in support for ecosystem research so that this research program can continue its essential monitoring of the health of vital ecosystems, develop and implement new measures of the value of environmental services, and create the basic understanding that will be needed to respond to the challenges facing our ecosystems from climate change and from the "externalities" of new technologies such as biomass fuel and nanotechnology.
- b) Reverse the downward trend in support for the STAR extramural and Fellowship programs so that the agency can continue to benefit from fresh ideas and flexibility provided by institutions from outside EPA and continue a robust program of educating the next generation of environmental scientists and engineers.
- c) Reinststate the program in economics and decision sciences within ORD and add support to substantially increase its capabilities in behavioral social science. Even the best science and engineering results are useless if they are not combined with a sufficient understanding of human risk perception and behavior.
- d) Provide a significant increase in support for the programs in sustainability and global change, because these topics are both inherently important and provide effective vehicles for moving the agency in the direction of the innovative, cross-cutting research needed to address the critical environmental problems of the 21<sup>st</sup> century.

## **2. AIR, GLOBAL CHANGE AND MERCURY RESEARCH**

### **2.1 Clean Air Research**

EPA's 2008 Research Budget requests \$81 million for clean air research, reflecting a \$3.3 million increase. The \$81 million budget also reflects the consolidation of previously separate research programs on air toxics and criteria pollutants. The increase in funding for clean air research is important to assist the agency in meeting statutory requirements to review the National Ambient Air Quality Standard (NAAQS) for each of the criteria pollutants every five years. Additional support is also well justified to improve emissions inventories as needed to implement the NAAQS, and to initiate a new effort focused on near-highway exposures to air pollution. Consolidation of the research efforts on toxics and criteria pollutants is also consistent with recommendations from numerous parties (including prior SAB budget reviews) calling on EPA to follow an integrated, one-atmosphere approach. While consolidation of air toxics and criteria pollutant research should create new opportunities to pursue projects with multiple benefits and better exploit synergies in research efforts, the Agency needs to ensure that air toxics research efforts are not further reduced as a result. The air toxics research effort has lost significant funding since 2006 (a reduction from \$18.5 million to \$12 million) at a time when critical research needs remain.

In a summary of its five-year strategic vision for Clean Air Research, EPA identified a critical and appropriate strategic focus on improved mechanistic understandings of the health effects of particulate matter. The Agency is addressing the relationship between particle composition and toxicity as recommended by the National Research Council. The Agency appears to be pursuing a sound strategy by considering this extremely complex issue by examining the effects of compositional mixtures characterized by geographic location and source. The SAB believes that EPA is appropriately pursuing the development of improved processing tools to understand how future changes in climate will alter air quality. With additional resources, it would be highly desirable to extend these efforts to further develop coupled land-surface, meteorological and chemistry and transport models that would allow comprehensive assessment of the consequences of the effect of land-use and atmospheric composition changes on air quality.

Research on the effects of air pollution on ecosystems is a critical and growing gap in the Agency's research portfolio. This research is needed to support EPA's obligation under the Clean Air Act to set secondary air quality standards to protect the public welfare, and also to improve the Agency's ability to demonstrate results for existing air quality management programs. The National Research Council Committee on Air Quality Management in the United States (2004) highlighted the need for the agency to better address ecosystem protection as part of its air quality management programs. Recent Clean Air Scientific Advisory Committee (CASAC) reviews and recommendations on the PM and ozone standards affirmed this need. This concern is even more important because of the dramatic drop in EPA's overall budget for ecosystem research, its decision to terminate Environmental Monitoring and Assessment Program (EMAP) efforts to track ecosystem condition at the regional scale, and its decision to significantly reduce funding for deposition monitoring through the CASTNET program. As part

of its EMAP budget reductions, EPA is proposing to terminate the TIME/LTM surface water monitoring network in the Northeast, which has provided valuable data to both researchers and public agencies for use in assessing the effect of the acid rain program. EPA should reconsider its decision to reduce funding for these critical monitoring programs when their mission is far from complete.

## **2.2 Global Change Research**

Several Federal programs address specific parts of the global change issue. The EPA research program in climate change is doing a good job of addressing a small part of this very large problem. The EPA program is exploring the questions of how global change is likely to impact air quality and water resources. These are obviously important questions both for the nation and for the design and evolution of EPA's future regulatory efforts for clean air and clean water. However they represent only a small part of the research needs raised by climate and other issues of global change.

On the impacts side, climate change will profoundly affect natural ecosystems. The U.S. is a large developed country that already operates its society and economy across a wide range of climates. Unlike many less-developed countries, the U.S. also enjoys high adaptive capacity. A New England without birch, maple and white pine; Florida with much of the Everglades lost to rising sea levels; or the loss of polar bears in Alaska may turn out to be of greater concern to Americans than many of the more direct human impacts. However, because of very limited resources, the EPA's global change research program is currently unable to address any of the questions associated with these issues.

Many of the responses to global change may also have impacts that should be studied so that they can be understood and plans can be made to manage them appropriately *before* they arise. For example, while biomass fuel holds the potential to drastically limit future net CO<sub>2</sub> emissions to the atmosphere, it will require vast amounts of land and may have important impacts on ecosystems, on soil degradation, and on water quality and water demand. These fuels can also yield different combustion products that will present changing concerns for air quality. While some of these issues now appear to be on the agenda of the new sustainability initiative, they have yet to be addressed in a serious way, or integrated with the global change research program.

The U.S. has vast reserves of coal. Modern methods of carbon capture and deep geological sequestration (CCS) hold the potential to allow the country to continue to make use of those reserves without unacceptable emissions of CO<sub>2</sub>. While the Department of Energy (DOE) has the lead for developing these technologies, sooner or later the EPA will likely be responsible for regulating some of the activities associated with their use. It is not too soon for the Agency to begin to ask some important questions. For example, will the knowledge that is being developed by the DOE (and other public and private sector research programs around the world) be adequate to support science-based regulation of CCS when EPA is called upon to do so?

Current EPA managers in the global change program are technically knowledgeable and proactive. With a substantial increase in research support, the program could be making much larger and more important contributions.



