



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
WASHINGTON D.C. 20460

OFFICE OF THE ADMINISTRATOR  
SCIENCE ADVISORY BOARD

March 30, 2006

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

Subject: Science and Research Budgets for the U.S. Environmental Protection Agency  
for Fiscal Year 2007; An Advisory Report by the Science Advisory Board

Dear Administrator Johnson:

Over the past few years, the chartered Science Advisory Board (Board) has been working with EPA to review the Agency's science and research programs and budget on a systematic and ongoing basis. This year the Board met in Washington, DC on March 2-3, 2006 to review the EPA science and research budget for FY 2007. The Board appreciates the opportunity to provide you with advice on this important matter.

The Board is aware of the budget pressures that we face as a nation in these difficult times. However, as in previous years, the Board is gravely concerned with the declining resources available to EPA's Office of Research and Development (ORD). On March 16, I provided testimony before the U.S. House of Representatives Committee on Science Subcommittee on Environment, Technology and Standards on EPA's science research budget. My testimony is attached to this report. Between 2004 and the current FY 2007 proposal, the inflation adjusted budget for ORD has declined by as much as 16%. Yet, the environmental problems faced by the Agency have grown and become increasingly complex, a trend that will surely continue over the coming decades. The erosion of research and development remains a serious impediment to the Agency's ability to meet its mission of protecting human health and the environment through science-based initiatives. This fall-off in the development of scientific knowledge will increasingly have international competitiveness dimensions as we lag our competitors in developing new technologies using new approaches. It is the opinion of the Board that EPA's research and development resources are grossly inadequate to address the scientific complexities of the nation's environmental protection needs.

Given the available limited resources, the Board understands that the Agency must make hard choices to best accommodate EPA's five environmental goals areas, i.e., clean air, clean water, land preservation and restoration, healthy communities and ecosystems, and compliance and stewardship. However, there are several issues in the FY 2007 request that concern the Board, some of which have persisted for several years.

- The proportion of EPA's research budget devoted to basic science or "core" issues has markedly and rapidly been reduced from as much as 60% only a few years ago to about 30% in the FY 2007 budget. The level of near term problem driven research has increased from about 40% to nearly 70%;
- There appears to be a systematic bias against ecosystem research in the Agency – this program has sustained a decrease of nearly 26 percent since 2004. The \$79 million for ecological research in the proposed 2007 budget amounts to just 15% of the overall ORD research budget. Over the past several years the Board has called on both the Agency and the Congress to revitalize, raise the profile of, and increase the funding for ecological research at EPA. We are distressed that instead, work in this area continues to decline;
- The Board is concerned that EPA's Homeland Security Program appears to be drawing resources away from other essential research programs. We are also concerned that the work may be too focused on individual devices and sub-systems, without first understanding broad level issues such as how effective alternative approaches can hope to be in providing needed protection at an affordable cost. The Board is also concerned that current programs are not sufficiently informed by the behavioral and social sciences to effectively manage and communicate the homeland security research and risk results to the general public.
- The Board is troubled by the ongoing difficulty that EPA has had with the application of the OMB Performance Assessment Rating Tool or "PART." EPA should continue to work to improve its performance, outcomes, and accountability systems to better communicate the benefits of research, including fundamental research, for the protection of human health and the environment.
- EPA has mature scientific staff reaching retirement age, and the Agency will face significant staffing challenges in environmental sciences, engineering, economics, behavioral, and decision sciences in the next five to ten years. The proposed reduction in the STAR Fellowship program will further exacerbate the workforce planning for the coming years.

The Board plans to have further discussions with ORD soon and we will provide additional advice as the Agency plans for its budget request for FY 2008. We look forward to receiving your response to this advisory report.

Sincerely,

/signed/

Dr. M. Granger Morgan, Chair  
EPA 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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## 1. INTRODUCTION

Over the past few years, the chartered Science Advisory Board (Board) has been working with EPA to review the Agency's science and research programs and budget on a systematic and ongoing basis. This year the Board met in Washington, DC on March 2-3, 2006 to review the FY 2007 EPA research budget.

The Board is traditionally guided in its consideration of EPA's research budget by a charge that asks if EPA's science programs align with the strategic priorities that have been articulated to guide the EPA mission; whether the programs reflect coordination and cooperation both inside and outside of EPA; and whether EPA's science programs are positioned to address the nation's emerging environmental issues. For the FY 2007 research advisory, the SAB also considered the program from the strategic perspective of whether significant research was missing and also the changing trends in EPA's overall research program. This year, the SAB also expanded its consideration of Regional Office science issues as a result of several events that occurred during 2005 that highlighted the need for science research and technical support to the EPA Regional Offices.

The Agency provided several types of background information to the SAB, ranging from budget documents to research program descriptions. Included were: a) EPA's FY 2007 Budget Summary ([www.epa.gov/ocfo/budget/2007/2007bib.pdf](http://www.epa.gov/ocfo/budget/2007/2007bib.pdf)); b) Portions of the FY 2007 Annual Performance Plan and Congressional Justification ([www.epa.gov/ocfo/budget/2007/2007cj.htm](http://www.epa.gov/ocfo/budget/2007/2007cj.htm)); c) US EPA ORD Program/Project Descriptions (18 separate summaries), and d) several resource tables.

Members of the SAB were assigned the lead on one or more specific research Program/Projects prior to the date of the meeting. During the March 2 – 3, 2006 meeting, Members discussed Program/Projects with EPA representatives using logically grouped clusters and then developed their consensus remarks on each as they decided to be necessary. The groupings used were: a) Air, b) Water --including Ecosystems, c) Human Health, d) Technology, e) Economics and Decision Sciences, f) Homeland Security, and g) STAR/Fellowships. These discussions led to a series of conclusions by the SAB which are discussed in the report sections that follow. They also provided the basis for the Congressional testimony delivered on the issue by Dr. M. Granger Morgan on March 16, 2006 (this testimony before the Subcommittee on Environment, technology and Standards of the Committee on Science of the U.S. House of Representatives, The Honorable Vernon J. Ehlers, Chair, is in Attachment A).

Between 2004 and the proposal for 2007, the inflation adjusted<sup>1</sup> budget for EPA's Office of Research and Development has declined by just over 16%. However, the environmental problems that face EPA have grown in number and complexity, a trend that will continue over the coming decades, and these environmental issues will also increasingly be linked to the international competitiveness and relationships of the United States and other nations.

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<sup>1</sup> Computed using the NASA Gross Domestic Product Deflator Inflation Calculator, available at <http://cost.jsc.nasa.gov/inflateGDP.html>



## **2. AIR RESEARCH PROGRAMS**

The Air Research Program provides knowledge, information/data, and tools that provides the scientific foundation for the Agency to fulfill its responsibilities under the Clean Air Act. The Agency focuses its research on National Ambient Air Quality Standards (NAAQS) pollutants and also studies Hazardous air pollutants (HAPs). This research intends to improve the efficacy of science-based regulations that protect human health and the environment from significant exposures to certain air pollutants. In FY 2007, EPA's air research will continue to strengthen the scientific basis for the periodic review and implementation of air quality standards. This research is concentrated on particulate matter (PM), but includes other NAAQ pollutants in a cycle that repeats (nominally) every 5 years. Air toxics research will begin to transition toward a Multiple Air Pollutant Program (MAPP) focus in FY 2007. The budget proposal is that Air Research be funded at \$77.7 million, down from \$90.4 million in 2006 (note: \$7.4 million of the 2006 total reflected Congressional add-ons thus, the actual comparative figure for 2006 would be \$83.0 million – thus the drop in funding without the add-ons would be a decrease from \$83 to \$77 million or about \$6 million across air toxics, NAAQS, and Global Change).

There is a need for greater funding for the Air Research Program. The subsections immediately below point to a number of key issues and needs.

### **2.1. Criteria Pollutants and Multi-Pollutant Analyses**

Multi-Pollutant Focus of the Air Program: The Agency has correctly determined that we need to move from addressing one pollutant at a time to addressing sources of mixtures of pollutants in a Multiple Air Pollutant Program, as recommended by the National Research Council. Of key importance is the fact that we are exposed to a mixture of criteria and hazardous air pollutants at any given time and thus there is a need to examine health and welfare effects on a holistic basis. This shift in emphasis has a potential to save money in the future. However, realizing the benefits of a multi-pollutant focus will require an initial increase in funding to conduct research to develop the tools and information necessary to support the Agency's air programs. This initial investment will have the potential to pay future dividends in the form of regulations that are more reflective of real world exposures.

Particulate Matter Research: EPA's air research program has played a major role in helping to determine the role of fine particles in causing adverse human health effects. Most of the research related to fine particles comes from urban environments, because that is where there are sufficient people to conduct quality epidemiology studies.

There is now a critical need to determine the toxicity of coarse particles, especially rural dusts generated from such industries as mining and agricultural activities. A new NAAQS for coarse particles (PM10-2.5) has been proposed for promulgation later this year and because the current understanding of the role of coarse particles in producing adverse health effects is weak, the Agency needs more information on the nature of coarse particles in urban and rural settings

and the potential health effects of these particles from a variety of sources including agriculture and mining. Additional resources will be required to begin the study of coarse particles (e.g., the relationship of the composition of particles and their physical size on associated health effects) and at the same time continue to make the significant investments needed to understand the health and ecological effects of fine particles. Thus, more research and continued funding is urgently needed in the area of particulate matter where it is necessary to integrate criteria and hazardous pollutants and increase the depth of study on coarse particulate matter. Decreasing the overall air pollution research budget is clearly counterproductive.

Criteria Documents: There is an urgent need for increased staffing to get the Agency out of the vicious cycle of rushed development of criteria documents. The development of criteria documents is an essential step in linking the output of the EPA's experimental research to the development of science-based regulations for criteria pollutants. The ORD group responsible for preparing Criteria Documents is greatly under-staffed and often only one person is available to both oversee the production of these documents and for writing the critical synthesis chapters that pull together the voluminous amounts of research data from specific chapters of the document into conclusions on the available science. The result of this is that completion of Criteria Documents is continually behind time resulting in lawsuits and Court Orders that create a work environment of duress that impedes the completion and quality of these documents and lead to the need for additional revisions of draft documents

Need for Resources for Emission Monitoring and Modeling: EPA needs resources for emissions monitoring and modeling (e.g., to deploy monitoring networks that can provide data on fine particles and mercury).

EPA has made major research investments in evaluating the role of ultrafine particles in inducing adverse health effects. However, EPA has yet to deploy a monitoring network that will provide the data sets needed to support health effects modeling and enhanced epidemiologic study. These data, and the subsequent studies and modeling will help to inform EPA policy-makers on the need for a particle number NAAQS.

EPA promulgated the Clean Air Mercury Rule (CAMR) and the Clean Air Interstate Rule (CAIR). There is a monitoring infrastructure in place to determine the changes in sulfate and nitrate levels in the air (CASTNET, IMPROVE, STN), but there is no capability for EPA to measure total gaseous mercury (TGM) and reactive gaseous mercury (RGM) over the spatial and temporal scales needed to assess the effectiveness of the CAMR. Further, there is virtually no capability to examine the global mass-balance of mercury. This baseline is likely to be changing because of the rapid increase in the use of fossil fuels in Asia (China, India, etc.). (See subsection 2.3 below for more information on Mercury research).

The Agency did an excellent job of strategically evaluating their current air monitoring system and matching their data needs and monitoring approaches for collecting critical data. However, rather than using the results of this strategic approach to maximize the benefits of their current investments in this area, the strategic analysis was used to reduce their monitoring resources. These reductions will diminish EPA's ability to make informed decisions on the effective and efficient management of air quality.

As part of the monitoring strategy, EPA properly identified the need to integrate new technology into the monitoring network through a limited number of "supersites" that will evolve and change over time. However, resources have not been available to support this activity that is an important and integral part of the overall air monitoring network.

The Agency also has a need for research information on atmospheric fate and transport to support their consideration of regulatory mechanisms. In the Program Area for Air Toxics and Quality, we commend the Agency for its efforts to support market-based methods for allocating emissions reduction. Even though benefit-cost analysis is not to be used for setting ambient standards, economists advocate the importance of its use in devising mechanisms to meet standards at the lowest possible overall cost to society. Market-based methods, such as tradable emissions permits, have been very successful in the SO<sub>2</sub> allowance program and for RECLAIM in Los Angeles.

However, the idealized marketable emissions permit program applies to uniformly mixing pollutants, where it does not matter which sources generate the pollution (e.g., atmospheric carbon -- as CO<sub>2</sub> -- is an approximately uniformly mixing pollutant). Trading programs may need to be modified where pollutants are not uniformly mixing (i.e. when there may be "hot spots"). Sometimes, these modifications can be very crude, such as a restriction that permits may not be sold upwind (e.g. RECLAIM's differentiation between inland and coastal zones), but more sophisticated modifications are potentially available.

In theory, it is possible to design elaborate systems of "ambient permits," where firms purchase the right to contribute a certain amount to ambient concentration levels at one or more receptor sites (permits for each receptor site form a distinct market). To implement such an ambient permit system, however, it is necessary to "map," back to each source, the quantity of emissions that is associated with a given change in ambient concentration at the receptor site. This connection requires a statistically estimated empirical model that connects changes in emission levels from each source with changes in ambient concentrations at receptor sites (presumably located at suspected hot spots).

Research resources are needed to improve the quantification of the connections between ambient levels (what matters to human and ecosystem health) and the patterns of emissions from different sources (what can be controlled).

The SAB is concerned that the success of simple tradable emissions permits programs will degrade as they are implemented more widely, in contexts that lie farther from the idealized case of a uniformly mixing pollutant. Tradable ambient permits programs have much greater information demands. If it is necessary to worry that a tradable emissions permit program might exacerbate hot spots, despite controlling overall emissions levels, then it is necessary to plan for empirically based and defensible fate-and-transport models that will form the basis for ambient permit systems (see the mercury case in "c" below for more information on this issue).