## **2.3 Mercury Research**

Like the global change research program, the mercury program is of high quality, is addressing a number of important questions, but is not able to address other key questions because of severe budget constraints. While the U.S. spends growing amounts of money to reduce emissions from industrial sources such as coal-fired power plants, we still do not fully understand where all the mercury in the environment comes from, where it goes, and how different chemical forms interact with the ecosystem and humans. The EPA program is addressing some of these questions within a national context, but mercury is a global problem. While the EPA program has begun to document important issues such as mercury that is carried across the Pacific from Asia, both scientific understanding and the process of developing efficient regulatory approaches would be considerably aided if there was a better understanding of the global mass balance of mercury (i.e., where does it come from on a global basis, how much comes from natural and from human sources, where is it transported, how is it converted chemically, and where does it end up?) Whether EPA should undertake such a global program on its own or in conjunction with another Federal agency (such as NOAA) is a legitimate policy question, but either way, the need for a better understanding is urgent.

Clearly the EPA's focus on the United States, particularly on local "hot spots," is very important. However, without a more basic understanding of global issues, serious limitations may arise in our ability to limit human exposure to this neurotoxin.

### 3. HOMELAND SECURITY

The Environmental Protection Agency bears responsibility for important elements of the nation's homeland security, notably in areas of water protection, decontamination, and rapid risk assessment. EPA's tasks require cutting-edge research in the natural and social sciences. On the one hand, it needs technology capable of rapidly characterizing a wide variety of potential contaminants, with sufficient precision to guide individuals with diverse needs (e.g., consumers, healthcare professionals, water system operators, first responders). On the other hand, it needs to ensure that these technologies are maintained despite long periods of inactivity and are integrated with routine and emergency communications systems. The Agency must also establish and maintain widespread public trust as an authoritative, useful information source in potentially stressful and chaotic situations, and among multiple competitors.

The Agency's budget provides for some natural science and engineering research in the Homeland Security program (as well as many other programs). However, it does not provide for any significant social science research beyond basic cost-effectiveness assessment. Even when the importance of social variables is recognized (e.g., risk communication and perception, emergency response), the topics are treated in an unsophisticated, *ad hoc* way. Without sound behavioral social science, it is impossible to take full advantage of the conscientious work done by the Agency's natural scientists and engineers.

The SAB believes that the absence of social science expertise, other than the limited amount of economics required for cost-effectiveness analysis, imperils the effectiveness of programs throughout the Agency, wherever they influence processes that affect people or depend on their behavior. The Agency must provide the science needed for specific projects, but it must also develop a future workforce with these competencies. Although the Agency has made workforce issues a priority, its proposed budget not only ignores social science, but eliminates one of its few research programs (Economics and Decision Science) that made any significant contributions to such development. Without a suitable workforce, the Agency has little to draw upon when new challenges emerge, like homeland security, nanotechnology, or sustainability.

The SAB is also troubled by the lack of a compelling rationale for the Agency's overall portfolio of homeland security research. All of the programs might be worth doing if executed well (assuming they also included attention to their human behavior elements). However, it was not clear that they are conceptualized in ways that would create results with the greatest usefulness for the universe of homeland security threats – especially given the all-hazards perspective that Hurricane Katrina brought into focus (e.g., it is easier to imagine the general value of a technique to optimize sensor placement rather than that of a sensor for a specific contaminant.)

A very significant omission from the Homeland Security research program is the lack of activities that respond to the challenge of identifying the social values that should guide decontamination standards (once the science has been summarized by technical specialists). As mentioned earlier, EPA has also reduced work on developing restoration techniques for clean-up

after a dirty bomb in an urban setting. EPA has experience with clean-up of radioactively contaminated sites. However, EPA requires research support as it moves from technical decommissioning projects to the integration of social values into decommissioning decisions particularly with respect to those affecting urban areas.

A third omission, which also demonstrates the need to integrate natural and social sciences, is the critical need for a plan for the disposal of infected animal carcasses, for which EPA has leadership responsibility among federal agencies. The need for such disposal could arise from avian flu, hoof-and-mouth disease, or a terrorist attack. Appropriate strategies must consider where farms are sited, how to minimize carcass transport, the possibilities for mobile incineration, the groundwater quality effects of burying carcasses or ashes, the acceptability of disposal on public and private sites, and public understanding of residual risks (if any) to the food supply. EPA has thus far failed to provide scientifically sound guidance, so states have begun to perform their own rudimentary evaluations. Inevitably these state-level standards will vary and this will send confusing signals to the public, which will see different practices in different states.

A positive feature of the budget is that it proposes to reduce expenditures on the Water Security Initiative, given completion of demonstration projects. That means both that the program has achieved Agency milestones and that the science budget will not be burdened with a long-term operational responsibility in this area.

## **4. ECOLOGICAL PROTECTION, WATER QUALITY AND DRINKING WATER RESEARCH**

### **4.1 Ecological Protection Research**

EPA's Ecological Research Program (ERP) in ORD has experienced a crippling decrease in funding from \$108 million in FY 2003 to \$68 million in the FY2008 budget. The program was in the process of developing the science for assessing the status, and trends in the health, of several key components of our natural resource capital (streams, rivers, forests, and wetlands). In this effort, the ERP has provided valuable methods and data. Now, the ecological research program is in the planning stages of a program reorientation that would focus on defining and evaluating ecological services, and changes in their levels. The SAB understands the need for a clearer definition of ecological services and their values and therefore endorses this effort as an *added* effort in ecosystem research. It is the SAB's belief that a clearer understanding and illumination of these services may well lead to greater appreciation of their value to our society. The SAB believes that this program has a fundamental need for the inclusion of economics and behavioral science expertise.

*High Quality* research on ecological services must be built on a conceptual foundation that rests on an understanding of ecosystem conditions and functions, and how ecosystems respond to stresses. It will not be possible to implement the new focus on ecological services without continuing EPA's core research on ecosystem function. Similarly, the focus on ecological services is explicitly impacted by the phase-out of ecosystem condition assessments. Such ecosystem assessments produce the inputs – in terms of both data and understanding – needed to assess ecological services and their value to society. The termination of many of the current programs will cause data gaps that preclude determination of long-term trends. The SAB is concerned about the concurrent reduction in work and contributions to our understanding of the status of our nation's ecosystems and the more basic science necessary to protect and restore the same services in question. Given the continuing budget cuts to core programs for ecosystem function and condition research, it is not clear how a shift in attention to ecological services can be accomplished.

### **4.2 Water Quality**

The Water Quality Research Program's strategic directions for 2008-2012 focus on water integrity, watersheds and urban issues. High-priority research areas include: research in support of developing nutrient criteria, research that supports improved TMDL decision-making processes in watersheds, and research concerning strategic for dealing with the country's aging wastewater infrastructure.

The three long-term goals appear to be an extension of the program's research goals as stated over the last five years. However there is a shift in the priority attached to each of the goals to address changing research needs of users. The SAB supports the long-term goals of the water quality research program. The goals address important and critical research needs to protect, restore and sustain the integrity of the nation's waters. However, the technical skills,

time, and money available to develop and implement TMDLs appear to be a small fraction of what is required to achieve the goals of the program, and progress has seemed glacially slow to date. We encourage ORD to continue to refine its strategic directions for this research effort to ensure that the research results can most effectively help speed the process of TMDL development, especially in making TMDL development more operable and consistent at the local and regional level.

#### **4.3 Drinking Water Research**

The strategic focus of the Drinking Water Research program is on pathogens, unregulated contaminants, distribution systems, and source water protection. These topics respond to, and anticipate, the needs of the program's major client, the Office of Water, and its rule-making, enforcement, and guidance activities. Program plans intend to increase the emphasis of research on epidemiological studies of gastrointestinal illness, development of methods for assessment of viability, infectivity and virulence of water-borne pathogens, appropriate technology for small systems, minimization of water quality changes in distribution systems, management of the aging infrastructure of distribution systems, impact of water reuse on the safety of tap water, development of well-head protection tools, impact of subsurface carbon dioxide storage on source water quality, and development of best management practices for point and non-point sources of contaminants. Decreasing emphasis is planned for research involving arsenic and disinfection by-products as these contaminants have already been regulated by the Office of Water. Emerging unregulated contaminants (both chemical and biological) will receive continuing emphasis in response to Office of Water needs to address agents on the contaminant candidate list.

The SAB believes that the Drinking Water Research program is being proactive and is addressing the appropriate research needs related to drinking water. There appears to be a good blend of long- and short-term research. The plan to address chemical mixtures rather than individual contaminants is a good one, although regulation will still need to be done on a contaminant-by-contaminant basis. In view of recent questions involving potential adverse reproductive and developmental health effects of drinking water contaminants, the plan to address non-cancer end-points is also a good one. While arsenic and regulated disinfection by-products will receive decreased attention, it is good to see that there will still be a core component addressing these regulated contaminants to support the required periodic reevaluation of the public health benefits of the standards developed in previous rule-making activities.

The SAB notes that a number of Drinking Water Research Program activities intersect with and complement the Water Quality Research Program (e.g. watershed protection) and the Human Health Research Program (health effects of single contaminants versus mixtures; viability, infectivity and virulence of pathogens). The SAB notes the importance of managing the interface of these programs in order to maximize the value of the limited resources of the Agency and to avoid duplication of effort. The SAB also notes that the Drinking Water Research program is addressing a large number of very important questions. However, the rationale for the current allocation of resources (dollars and manpower) to each of the research areas is not clear. Without seeing such a breakdown, it is difficult to assess whether or not resources are adequate for the issues being addressed. There appears to be a natural synergy between some Drinking

Water research and some of the Homeland Security research activities, especially in the development of better, rapid biologic contaminant detectors that might replace existing public water supply monitoring methods for regulated contaminants.

## **5. HUMAN HEALTH AND HUMAN HEALTH RISK ASSESSMENT RESEARCH**

### **5.1 Human Health Risk Assessment**

The Human Health Risk Assessment Program (HHRAP) is housed in the National Center for Environmental Assessment, and is the principal EPA program for developing hazard and dose response methodologies and some specific analyses to support program office and region activities [most Program Offices also conduct assessments to support decision-making and, in so doing, often collaborate with NCEA in the conduct of such assessments, (e.g., Office of Prevention, Pesticides and toxic Substances, Office of Water)]. Over the next five years, the program plans to complete a large number of IRIS assessments (128), release many additional provisional peer-reviewed toxicity values (400), institute its Integrated Science Assessment program for the criteria air pollutants, and improve risk assessment methodologies. Uncertainty analyses, variability analysis, increasing use of mode-of-action information, physiologically based pharmacokinetic modeling, categorical regression, meta-analysis, approaches for assessing risk of environmental exposures to age-susceptible populations, and less-than-lifetime assessments were named as areas for improved assessment methodology development.

The \$42.8 million budget for this program reflects a \$4.5 million increase, which will accommodate increased staff salary and benefits, the start up of the NAAQS Integrated Science Assessments process, increased consultation with the National Academies on risk assessment issues, and improved methodology for uncertainty analysis. In this regard, the SAB notes the following:

- a) The development of integrated science assessments (ISAs) for criteria air pollutants appears to be a major step forward in improving the efficiency of the review of the NAAQS. The ISAs should be written in concert with a risk assessment document done by the Office of Air and Radiation that describes the scientific basis for evaluating the risks associated with various regulatory options.
- b) The SAB recognizes and strongly supports the Agency's commitment to develop a large number of IRIS and provisional peer-reviewed toxicity values.
- c) In the development of approaches for uncertainty and variability analysis, the program appears to have coordinated with other EPA programs - with the HHRAP developing the methodology, the Human Health Research Program providing some data, and the Computational Toxicology Research Program developing tools that would, in the long term, provide a basis for susceptibility assessment. The SAB has in past reviews of EPA assessments and methodologies, encouraged the Agency to develop and utilize probabilistic approaches to better characterize health effects. The SAB notes that research to develop or mine data and construct distributions to support the incorporation of variability into assessments was not apparent. The degree to which probabilistic approaches are being developed for non-cancer endpoints is also unclear. In this regard, the EPA needs methodologies and research to better understand human-to-human variability due to the cumulative impact of endogenous biological processes and environmental exposure processes, as well as predisposing health conditions.