## **2.2. EPA's Global Change Program**

The EPA Global Change Program received \$19.6M in FY2005, \$18.6M in FY2006, and is proposed to receive \$17.5M in FY2007. This proposed amount represents an approximate 15% decrease over the time period, in standard dollars.

As designed, the Global Change Program has five components: a) Assessments at the National/Regional level, b) Air quality, c) Ecosystems, d) Water quality, and Human health. The assessment activity is legislatively mandated and occurs through the Climate Change Science Program. The other four components have both intramural and extramural activities.

Because the Global Change program's has mandated obligations for assessment within the Climate Change Science Program, the cuts in the FY2007 budget will have to be taken from the other four program components. These cuts will eliminate almost all of EPA's research on the impacts of global change on water quality, and will essentially eliminate EPA's intramural research programs on the effects of global change on air quality and ecosystems health. These cuts cause two serious problems. First, the lack of an EPA based program on the impact of global change on national water quality and the elimination of intra-mural research on air quality and ecosystems are inconsistent with EPA's mission. Second, the elimination of intramural programs will seriously impact EPA's human infrastructure resources (human capital) and make it much more difficult to address these issues in the future. These two issues are discussed further in the paragraphs that follow.

Climate change and water quality: The Agency's climate change research appears to be limited to impact of and adaptations to climate change, rather than mitigation. Other agencies are concerned with the implications of climate change on the supplies of water (i.e. water *quantities*) but not water quality. EPA should retain its interest in the implications of climate change for water *quality*.

Human Resources: Many EPA scientists and science-based professionals are moving toward retirement age. In addition, fewer investments in intramural research will lead to fewer opportunities for providing persons with expertise in specific areas such as global change. It will be important to ensure the continuation of resources to support EPA's inhouse development of such expertise and to continue to support graduate fellowship and grants programs to help provide the knowledgeable staff to fill these positions and to meet EPA's needs.

## **2.3. Mercury Research Program**

The proposed FY 2007 budget for mercury research represents a reduction of about 29% from the level of two years ago (2005 enacted), although at \$3.7-million the proposed FY 2007 amount is an increase of \$300k over 2006 enacted.

Because mercury is persistent in the environment and because it is a serious neurotoxin, the agency has mounted a major control effort, to limit emissions from sources such as large coal-fired power plants. In the past this program largely supported work on monitoring and control technology. From this work, measurement of "wet deposition" is available in some

regions, but measures of “dry deposition” are still being developed and ambient concentrations are more challenging to devise.

With the passage of the Clean Air Mercury Rule, this program acquired additional responsibilities to evaluate the effectiveness of control measures. It is apparent that EPA can not adequately address all its current mercury-related responsibilities at the current budget level.

With respect to the CAMR, it is therefore important to determine whether hot spots exist for mercury. Tradable permit programs are best-suited to “fund pollutants” for which the environment has some assimilative capacity. They are less well-suited to stock pollutants, where the social costs of pollution depend on the cumulative amounts received in the environment. Stock pollutants may imply that constraints need to be placed not on annual emissions, but on total cumulative emissions. This would make the stock of available permits an “exhaustible resource,” and a need for firms to manage these as a mine-owner might manage the exploitation of an exhaustible mineral resource.

EPA’s lack of adequate research resources to meet its programmatic mission for mercury is troubling, but there is a much more fundamental reason why the very low level of support for mercury research poses a serious problem. As acknowledged in the Agency’s background information for this review, mercury pollution exists on a planetary scale because mercury is transported across oceans and continents. While some comes from human sources, such as power plants all over the world, much comes from natural sources such as volcanoes and other geological sources. We simply do not know where all the mercury comes from, where it goes, how much exists in different chemical forms, and how all the transport and transformation occurs. Without this knowledge, it will be impossible to know how well the current or future control programs will be able to reduce human and ecological exposures. There is a US interagency group responsible, as well as an international (UNEP) group considering this issue. However, in our view the support for research on global sources, transport, and fates is seriously deficient. EPA should be funded to play a leading role in such an effort, but at the current budget levels can not even begin to address the issue.

#### **2.4. Research Program Evaluations**

It is apparent that evaluations of research program effectiveness will continue to be conducted using the Program Assessment Rating Tool (PART). Therefore, it will be important for the Agency to anticipate the “outcome” measures that will be used in these evaluations and to collect data explicitly on these different outcome measures. In the Air Toxics and Quality Program area, it appears that the outcome measures to be used consist almost entirely of data such as a cumulative percent reduction in population-weighted ambient concentration of “pollutant X” from a 2003 baseline. Presumably, this measure translates into some expected improvement in human health.

Human exposure and health outcomes are indeed important concerns. However, since only human populations seem to be counted in developing these outcome measures, it appears that ecosystem health does not “count.” The Agency should be very careful not to build into their accountability data a systematic bias against ecosystem health or against the more fundamental types of research that are often needed to develop a proper understanding of

complex environmental and ecological systems. Admittedly, the greatest ambient concentrations of many pollutants will occur in conjunction with the greatest concentrations of people (i.e. in urban areas). Ambient concentration monitoring in less-populated areas may await more-sophisticated remote-sensing technologies, but the fact that current measures disenfranchise ecosystem health should not pass unnoticed and the Agency should work with OMB to educate them on the need to adopt a broader metric.

The existing evaluation process (PART) apparently requires a significant use of Agency resources. In some cases, these may be one-time costs, since one program's scrutiny and measures development could help other Agency programs to realign their ongoing investments in accountability data development towards outcome measures that are more useful to the current evaluation process. However, it is essential for the Agency to negotiate the weights to be used for evaluations in less-standardizable programs. In particular, EPA should insist that while one-dimensional summaries are useful in evaluating program successes, they necessitate the use of weights on different program attributes and that those attributes are measured in different units that are difficult to compare. Further, for the current system, many of these weights likely do not reflect social preferences for the country as a whole. Instead, they appear to be negotiated between OMB and the Agency. Arbitrary weights merely reflect the preferences of the group(s) involved in negotiating them. It is possible that neither group may have the overall (intertemporal) welfare of society as its objective function. The "right" set of weights to use in a metric such as the PART is normative (a matter of opinion, rather than a matter of fact), should include inputs from the most affected, and depends upon what one is seeking to maximize.

Also somewhat troubling about the current evaluation process is the discreteness of the categories into which different programs are placed. Inappropriate weights, and inappropriate formulas for combining the components of the PART formula, both contribute to "errors" in the assignment of numeric scores. The PART score is interpreted as a point value, and the score for a program places it into one of five categories, creating an artificial impression of certainty. Ideally, the rating would acknowledge the existence of some doubt about the correct magnitudes of the weights and the correct functional form used to combine program attributes with these weights. A PART score should be a range, at best. That range may lie entirely within one of the five designations, or it may span two or more categories.

### 3. WATER RESEARCH PROGRAMS

#### 3.1. Drinking Water Program Budget Comments

The SAB believes that the Goals and Metrics for meeting the Safe Drinking Water Act mandates will be attained and measured with the support of ORD's research products developed for the Office of Water, Regional Offices, States, and municipalities.

The drinking water research program has been reviewed by the EPA SAB, the ORD's Board of Scientific Counselors, and by OMB using the PART. In the PART evaluation, the drinking water research program was rated as adequate. The Board of Scientific Counselors recently produced a final report (Oct. 17, 2005) on the "Review of the Office and Research and Development's Drinking Water Research Program at the U.S. Environmental Protection Agency" and had a series of recommendations. These recommendations are incorporated into the recommendations made by the SAB that follow.

- 1) The drinking water research program Multi-Year Plan is being revised during FY 2006. In addition, the Agency has decreased their three Long Term Goals into two in this area. It appears that collapsing the three LTGs from the past into two was driven by considerations associated with the PART process and not by a scientific rationale. From a science perspective the themes that were in Long Term Goal 3 [source water protection (watershed) and distribution systems] have some commonality in that both the source water protection (watershed) and distribution systems are highly complex, difficult to monitor and require multiple-scale assessments involving in-situ systems (gauges and sensors) as well as extensive modeling efforts. Therefore, the Agency should consider returning to three Long Term Goals in this area instead of the two which now exist because of the possibility that parts of the program (e.g., source water and distribution systems) might not receive adequate consideration if merged into the other LTGs. In revising its plan, EPA should clearly reflect the need for long-term basic research and work to clarify their Long Term Goals, as well as to develop initiatives that recognize their expanded client base that now includes communities. EPA should incorporate this into their efforts to identify measurable outcomes of activities covered by this program.
- 2) EPA intends to initiate research on drinking water distribution system infrastructure (e.g., leak detection, assessment of high risk mains, cost effective rehabilitation and replacement, distribution system design). Research on technologies to decrease operating costs of distribution systems provides an opportunity to define outcomes that can be readily achieved via EPA's external and internal research programs. Currently, these programs have different emphases, i.e. the internal program focuses on applied research and the externally funded research focuses on basic research. EPA should articulate a budget and activity plan that will clearly show the research strategies that will be used to implement this new distribution system research initiative.

- 3) EPA's research budget reduces the regulated contaminant activity by nearly one million dollars. Even though EPA considers this research to be a "low priority research area" there is a need to continue research on regulated contaminants because some are still in the implementation stage of regulation and all drinking water standards will undergo a 6 year review to determine whether there is a need to revise their existing standard. These reviews are mandated by the US Congress. Thus, EPA should determine the critical level of funds required to achieve its legislated mandate in this area. In addition, the strategy for meeting the mandate under this reduced funding scenario should be outlined.
- 4) EPA's CCL research is one area that focuses on the risks associated with emerging contaminants. In evaluating whether these contaminants might need to be regulated, EPA must evaluate both exposure pathways (transport and fate, removal by treatment, exposure to the public, as well as the ability to reduce the exposure (e.g. treatment controls) and health impacts. Thus, funding in the Water Quality Research side may impact the effectiveness of the Drinking Water research in achieving the LTGs and perhaps Annual Performance Measures. This interrelationship among these two research programs should be better articulated.
- 5) The SAB supports and encourages EPA's research collaborations with other agencies (e.g. USGS); however, it is ultimately EPA that must link the environment and human health together thus, EPA's research programs must be funded at a level that is adequate to do the task. EPA is leading the research in pathogen studies in water particularly via molecular characterization. Pharmaceuticals and Mercury are other examples of contaminants that move through the environment via various matrices (land/air/water) and these contaminants and others, require a national data base on water quality to eventually understand the impact on drinking water and human health.
- 6) EPA's Program in Drinking water research needs to ensure that it includes activities that will allow the Agency to include scientific advances in microbial risk assessment in its evaluations of the public health benefits from reduction of contaminants that are microbial pathogens.
- 7) The SAB supports EPA's goal to achieve national and global scientific leadership in issues relevant to safe drinking water. An assessment of the critical areas where EPA can position itself to take the global lead is needed as is a strategy to move the leadership program forward. Thus investment and participation in organizations like the Global Water Research Coalition is appropriate and EPA could incorporate this activity within its drinking water research program in the future.

### **3.2. Water Quality**

The water quality research program provides ORD's research and expertise in support of the development of water quality criteria for designated uses of aquatic systems that are intended to protect human health and the environment and research on the beneficial use of biosolids. The research program also develops tools to assist in the selection of watershed management technologies in protecting and restoring these systems and in forecasting their effectiveness. The Water Quality Research Program budget has a net increase of nearly \$6 million dollars in FY



2007. These increases are for new activities on the protection of ecosystems with an emphasis on the impacts of multiple stressors from CAFOs on water quality (~\$2.8M), and a new investment in innovative strategies for sustainable wastewater infrastructure (~\$5M). These investments are worthwhile and fit with the mission and goals of the program.

The water quality research program is clearly relevant to EPA's mission and it is effectively coordinated with other program and regional offices within the Agency. There is also a history of coordination with the European Union and the private sector in certain areas such as ecological risk assessment. It is less clear how it coordinates with other Federal agencies that also have responsibilities for water resources.

The Water Quality Research Program has linkages to research needs in several other EPA programs, for example, EPA's ecological research program and EPA's drinking water program. However, the interrelations among these programs are not clearly articulated in the materials provided to the SAB. By definition these programs are related and require coordination. Specifically, the SAB is concerned that the substantial decreases in funding ecological research have not been mitigated by any funding or corresponding increase in funding or programs in water quality research. Further, decreases in funding for mercury fate and transport and exposures to endocrine disrupting chemicals are not being replaced by efforts in water quality research. All funding for the impact of climate change on water quality has been eliminated. Thus while some goals within the water quality research program are being adequately funded, the ecosystem goals are not being adequately funded by either water quality or ecological research.

The Agency is also considering implementation of watershed pollutant trading as a means of achieving water quality goals. To do this, EPA will need to evaluate and align the goals of the water quality and ecological science research programs. This will also require that EPA also strengthen its scientific knowledge base and research activities that address ecological uncertainties.

## 4. ECOLOGICAL RESEARCH

The Ecological Research Program has three major components:

- i) condition assessment and accountability,
- ii) development of methods and tools (primarily diagnostic), and
- iii) research on ecological services and restoration.

In the FY 2007 budget, ecosystems research programs are once again the target of significant resource reductions (approximately 10% relative to FY 2006). The SAB is greatly concerned with EPA's continuing reductions in Ecological research funding. The ecological research budgets have removed nearly \$30million since 2004. Even though the Congress has restored some of these reductions, real reductions of approximately \$20 million have been taken in the STAR ecosystems grant program during that time.