## **5.2 Human Health Research**

The Human Health Research Program within ORD provides mechanistic data and exposure factors to support risk assessment activities by the HHRA program and several program offices. It also provides tools to aid in assessing the effectiveness of regulatory controls. The budget of \$56.8 million reflects a cut of \$4.0 million. Reductions were taken in the EPA's contribution to support the National Children's Study; exposure and effects assessment efforts for children, adolescents and older adults; cumulative risk and research on exposure models. Over the next five years, research in this program is expected to produce: "biologically interpretable indicators for health effects and chemical classes," a biomonitoring information tracking system developed in collaboration with federal partners, tools and approaches for assessing community risk, and tools to assess risk management decisions.

The baseline program budget for human health research has been essentially flat from FY05. The \$4.0 million drop in the FY08 budget request raises serious concerns about the Agency's commitment to meeting public expectations for health protection. This is particularly true for research concerning susceptible subpopulations, which will experience the deepest cut in this budget area. Without continued, substantive engagement in research on subpopulations, the Agency will not have the scientific bases it needs to support health-related decision making. The Board is very concerned about this major decrease and strongly encourages the Agency to identify ways to restore and further increase its FY08 support for subpopulation research.

The Risk Assessment Forum serves a crucial, integrative role for advancing risk assessment strategies and methods. The Forum provides an important mechanism for risk assessors to share knowledge and approaches, build skills across organizational units, and advance the Agency's risk assessment capacity, even as personnel and programs change. The SAB recognizes the synergistic value of the Forum and supports its activities. In addition, The Agency has done a good job coordinating its research efforts with other Federal partners such as the National Institute of Environmental Health Sciences (NIEHS) and choosing areas of research not being addressed already.

Adequate EPA funding for the National Children's Study is needed to ensure that the effects of environmental chemicals are studied using state-of-the-art methods that address appropriate hypotheses. The \$0.5 million cut in support for this effort and the additional \$2.5 million reduction of funding of research on exposure and effects in children, adolescents and older children raises serious concerns. Given the still limited understanding of the quantitative impact of environmental pollutants at early developmental stages, and in aging populations, reductions in this area seem misguided. The SAB expresses its support for providing additional resources to EPA to enable the Agency to support the National Children's Study.

Although aggregate and cumulative risk research is noted in documents provided to the SAB by the EPA, there is no explicit mention of research focused on the impacts of chemical mixtures. This is an important omission because mixtures make up the exposures actually experienced by human populations. It is not clear whether this is addressed by the multiple environmental stressors effort noted in the materials received by the SAB. Without research on this topic, risk assessment will continue to be limited to the single chemical approach. To meet



increasing public concerns about mixtures, the Board urges the Agency to find support for research on mixtures if it is not contained in the budget already.

The objective of the program to assess the impact of multiple environmental stressors on individual communities is timely and important. It is not clear what research efforts are being considered in this area (e.g., spatial mapping of potential environmental hazards using GIS technology in combination with human disease surveillance data).

While the SAB did not review the indicator research program in any detail, it notes the very brief program description received by the SAB was vague and planned activities were unclear (e.g., there is little information on what types of exposures and endpoints are being considered).

The extent to which the research program overall will produce data that will assist in human health risk assessment efforts was unclear. However, the extent of the effort appeared to be limited given the deliverables expected for the 2008-2015 timeframe. The research appears to focus on modeling and assessment tools for possible regulatory impact, as opposed to data generation for direct use in risk assessment. There does not appear to be research utilizing state-of-the-art approaches to elucidate gene-environment interactions. Research to support variability assessments for probabilistic assessment appears limited as well. Decreased support of mode-of-action research is also an area of concern to the SAB.

Improved linkages and collaboration with programs within and outside the Agency are needed to develop methods and assessment approaches using structure activity relationships or other predictive approaches to address existing chemicals for which toxicity test data do not exist. This is clearly an area of large uncertainty which goes uncharacterized. To support environmental decision-making, a research strategy needs to be articulated which will begin to address this deficiency for existing chemicals.

The SAB understands that it is important to assess the effectiveness of regulatory and research programs in general and the human health research program discussed above. However, in this case as in the earlier discussion of shifting the ecosystems program focus to services without conducting the needed underlying ecosystem function and condition research, the SAB is concerned that the research to develop necessary underlying information that will directly impact risk assessment has not been given a high enough priority in this proposal. Of particular concern is the reduction of effort to support assessment of impacts upon susceptible populations and a lack of emphasis on human variability research in general.

## **6. CONTAMINATED SITES/RESOURCE CONSERVATION AND NANOTECHNOLOGY**

### **6.1 Contaminated Sites/Resource Conservation (Land Preservation and Restoration)**

EPA's approach to Land Use and Preservation research remains strongly oriented toward "legacy" issues, with a much greater level of resources focused on restoration rather than prevention or preservation. Of the \$32.4 million total FY2008 request, \$20 million is provided by the Superfund Trust Funds, \$901,000 is dedicated to oil spill response, and \$660,000 to the LUST program. This leaves \$10.7 million for discretionary S&T research. The major shift in S&T for FY08 is \$685,500 for research on nanotechnology fate and transport.

While this shift is applauded by the SAB, it is still small relative to the size of the S&T budget in this area (approximately 7%). Research needs are significant in the area of land use, preservation, and prevention of contamination. In the future, the SAB recommends that the research emphasis shift to address the problems of the present and preventing those of the future, and not just cleaning up problems which are legacies from the past. The Agency would be well-advised to re-consider its strategy for such a shift, including the kinds of metrics that are appropriate. The use of Superfund resources for research is interpreted too narrowly; the Agency needs to think more carefully about the best use of these funds to protect the environment and human health in the future. Such a need for preservation-based-thinking is immediate. As examples, the Board raises the following concerns:

- a) Urban sprawl and associated problems (sustainable transportation, stormwater, infrastructure renewal, the built environment, etc.)
- b) Intensive agriculture (nutrient flows, marginal lands brought under cultivation, exacerbated by the policy of increased production of biofuels),
- c) Population increases in coastal areas, with associated land-use implications,
- d) Development of new regulatory approaches that are tailored to the specific properties of challenges posed by a range of different types of nano-material.