The total budget for Ecological research is down \$ 6.1 million in the 2007 budget. This reduction in budget is inconsistent with the prevailing position that such research is critical for the Agency to better manage and track the benefits of such management of the environment. A number of external Agency Advisory groups, such as the Board of Scientific Counselors, the National Academy of Sciences, and even EPA Science Advisory Board groups such as Environmental Processes and Effects Committee and Committee on the Valuation and Protection of Ecological Systems and Services, have explicitly expressed support for greater research in this area.

Understanding the response of ecosystems to biological, chemical and physical stress is essential for protecting the environment and the humans that live in it. The short-sightedness of the continued ecosystems research budget decreases is clearly demonstrated by events of the 2005 U.S. hurricane season. Ecosystems such as coastal wetlands and forests provide significant ecological service by acting as natural buffers to dampen the damaging force of such severe storms. Had the nation possessed the scientific understanding of the services provided by those coastal ecosystems and used that information to manage their protection, the costly damage associated with storms such as *Katrina* and *Rita* would most likely have been greatly diminished.

The SAB recommends that the funding for this key area should be reestablished and expanded in future years. Further, the Agency needs to do a better job of communicating the importance of this research area and the breadth of substantive supporters that it has for these research efforts. While motivated by real-world problems, a significant portion of the Agency's ecosystem research needs to be fundamental in nature, and the Agency also needs to do a better job of explaining this fact.

The U.S. Environmental protection Agency's Ecological Research Program directly supports EPA's mission objectives and it appears to be effectively linked to programs within the agency and to the Agency's Regional Offices and laboratories, as well as to the states. However, the linkage to other federal agencies, and non-government ecological organizations has not been articulated as clearly. The agency needs to advance its efforts to demonstrate this coordination

with other agencies so that it can better communicate those connections and their collaboration in future PART assessments and budget discussions.

The budget for Ecological Research is actually part of a budget area titled “Human health and Ecosystems. Although there is no indication that this is a barrier to effective planning, it seems this valuable area should stand on its own as a research focus area. The Agency should consider separating this budget category into a separate area.

It was noted during further discussions with the agency that two principle factors may well have contributed to the reduction in the 2007 budget for Ecological research. First, the most recent update of the OMB PART assessment resulted in a rating of *ineffective* for this program. It appears that the PART assessment focused primarily on one aspect of the Ecological Research program, i.e., the Environmental Monitoring and Assessment Program (EMAP), which is only about 1/3 of the actual budget expenditures. In efforts to justify this program the agency either failed to communicate or OMB did not understand the EMAP program’s value to environmental management decisions and actions. In particular the program was given low scores in areas of the PART assessment related to the uniqueness of the research, clarity on aggressive timelines for achieving deliverables and related cost-effectiveness methods rather than the scientific relevance of this area of research.

The Ecological Research Program has developed important probabilistic tools (e.g. Environmental Monitoring and Assessment Program) to assess the status and trends of aquatic and terrestrial resources (streams, lakes, estuaries, forests, etc.) at a variety of scales (regional, and national).

It is important to recognize that although Water Quality research and Ecological research are placed into different budget areas these two programs are critically linked to each other. The SAB emphasizes that reductions to ecosystems research can and will lead to time, data or other resource limitations for accomplishing EPA’s Water Quality research objectives. The agency needs to aggressively improve its communication of the broader value of its Ecological Research program and its critical and systematic linkage to other research and also program areas such as the Water Quality program.

Additionally, losses in several ecosystems programs may have much greater or amplified impacts on progress on other research programs. The logic seems to be to cut programs because of perceived redundancies with programs of other agencies or because of perceived redundancies with other programs within EPA. However, those making budget decisions need to recognize that some research that seems to be redundant because of the superficial information available to them can in reality be a lynch-pin in a larger, overarching and integrated research program that is conducted by multiple organizations, each of which specializes in areas where they have explicit missions and expertise. Examples of this include the elimination of the global climate change program funding of water quality research, and the reduction in extramural research in mercury fate and transport. It is difficult to see how EPA will achieve some of its strategic goals with continuous erosion of these small but important pieces that are not understood within a larger context.

It is obvious that in the broad area of Ecological research there are many important gaps in EPA and the nation's knowledge of the environment that are worth bringing into the research program as other projects are completed. Answering a small piece of the puzzle does not remove the need to study other issues that are also quite important to EPA's mission. Ecological Research is not a small definable set of activities that can be reduced one-by-one like a list of steps in a project. There are many of important research initiatives waiting to be addressed. These are not of lower importance rather they may only be waiting on other research to be completed so that they can be placed onto the active research agenda.

An important consideration was highlighted for the SAB through anecdotal information on how EPA sets its specific goals for research. It seems to be that the agency must negotiate the specific language that specifies its goals. In one example of this practice, it appears that EPA staff was not allowed to include a goal that focused on regional and local decision-making needs. The practical outcome of this was that EPA was not able to include an important focus of ORD's activity, support of real-world decision-making on actions needed to respond to localized events. Therefore, it appears that assessments of value and performance of the research is constrained to National policy making. In reality the more likely key audience for the ecological research is a regional, state, and local scientific communities that assesses real problems at regional and local levels (e.g., regional ecological systems such as watersheds) while implementing specific federal regulations in their own localities. During its meeting on March 2-3, 2006, the SAB received an excellent and effective presentation of such an example by Regional and ORD representatives (i.e., the Georges Creek, MD case that demonstrated an explicit link between EPA ORD research and an outcome of improved stream quality in Maryland). The SAB believes that this is a powerful example showing an important real-world environmental improvement outcome that was directly related to EPA's research program. This lack of linkage to of ecological research to Regional benefits may well have constrained the agency as it attempted to demonstrate the value of the ecological research during the PART review.

The SAB believes that the agency should not be constrained in setting goals that demonstrate the alignment of its research with attaining real world outcomes that assist state and local governments to implement Federal mandates.

Finally, Long Term Goal 3 (Ecological Services & Restoration) appears to address impacts on ecosystem services. This is an important emerging environmental issue. EPA must continue to move beyond status and trends data and focus more on linking their regulatory efforts to ecological services protected or restored. EPA should pursue research to develop the capability to demonstrate how regulatory programs impact ecological services. EPA also needs to develop analytical approaches for regional and local assessments and at the same time not abandon research on national level tools.

## **5. HUMAN HEALTH RESEARCH**

### **5.1. Human Health Research**

The Human Health Research Program is one of only two core research programs in the Agency, the other being ecology. Core research programs generate, and provide incentive for researchers outside EPA to generate critical parts of the basic scientific knowledge that underpins EPA's applied science program and the regional and headquarters operating programs that carry out EPA's human health and environmental protection missions. According to comments made by EPA's Assistant Administrator for Research and Development, during the SAB March 3 session, the proportion of EPA's research budget devoted to core science issues has changed from what used to be close to 60% core to 40% program driven research to about 30% core and 70% problem driven research. The purpose of this program is to provide to risk assessors, and other interested parties, scientific data that are necessary to assess and to make important decisions regarding human health risks. The program develops and collects the scientific information to make decisions about exposure that provide appropriate protection to the health of humans. These policy decisions often involve substantial monetary impacts to industry, governmental agencies, and eventually to the public that may amount to many millions of dollars. In contrast, errors in these policy decisions may lead to risks to living persons or even to future generations.