The Resource Conservation Challenge (RCC) focus on increasing the supply of recyclable materials, and to a lesser extent encouraging novel re-uses is apparent. The common feature for both programs is on influencing human behavior. It is unclear why research on these, and related, decision dynamics is not supported.

The RCC focus on relatively high volume, low toxicity materials (e.g. fly ash, consumer packaging) is certainly important. However, it is not obvious given the strong emphasis on hazardous waste remediation activities, why the RCC has declined to tackle more toxicity-related problems, i.e. to prevent land disposal of toxic substances, not just relatively benign materials.

The RCC has not addressed, in any substantive way, the control of nano-based materials. It could endeavor to influence the design of nano-products which would reduce the use of toxic

materials. It could also seek to improve the probability that materials can be recovered from nano-products.

There should be more research related to recycling, waste minimization, and energy recovery. These areas are poorly supported.

## **6.2 Nanotechnology**

This is a new research area for EPA that is based on its traditional risk model (fate and transport, exposure, toxicity, and risk management). The Agency has considerable experience and expertise that is relevant to nanoparticles because of its earlier and ongoing particulate matter research programs. However, it is not evident whether these two research groups interact and share their expertise.

EPA has described a clear strategic vision and timeline with appropriate short-term and long-term goals. Following an initial focus on using nanotechnology for environmental remediation, the STAR grant program has now identified several high priority areas: environmental fate and transport, transformation and exposure, and monitoring and detection methods. These priorities have been developed following collaboration and interaction with other federal agencies in the context of the National Nanotoxicology Initiative.

EPA's immediate budget priorities are to continue the STAR grant program and to develop an intramural research program. It is not certain whether the Agency has devoted sufficient funds and infrastructure support to meet the following needs:

- a) Assessment of novel structures and new materials used for nano-products
- b) Environmental and human health impacts of manufacturing methods that incorporate nanotechnology principles: advantages, disadvantages, or no impact?
- c) Consideration of recovery/recycling/reuse of nanomaterials and nano-structures

The nanotechnology industry is expanding rapidly and the Agency needs to reach out to small companies, particularly in the early stages of their development, to ensure that research is conducted on environmental and human health impacts that might be associated with potential nano-products. If firms address safety, health and environmental issues early in their product development cycle, they should increase the likelihood that health and safety issues will not later become impediments to the realization of the economic benefits from investments in nanotechnology. The Agency should support research to better understand what information is needed to regulate nanomaterials, and also to identify an appropriate regulatory framework.

Nanotechnology is an international industry and the United States must act quickly to be competitive. The Agency should engage international organizations in deliberating the proper management of nanomaterials and should devote sufficient funds and effort to developing health and safety guidelines for manufacture, use, and disposal of products based on nanomaterials.

## **7. PESTICIDES AND TOXICS SUBSTANCES RESEARCH**

### **7.1 Safe Pesticides/Safe Products Research**

The ORD Safe Pesticides/Safe Products Research Program provides critical technical and scientific support to the Office of Prevention, Pesticides and Toxic Substances (OPPTS) in support of that office's risk assessments and pesticide review and registration processes. In addition, the Program is conducting research in a number of scientific and bio-mathematical areas that are important to future challenges and opportunities that will certainly arise in OPPTS risk assessments. These include methods for monitoring gene flow from genetically engineered crops and applications of advances in genomics and protein sciences to better understand modes of action and quantify risks for existing and new pesticides and chemicals. The Safe Pesticides/Safe Products Program is commendable for continuing to focus a share of its program resources on the effects of pesticide and biotechnology products on non-target species (i.e. native plants, wildlife, aquatic species, and birds).

The Program will undergo both a PART and BOSC review in 2007. The strategic plan for 2008-2012 retains the balance in current program activities with emphasis in three major areas: 1) continued research to improve methods, models and available data in support of OPPTS testing requirements and risk assessments for new and existing pesticides and chemicals; 2) continued development of tools for measuring impacts of pesticide and herbicide use on non-target species; and 3) investment in biotechnology research that will enable OPPTS and other EPA offices to better interpret data and the risk assessment/registration process for the increasing number of products of biotechnology. Given current funding constraints this is a well-balanced set of research activities and reflects the areas (if not the scale) of investment needed to upgrade the scientific data and tools that OPPTS and other offices require in conducting risk assessments and guaranteeing the safety of marketed pesticides and chemical products.

The SAB encourages the Program to keep a share of its focus on the development of data and models for the assessment of effects of pesticides and related chemicals on non-target species. The current plan anticipates continued work in this area, tapering off over the next eight years. The plan to move resources out of the non-target species assessments and into research on risk quantification tools, "omics," and biotechnology impacts should only proceed once EPA's Long Term Goal 2 for this area has clearly been met.

### **7.2 Endocrine Disruptors**

The President's budget for endocrine disruptor research for FY08 includes 54.4 FTE and a budget of \$10.1M dollars. This is about \$1M more than the FY07 budget, but is about \$1M less than the FY06 budget. The SAB recommends that the EPA continue to support the Endocrine Disrupter research program incorporating "omics" technologies as recommended by the Board of Scientific Counselors (BOSC), and that additional funding be given to this program to support STAR grants in this area.