EPA focuses on four long-term goals, to provide the science necessary for risk assessors and managers to make the best informed decisions based on science. These Long Term Goals include efforts to: reduce uncertainty using mechanistic information, to characterize the cumulative and aggregated risks from multiple chemicals to characterize the susceptible populations to provide adequate protection for all groups by age and by factors related to genetics such as race and ethnicity and develop principles to evaluate risk management decisions.

This program has been evaluated by both the ORD Board of Scientific Counselors and by EPA and OMB using the PART process. The BOSC determined that the mission of this research program was being well conducted. In addition, the SAB's scientific panels have also given parts of the programs that have reviewed their general approval. At the same time, the SAB has also asked for more and more science from EPA as it carries out the Agency's mandates. The SAB has also asked for a greater level of review of the science that is used in regulation.

As the program has continued to work to fulfill these demands, the science and technology surrounding the information about human risks has grown rapidly. For example, the development of the fields of "omics" and the relationship of the information in these areas to human disease is increasing at previously undreamed of speeds. Therefore, EPA has more science to gather for each pollutant that it evaluates both from internal and external sources. In addition, the data are very complex and requires even more time, effort, and resources to integrate into a rational scheme for developing a regulation. As the agency science budget continues to be reduced, the number of evaluations that it can conduct decreases and evaluations that are carried out are delayed. In turn, this means that when a document is subjected to peer

review by scientific experts, the data are often old and more uncertainties have often identified. There is no easy solution to this problem. Thus, if EPA continues in this “spiral,” it may be important to consider just how closely the scientific demands can be met in the future.

The preceding paragraphs have discussed primarily the problems encountered by a reduced capacity in Long-Term Goal 1. The SAB believes that all four goals are important and thus is concerned with the potential impacts associated with the reduced budgets in the other three goals. There, considering the risks of joint exposures to multiple chemicals will likely experience major delays. In goal 3, the Agency has had to withdraw their financial support for the National Children’s study although they continue to look at the risks from exposures in the youngest of our population. However, other factors that can influence the risks both by life stage, especially the elderly, and the potential genetic differences by race or ethnicity will not be part of the current activities in any serious effort. The fourth aim is essentially to look at the public health consequences of the decisions made by the agency. This effort is also delayed.

There are also areas that the Human Health Program is not able to address adequately. While the Agency is collecting the data relevant to humans it has not, they have not extensively addressed the issue of the exposures. Its effort at collecting relevant data from other sources is also greatly delayed by lack of funds.

## **5.2. Computational Toxicology**

The Computational Toxicology program focuses on improving the linkages in the source-outcome paradigm; providing tools for screening and prioritizing chemicals under regulatory review; and enhancing quantitative risk assessment. Efforts in this program appear to be targeted at supporting both human health assessments and ecological assessments. The program has a planned increase of about \$2.0 million in FY 2007.

The SAB commends the expanded investment in the Computational Toxicology research program. This investment is essential to providing EPA with the expertise and technologies necessary to keep pace with the rapid expansion in genomic and modeling sciences occurring in biomedical research. However, because the Computational Toxicology program is highly dependent on data inputs from other EPA human health and ecosystems research programs, the SAB is concerned that the flat or declining research investments in these associated areas will likely compromise the future effectiveness of this research investment.

## **5.3. Human Health Risk Assessment**

EPA’s Human Health Risk Assessment program includes the Integrated Risk Information System (IRIS) and other health hazard assessments; development of risk assessment guidance, methods, and models; and development of Air Quality Criteria Documents. The program reduces from \$39.4 to \$38.3 million in 2007. The cuts are in the children’s health area while a \$0.5 million increase is provided to obtain peer reviews of IRIS assessments by the National Academy of Sciences.

Resources are planned to decrease in this program area, even though there is an increasing need for high quality risk information and increasing requirements for complex

scientific analyses at the EPA. There is a need to increase risk assessment research resources to support these efforts. For example, pharmacokinetic analyses are an essential component of dose response evaluations; data permitting, and exploration of pharmacodynamic approaches have also been recommended to the EPA. At a minimum such approaches would help to articulate the range of model uncertainty. It is important to recognize that even if EPA does not conduct research to improve how it incorporates more and more complex data into assessments, data continue to be gathered at a high rate, thus, without better methods, EPA will fall further behind in the risk assessment area.

Past involvement by outside groups in the review of EPA assessments, as well as the development of additional review requirements, have resulted in the advice that increases this complexity further. For example, the SAB strongly recommended the development of methodologies for quantitative uncertainty and variability analyses of toxicological parameters such as cancer unit risk values and reference doses (EPA SAB, 2004<sup>2</sup>). Further, the OMB's Risk Assessment Bulletin, if adopted in its present form, could in essence make such analyses a requirement. Demands on Agency risk assessment resources have also resulted from the Data Quality Act and OMB's Peer Review Bulletin. The need to address multiple pollutant exposures to support air program efforts is also clear. Agency products such as certain IRIS assessments and other health effects assessments (e.g., dioxin and trichloroethylene) are undergoing expensive reviews by the National Research Council. Without an increase in resources, the ability for the Agency to produce high quality assessments for the large number of chemicals of public health interest will be severely limited, as will the number of peer reviews that EPA can obtain from independent groups, such as the NAS as is planned in its IRIS program.

#### **5.4. Safe Pesticides and Safe Products Research**

This program focuses on research that addresses specific issues managed by the EPA Toxic Substances program and the EPA Pesticides program. This program complements research efforts in the Human Health and Ecosystem Research programs as well as those in the Human Health Risk Assessment, and Endocrine Disruptor programs. The efforts in this area: i) provide predictive tools for prioritization and enhanced interpretation of exposure, hazard identification and dose-response information; ii) create the scientific foundations for probabilistic risk assessment methods that protect natural populations of birds, fish and other wildlife; iii) provide the scientific foundation for guidance to reduce risks to human environments within communities, homes, workplaces; and iv) provide strategic scientific information and advice concerning novel or newly discovered hazards.

The Safe Pesticides and Safe Products Research program Presidential Budget for FY2007 is set at \$26.2M, down \$4.1M from the enacted budget funding for FY2006. The \$4.1M cut in the President's FY2007 budget is in fact funds in the FY2006 budget that were allocated to this program from a special allocation designated by Congress for added science and technology projects. These one-time funds were applied to special initiatives and grants related to this

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<sup>2</sup> EPA Science Advisory Board. 2004. *EPA's Multimedia, Multipathway, and Multireceptor Risk Assessment (3MRA) Modeling System*. EPA-SAB-05-003, November, 2004. Available at: <http://www.epa.gov/sab>.

program's long term goals. The EPA budget notes that these decreases will impact biotechnology, and collaborative and risk related research efforts.

Projects included under Long Term Goals 1-4 are funded in the FY2007 budget. The major areas covered by these projects appear to be consistent with both the short-term and long-term research needs of the Office of Pesticide Programs and Toxic Substances (OPPTS). The SAB's greatest concern for this program area is not the proposed level of funding for FY2007 but the fact that the level of funding has remained flat for several years (notwithstanding the one-time increase in 2006) and in real dollar terms has consistently declined. The scientific demands on ORD research staff and OPPTS regulatory functions are becoming increasingly complex, and involve genomics, proteomics, genetic engineering, and endocrinology. The SAB recognizes that ORD cannot be expected to maintain large intramural or extramural research programs in each of the rapidly expanding areas of science and technology. However, ORD must have senior scientists who are capable of understanding these areas at an expert level and who can integrate research results from other government agencies, industry and academic research programs into its support of OPPTS policy formation and regulatory activities. If the ORD budget in this program area continues to decline in real dollar terms, it will not be able to maintain the scientific staff and infrastructure to fill this critical role.

Finally, the proposed FY2007 budget for this program will not permit ORD to launch a planned initiative to develop standard biomarker measures that the FIFRA Scientific Advisory Panel and other EPA panels have regularly stated are essential to the validation of the probabilistic risk assessment models that are increasingly important components used in the aggregate and cumulative risk assessments of pesticides and herbicides

### **5.5. Endocrine Disruptors**

The endocrine disruptors program is organized to address a major nationally recognized human health and ecosystem health concern. The program long term goals are to: i) improve the underlying science regarding the effects, exposures, assessment, and risk management of endocrine disruptors; and ii) to determine the impact of endocrine disruptors on humans, wildlife, and the environment. The budget proposal for FY 2007 is for \$9.1 million, down from \$10.5 million in FY 2005 (as enacted).

The Endocrine Disruptor program was evaluated (using the PART process) during 2004 and it was the first USEPA program that received a passing score (adequate), a score not surpassed by any other program in the EPA. The Board of Scientific Councilors (BOSC) also evaluated this program in 2005. The BOSC found the endocrine disruptors program to be highly effective especially in view of an extremely limited budget in FY 2005 (\$10.4 million) and 2006 (\$10.5 million). The BOSC indicated that this budget was grossly under funded.

Despite the Endocrine Disruptor Program's focus on addressing a high national priority, and despite its conduct of this program in a scientifically high quality and efficient manner, the proposed 2007 President's budget cuts this program by \$1.4 million (10%). All of the cuts occurred in the STAR program, the extramural program that recruits the nation's academic community to address the endocrine disruptors science program needs. The SAB recommends that the budget for endocrine disruptors be reinstated.



## 6. TECHNOLOGY

### 6.1. Land Restoration and Preservation Research

The Land Research Program supports that Agency's objective of reducing or controlling potential risk to human health and the environment at contaminated waste sites by providing science to support decision making at complex sites. The program has two themes restoration and preservation. Resources come from the Science and Technology account (about \$10.5 million is budgeted for FY 2007) and the trust funds (\$21.9 million from Superfund; \$650 thousand from UST; \$900 thousand from Oil Spills). The S&T account that primarily supports the RCRA program research decreases by about \$1.0 million in 2007 and the Superfund account decreases by about \$1.0 million as well. Overall, the Goal 3 FY07 budgetary priorities have changed little from those in FY06, although the overall goal budget is down by 15% (\$40.0 to \$34.1).

Three programs have either been eliminated or maintained at a minimal level (Oil spills, Superfund Innovative Technology Evaluation, and Underground Storage Tanks). The Board is satisfied with the notion that elimination of mature programs that can be assumed by the private sector, or other agencies is justified, however there is concern that there has been little planning associated with the phase outs in this program. These programs contain expertise and capabilities that should not be lost in the future, since there remain many waste cleanups yet to be carried out. In addition, the Board believes that there are still significant research needs associated with the waste cleanup program, particularly related to site characterization.

The strategic targets for Goal 3 are certainly worthy, but it is not clear how the S&T budget will be used to achieve these goals. The Resource Conservation Challenge (RCC) is presented as an important tool for promoting voluntary cooperation, but the research budget for RCC is still unclear (anecdotal evidence suggests that about \$1 million has been allocated—if this is so it would indeed represent an increase).

The only specific information on the RCC research program is from page S&T-99 in the budget document that notes that RCC is "...a major national effort to reduce waste and conserve natural resources by promoting the use of recycled products. EPA will continue to develop effective options for minimizing waste, and for assessing the performance of waste minimization programs through multimedia risk assessments...In FY 2007, utilizing its multimedia modeling risk assessment methodologies, EPA's research and development program will provide an estimate of the benefits realized (i.e., reduction in risk to human and ecological receptors) in reducing priority chemicals waste streams." As the Board pointed out last year in its commentary, areas of relevant research are many and varied, ranging from material flow and life cycle studies, to data certification, to appropriate policy instruments to create incentives for material conservation.

The Board notes that the goals and objectives of the RCC are consistent with the Agency's Sustainability Research programs, which appear to have emerged from the previous

“pollution prevention” and “technology for a sustainable environment” programs. The SAB will soon review EPA’s Sustainability Research Strategy and the Board will have more to say on this in the future. However, we believe that among the important topics to include in a sustainability program would be: re-engineering processes, the implications of new products for commerce, and the need to provide meaningful incentives for maintaining and improving environmental performance. The Board believes that it is possible to articulate Sustainability – RCC research budgets, strategies, and plans in a way that shows their relationships, and their individual focus, e.g., the RCC might provide the basis for the kinds of research needed as drawn from connections with EPA’s partners, and Sustainability Research might focus on using the best and most appropriate research tools. The RCC would then serve the dual purpose of mining information from its partners for relevant research needs, and then to the extent possible transferring the results of Sustainability Research to the field.

In carrying out this task, the Board suggests that it be subjected to PART review as soon as practicable so that the PART tool can be used for program design and documentation, as well as ex post evaluation. The Board looks forward to the presentation of a coherent Sustainability/RCC research program next year.

Science programs in Goal 3 reflect coordination among EPA organizations. The Board notes that the targets of Goal 3 and those of Goal 5 overlap, with the latter supporting S&T research on pollution prevention. It is important that these functions be closely coordinated if the research is to be relevant and useable in the short term.

The Board is on record as stating that the Agency does coordinate well with other agencies, but the SAB has requested more specific information on the quantitative amount of leveraging that is actually achieved (see the Board’s FY 2006 advisory). Such information should be developed across the Federal government routinely as part of the science and research budget evaluation. It would be helpful if this information would include trends over the preceding five years. This information on Agency resource leveraging is important if all involved are to understand the degree to which environmental research portfolios across the federal government intersect and how well they are coordinated. As noted during the Board’s review meeting, the EPA S&T research budget accounts for about 7% of the total federal environmental funding. Without a more detailed knowledge of research supported by other agencies, it is difficult for the Board to assess the impacts of EPA’s programmatic cuts and reallocations, in this and other Goals, and how they impact overall federal research on specific topics (an example is the continuing de-emphasis in EPA’s ecosystems research program and its impact on other agencies having complementary research programs and mission areas. Accordingly the Board renews its longstanding request for more detailed information on the cross-agency collaborative research funding.