EPA has recognized that exposure to endocrine-disrupting or hormonally active chemicals may cause adverse health effects in wildlife and may affect human health as well. The

EPA is to be commended for developing research strategies in partnership with several program offices, including the Office of Water; Office of Prevention, Pesticides and Toxic Substances; Office of Air and Radiation; Regional Offices; and ORD's laboratories. An example of providing research support for a cross-cutting issue of great interest to several Regions is the analysis of impacts downstream from Concentrated Animal Feeding Operations (CAFOs). As described to the SAB, this work supports two of the program's long-term goals, including reduction in uncertainty regarding the effects, exposure, assessment and management of endocrine disruptors, and determination of the extent of the impact of endocrine disruptors on humans, wildlife, and the environment. Endpoints include both androgenicity and estrogenicity, and sources include swine and cattle CAFOs. Engagement in this research is regarded by the SAB as a best practice because: 1) it was conceived with participation from several program offices across the Agency, 2) it has immediate and direct relevance to some of the Regions who have brought their concerns to the SAB's attention, 3) multiple sources and endpoints were studied, 4) the studies were performed under extramural research grants, 5) the knowledge base will be extended through training of Regions, States and Tribes, and 6) the research is important in that it may set the stage for significantly improving the quality of ecological systems and their ability to support the animals and people who live there. However, the \$1.6M funding for this CAFO research (through the STAR program) was pieced together in the FY06 budget, and no further funding has been provided for FY07 or FY08 budgets. This type of research could be better informed by incorporating computational toxicological methods into the program.

The SAB commends the Agency for its work in developing a comprehensive battery of screening assays for endocrine disruption. The SAB notes, however, that the overall endocrine disruption identification program is structured to require whole-animal apical toxicological testing to confirm activity and to develop data for use in risk assessment. EPA is encouraged to develop a strategy which will allow the Agency to move away from apical multigenerational testing to newer, and more-rapid approaches to developing toxicology information about endocrine disruption without the need for confirmation in whole animal tests. Such efforts are clearly needed because of the large backlog of chemicals to be evaluated, the limited budgets for testing, the time involved from study initiation to results reporting, and emerging science developments. The SAB encourages the Agency to consider adding this topic as a long-term goal for strategic research and encourages continued collaboration with the Computational Toxicology Program, European institutions, and other federal agencies such as NIEHS to develop such a strategy.

Another concern is (what appears to be) limited research to support cumulative and aggregate risk assessment for endocrine disruptors, and consideration of how background endogenous processes and exposures may increase susceptibility.

### **7.3 Computational Toxicology**

The SAB supports the current plans for the nascent Computational Toxicology Research Program. Computational toxicology uses computing and information technology and biological data to understand and model the adverse effects of chemicals at various levels of biological organization. EPA's program is developing computational toxicology tools that may increase the number of chemicals addressed in agency assessments as well as improve the scientific foundation for Agency risk assessments.

The personnel resources and level of funding (\$15 million) appears reasonable for an Agency start-up effort of this type and importance. As experience and anticipated successes accrue, additional funding should be considered. The SAB heard about the Program's three initial research projects: 1) the ToxCast project to begin evaluation of high-throughput screening assays for initial screening and prioritization of chemicals for further testing; 2) the attempt to develop a biological model for arsenic carcinogenicity; and 3) the development of a "virtual liver" based on a systems biology approach for describing the impact of exogenous chemicals and stressors on complex disease processes. There is the long-term promise that high-throughput efforts will provide considerably greater coverage for the testing of potentially toxic chemicals, and the nearer term benefit that these efforts may provide a basis for tiered testing by suggesting potential types of toxicity for those chemicals screened. The ToxCast effort is a good initial project for the EPA in this area. The Agency appears to be collaborating with NIEHS and its approach appears realistic. One concern is the initial focus on pesticides, given the potential to bias the evaluation of the high throughput screen due to the limited types of biological activities of pesticides. The EPA is aware of this limitation and indicated plans to expand the project to a chemical data set with more varied structures in a later phase.

Regarding the arsenic work, attempts to develop biological models of carcinogenesis have had limited success over the past 25 years, and even the most recent of efforts have resulted in multiple orders-of-magnitude differences in predictions in the hands of different but very good and experienced model developers, supported by scientific experimentation. While Long Term Goal 3 is laudable – i.e., use of new models based on the latest science to reduce uncertainties in dose response assessment, cross-species extrapolation, and quantitative risk modeling – cancer may not be the best endpoint to consider at this stage. The results may be controversial and may not provide sufficient proof of concept. In this regard the second bulleted promise under this Long Term Goal (LTG 3) seems especially problematic - "EPA will be less reliant on default assumptions for risk assessment and better able to accurately characterize the uncertainty associated with risk predictions for various chemical classes (e.g., EDCs) under conditions more relevant to actual exposures and lifestyles." The SAB is aware of the need for more certainty in regulatory decision-making on arsenic, especially as regards drinking water, and is also aware of the need for responsiveness of the Computational Toxicology Program to this problem. While the SAB does not object to the effort, it suggests that the Computational Toxicology Program should proceed cautiously in undertaking this difficult scientific work and should not be overly optimistic about the potential results from in this relatively high-risk venture. With regard to the third project, beginning the systems biology work on the liver also appears a reasonable early project given the prior efforts and successes of the pharmaceutical industry and the potential to build on these findings in studying environmental chemicals.

Overall, the Computational Toxicology Research Program is headed in the right direction, and in the long term, if the research effort pans out, will provide new scientific approaches for the assessment of environmental chemicals and decision-making with respect to their use. The systems biology work may eventually yield significant insights for understanding the range of susceptibility to different compounds and this work may support alternative testing approaches. The ToxCast effort may eventually provide for new and efficient approaches for developing toxicity information concerning other chemicals that cannot be intensively studied.

## **8. SCIENCE AND TECHNOLOGY FOR SUSTAINABILITY RESEARCH**

Science and Technology for Sustainability (STS) is a new research program, scheduled to begin on October 1, 2007. As appropriate for an environmental agency, EPA's focus is on environmental sustainability, which is narrower than, but consistent with the definition of sustainability recently issued in Executive Order 13423:

Sustainable means to create and maintain conditions, under which humans and nature can exist in productive harmony, that permit fulfilling the social, economic, and other requirements of present and future generations of Americans (White House 2007).

Specifically, the initial research tracks of the Science and Technology for Sustainability Research Program will (1) develop and test metrics of environmental sustainability, (2) develop decision support tools to promote environmental stewardship and sustainable management practices, and (3) support and develop technologies that can create sustainable outcomes.

The SAB has recently reviewed the Sustainability Research Strategy and the associated multi-year plan; the SAB draft report is available and the final version will be issued in spring 2007 (SAB 2007). In its review, the SAB strongly endorses the establishment of a sustainability research program. Historically, environmental protection at the Agency has been carried out in single-media regulatory programs. The SAB applauds the Agency's movement toward a systems approach that reflects the complexity of the world in which we live and effectively balances environmental protection, economic viability, and societal interests.

The Sustainability Research Strategy (SRS) and Multi-year Plan (Plan) has the potential to provide an integrating framework for EPA core and problem-driven research in ORD and across the Agency. The SRS and Plan supports the transition from the traditional single-media stove-pipe approach of environmental protection to a more systems-based and fully integrative process based on life-cycle principles. ORD's sustainability research program would enable the Agency to address some of the most challenging and multifaceted environmental issues. The Sustainability plan provides an opportunity to address problems such as urban sprawl and the environmental impacts of the built environment, climate change, the environmental consequences of biofuels production, and ecosystem degradation. Taking an integrated, life-cycle approach to environmental protection can provide cost-effective options for reducing a range of environmental impacts, developing and deploying new technologies, and supporting quality of life, economic development, and environmental quality.

The SAB recommends that the Agency clarify the definition and scope of its environmental sustainability programs. Early progress on the development of sustainability metrics could provide a firm foundation for defining the Agency's sustainability efforts, and could distinguish environmental sustainability from the broad definition of "sustainable" contained in E.O. 13423.

The Science and Technology for Sustainability Research Program is the first coordinated effort within the Agency to address the research questions raised in the Sustainability Research

Strategy. The Sustainability Research Strategy lays out a strategy in which sustainability will not remain confined within an isolated research program, but will be incorporated throughout ORD research programs. Success of this strategy will require development of a workforce with training and skills related to sustainability. In addition, in order for sustainability research questions to be addressed throughout ORD research programs, and will require ORD management support.

The modest funding of the Science and Technology for Sustainability program limits what it can achieve. A substantially higher commitment is needed to make the program visible, to carry out research that will have a serious impact, and to provide a basis for the program to succeed and grow.



## 9. ECONOMICS AND DECISION SCIENCES RESEARCH

Economics and Decision Sciences (EDS) research is critically important to EPA's operating programs. Some statutes permit explicit consideration of both benefits and costs in the setting of environmental standards. Others specify a safety standard, regardless of cost, but permit benefits and costs to be used in comparing alternative strategies for meeting that standard. Even in those cases where a safety standard must be met, the Regulatory Flexibility Act/Small Business Regulatory Enforcement Fairness Act (RFA/SBREFA) already provides the opportunity for some small businesses to be given more latitude with respect to certain rules if the cost of compliance is so high that their viability is jeopardized. As scientific understanding points to evidence of measureable human health and ecological effects occurring at lower levels of pollution, the need for research in Economics and Decision Sciences to help us maximize the net benefits (benefits minus costs) of regulatory efforts will only increase. EPA cannot afford to allow its resources for research in Economics and Decision Sciences to continue to deteriorate along its current trajectory.

Economics research can be credited with significant success in improving the efficiency of environmental regulation. The development of economic-incentive-based regulatory mechanisms as an alternative to command-and-control regulation has led to drastically reduced costs of environmental protection. Traditional command-and-control rules require all firms to adopt the same pollution-control equipment or meet the same emissions standards. In contrast, economic-incentive mechanisms, such as tradable emissions permits, pollution taxes, and deposit-refund systems, allocate emission reductions across firms and facilities in a more cost-effective manner, substantially reducing the costs of compliance.

There are many good examples of the efficiency gains from economic incentive approaches to regulation. Tradable permits have been used to reduce the cost of controlling a number of environmental pollutants, including sulfur dioxide from power plants, lead in gasoline, and CFCs that deplete stratospheric ozone. For example, the sulfur dioxide trading program is estimated to have saved \$700-\$800 million per year compared with a uniform emission-rate standard and twice as much as compared with requiring all plants to install scrubbers (Carlson et al., 2000). Using tradable permits in the program to remove lead from gasoline is estimated to have saved \$250 million per year over the five year phaseout period (Jaffe et al., 2003). A comprehensive evaluation of before and after estimates of the cost and efficacy of environmental regulation, found that the cost per unit of emission reduction was smaller than anticipated beforehand for seven of eight economic-incentive-based regulations but larger than expected for five of sixteen command-and-control regulations. Moreover, because economic-incentive mechanisms provide an incentive for firms to exceed required environmental standards, the same study found that emission reductions were greater than anticipated beforehand for four of eight regulations that used economic-incentive mechanism, but fell short of the anticipated level for eight of fourteen regulations that used command-and-control mechanisms (Harrington, Morgenstern and Nelson, 2001).

Economics and Decision Sciences research at the Agency is in large part a public good shared by many different parts of the organization and by the broader community. As an analogy, consider the fact that although each of us has a need for fire protection, we do not all serve as our own fire department. Since there are economies of scale in provision, it makes sense to centralize this service so that we can obtain sophisticated and effective fire protection when we need it. Likewise, EPA some time ago decided to bring much of its core economics expertise together under one roof. This has left EPA with a core complement of economists in the National Center for Environmental Economics (NCEE), several additional research-focused economists in ORD to manage an Economics and Decision Sciences grant program, and a number of applied economists in Program Offices to conduct and manage extramural performance of specific economic analyses there. EPA's Environmental Economics Research Strategy, for example, was prepared jointly by all these groups with ORD taking the lead writing role.

Even though this restructuring and consolidation of much of economics at EPA has produced some of the benefits associated with economies of scale, funding of economics and decision sciences research remains at a low level. This might be expected, since consolidation, has converted EPA's intramural economics resources into somewhat of a public good. Unfortunately, public goods are plagued, in most cases, by a free-rider problem that leads them to be under-provided. Since more than one part of the Agency can simultaneously benefit from the same economics/decision-science research (for example, risk communication and risk perception), this research is a "non-rival" good. Likewise, if this research is provided for one part of EPA, it is simultaneously provided for all. Access to the results of such research is not denied to any group within the EPA.

To exploit scale economies, therefore, it is a good thing that research in Economics and Decision Sciences is proposed for consolidation under one roof within the Agency. However, the SAB is concerned that consolidation might actually decrease the amount of economics research at EPA and also impede the development of a high quality research portfolio in behavioral social and decision sciences. Evidence of this possibility is shown in the decreased resources proposed for the program for 2008 (from about \$2.4 million in 2007 to just over \$1.0 million for 2008). Shifting Agency personnel responsible for research in economics and decision sciences to NCEE also creates a significant risk that ORD would no longer encompass Economics and Decision Sciences as part of its portfolio of research interests. Just as the SAB has noted that ecosystems protection research is underprovided because of a failure to recognize the essential services that ecosystems provide, Economics and Decision Science research will be underprovided if the Agency does not fully realize the essential services these other disciplines provide for eventual policy-making.

Therefore, the SAB feels that moving Environmental and Decision Sciences from ORD to OPEI/NCEE is a risky strategy. OPEI already faces daunting responsibilities in terms of day-to-day applied economics and benefit-cost analysis required for individual regulations. The research mission of EDS could easily be diluted if it is moved to NCEE. The transition also jeopardizes the role of other social sciences, since the NCEE has an almost exclusively economics focus. Despite the expected scale economies from moving EDS to NCEE, the SAB believes that the economic and other social science research needs of the Agency will be best protected and enhanced if the research resources are housed within ORD.

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## APPENDIX A

January 22, 2007

### MEMORANDUM

FROM: Dr. M. Granger Morgan /S/  
Chair  
US EPA Science Advisory Board

TO: Dr. George M. Gray  
Assistant Administrator for  
Research and Development  
US Environmental Protection Agency

As we have in past years, the meeting of the EPA Science Advisory Board on February 22-23, 2007 will be devoted to a review of the Agency's research budget – not just the budget of ORD but of all research across the Agency. However, in contrast to years past, this year we do not want to do a detailed program-by-program review. Rather we want to try to take a somewhat longer term strategic perspective. In that regard we ask that you and your colleagues do two things that are more focused on the long term:

1. Briefly identify 3-5 issues which the agency believes will represent key environmental challenges over the coming decade or longer and explain how, whether, and to what extent, the R&D budget is designed to place the agency in a position to meet these challenges.
2. The SAB would especially like to learn about how the Agency's research plans will allow EPA to address four key problems that we believe will be of continued and growing importance over the coming decades. These are:
  - a) Climate change, including both impacts (for example on: natural ecosystems; water, coastal regions through sea level rise; air quality) as well as key issues such as terrestrial and deep geological sequestration that may arise as a result of future efforts in abatement. While we realize that the agency has a modest research program that is labeled as climate change, we would actually like to hear a more cross-cutting view. That is, how have concerns about the potential impacts of climate change, and possible abatement activities, influenced a range of research plans both within ORD and elsewhere across the agency?
  - b) Sensitive populations, both human and ecological. We realize that ORD has specific research programs targeted at specific human populations such as children. While we'd like to hear briefly about

those we'd also like a cross cutting view of how research plans will address other issues such as the immune suppressed, those with asthma, as well as a variety of other conditions. We are equally interested in learning how research across the Agency is being shaped to identify and address specific ecosystems that are at high risk and certain populations that are particularly sensitive and vulnerable to current or likely environmental stress and change.

- c) Urban sprawl and the associated consequences for land use, stresses on ecosystems, stresses on sensitive populations, water contamination, air quality, loss of open space, and related issues.
- d) Environmental disasters, both those that may arise as a result of natural causes (such as hurricanes, ice storms, drought, earthquakes and volcanism) as well as terrorist induced events. In the case of the latter we would be particularly interested in learning how research across the Agency is helping to prepare EPA for the possible need to clean up after widespread contamination resulting from chemical, biological or radiological attack, contamination that may result from attacks on facilities such as chemical plants and transportation systems, and contamination that may result from the interruption of key infrastructure services such as electric power (e.g. many sewer systems can not operate without electric pumps).

If some of the topics addressed in 1 above are the same as those we have identified in item 2 that would be fine with us.

- 3. In addition, we have two shorter term requests for information.
  - a. Please identify any research program for which the proposed FY 2008 budget level will substantially differ from the budget that was proposed for FY 2007 (for example, 20% or more would be a substantial increase or decrease). We understand that in fact the Agency is running under a continuing resolution and so will use the proposed FY 2007 budget only as a benchmark. Please provide us with a brief explanation of the proposed decrease or increase.
  - b. As always, the SAB must be prepared to comment to the U.S. Congress on the actual budget submission for FY 2008. Thus, we also need information on the full research program at the level of Program Projects that are a part of the EPA research effort. We received an informative set of background descriptions last year for the FY 2007 budget review and an update of this set would be helpful as the SAB considers commenting on the 2008 research budget. However, an alternative would be to provide information on Program Projects as envisioned in the ORD December 14, 2006 discussion with the SAB

on this topic. In this discussion, ORD representatives noted that it could provide background information based on NPD Key Recommendations from the ORD December and January strategic discussions on program change 2008-2012.

If in the course of addressing any of the topics listed above, you and/or your colleagues can point to any examples of ways in which the past R&D budget reviews by the SAB have influenced or shaped subsequent Agency budgetary plans, either in the short or long run, we would be most grateful if you would list them for us. To be frank, a number of members of the SAB are beginning to think that the annual budget review has little or no effect on Agency plans and they question why members should spend so much time on an annual review if in fact that impression is correct. Anything that you or your colleagues can present that would enlighten members on this point would be much appreciated.

Thanks very much to you and your staff for your assistance in these matters. We look forward to meeting with you and other agency staff on February 22-23.