This year the SAB was able to examine emerging research programs in the general area of nanotechnology, and also the GEOSS/Advanced Monitoring Initiative

## **6.2. Nanotechnology**

EPA's nanotechnology program increases from \$4.6 million to \$8.6 million in FY 2007. In FY 2007 EPA's program will conduct nanotechnology research through its extramural exploratory grants program which funds investigator initiated projects and they will develop an intramural research program.

The Board notes the significant (more than 80%) increase in funding devoted to the national nanotechnology initiative for pursuing environmental impact research. The increase in EPA's nanotechnology budget is encouraging, though the absolute amount is still small when compared with other agencies in the National Nanotechnology Initiative and given the level of public concerns about the environmental impacts of nanotechnology.

The SAB has noted over the past two years that nanotechnology will have immediate impacts on the environment. This will occur in two ways: i) nanotechnology support for environmental improvements (e.g., development of new sensors, water purification membranes, etc.), and ii) potentially negative environmental impacts associated with nanotechnology products or manufacturing processes.

Thus far, most studies seem to have focused on the fate, transport, and human health effects of fine particle structures. The Board has noted in its previous reports, and re-emphasizes again, the need to include nano-manufacturing within the EPA research portfolio. This trend is already well underway, in the industrial sector, yet it is unclear if the Agency understands the differential impacts of old versus new technologies, and if it has the correct regulatory tools at its disposal to address these issues.

The SAB supports the decision by EPA to build up internal capacity on nanotechnology. This will become increasingly important as more nano-based substances and products penetrate the marketplace. The federal government will increasingly need good science to permit it to evaluate and underpin the need for possible regulations in this area (e.g., under the TSCA, the Clean Air Act, the Clean Water Act, and RCRA).

EPA is still planning its intramural research on nanotechnology for 2007. The objectives of this program will be to understand the potential human health and ecological impacts of manufactured nano-materials, and to investigate how nanotechnology can be used safely in commercial and environmental applications. EPA's background information indicated that it was still planning its 2007 nanotechnology efforts and that from 60 to 80% of its new intramural research would likely focus on nanotechnology's environmental implications and the remainder would address nanotechnology's potential applications (e.g., nano-scale sensors for environmental monitoring).

The SAB believes that the current planning underway for EPA's nanotechnology program is appropriate and important to the design of both EPA's intramural and extramural programs. However, before investments are made planning should include an analysis of previous nanotech implications research (by EPA and other agencies) to identify the important gaps which might exist (e.g., in areas such as ecosystem impacts -- terrestrial and aquatic--, bioaccumulation, or chronic effects). Further, EPA should focus its efforts on research that is

not likely to be undertaken by any other agency in the government. NIOSH, for instance, can do nanoparticle characterization, and NIEHS can cover many areas related to human toxicology. There are, however, gapping holes in our understanding of the environmental impacts of nanotechnology, and EPA should include these in its research program.

The EPA will need to work closely with other agencies depending on the products (the FDA for cosmetics, for instance). The proposed emphases on dissipative uses and techniques to detect and remediate nanotechnology in the environment are also important.

EPA should carefully consider how much money it spends on applications research, what impacts that will have on their ability to undertake key implications research, and how they can partner with other agencies on applications development (DOD, for instance, funds work on nano-scale sensor systems).

The SAB has stated several times that the EPA's research program in nanotechnology should fund complementary research that industry either can not or will not fund. But partnering with industry, in order to leverage meager Agency funds, makes much sense because it is the various industries that understand the technologies involved. By partnering, EPA gets to learn the basis of new technologies and their environmental implications, and industry gets to have their input to Agency thinking on how best to manage the problems that might be associated with these new technologies. Proprietary issues will undoubtedly come up, and will have to be dealt with creatively, and diplomatically.

The Board in particular points to the need for a life cycle approach for existing and emerging nano-based substances and products in order to more fully evaluate systems on a "cradle-to-grave", and "gate-to-end-of-life" basis (product cycle). The EPA will need to work closely with other agencies to better understand the life-cycle impacts of products not under EPA jurisdiction (drugs and cosmetics would be examples, which fall under FDA). The proposed emphases on dissipative uses (such as fuel additives) and techniques to detect and remediate nanotechnology in the environment are also important areas of focus.

A key problem in this area is how to efficiently manage any risks that nanotechnology may pose without seriously impeding the development of these important new technologies. A simple extrapolation of past risk management strategies does not look like it will get us the kinds of results we need. EPA needs to work harder on developing strategies to create new and innovative ideas for risk management in the area of nanotechnology.

### **6.3. Advanced Monitoring Initiative (AMI) /GEOSS**

EPA's Advanced Monitoring Initiative (AMI) is linked to the interagency U.S. Global Earth Observation initiative and the international Global Earth Observation System of Systems (GEOSS) program. Resources in FY 2007 decrease from \$5.3 million to \$5.1 million. Overall GEOSS intends to provide planet-wide information to be used in policy making. EPA has begun its work in this area and continued funding of the Advanced Monitoring Initiative will permit EPA to continue its participation in this initiative and to develop its strategy and plans for the future use of the promising data that GEOSS will make available to users.

This is a new program that only started in the current fiscal year and thus, it is difficult to evaluate. There is certainly great potential for space-based and other dispersed observations to support protection of human health and the environment. The Board has been given little specificity as to how the technology will be integrated into the Agency's efforts. The focus seems to be more on the data collection and archiving systems and less on disseminating the information across the Agency or building a clientele for their results.

The SAB believes that cuts in the Climate Change program will impact the effectiveness of the modest EPA piece of the GEOSS program. The Societal benefits identified in regard to water, weather, climate and human health identified in GEOSS will be integral to the science in the Climate Change program. Thus while EPA is a minor player in terms of funding GEOSS, the unique role that EPA has [contaminant sources, discharges to water, transport, exposure and health impacts] suggests that these cuts will place EPA at a scientific disadvantage nationally and more importantly internationally (as this is developing as a global endeavor). In addition, this will impede the realization of the societal benefits in regard to water quality and health.

## **7. HOMELAND SECURITY RESEARCH**

### **7.1. Background Information on the Program**

Budget and Components: EPA documents available to the SAB indicate that during FY 2007, EPA proposes to allocate some \$184 million to activities in support of its total U.S. Homeland Security effort. This total investment increases by about \$55 million from FY 2006 to 2007. Of this increase, some \$33 million is in the S&T account for the EPA Office of Water and \$9 million is in the S&T account of the EPA Office of Research and Development. The total Homeland Security resource is allocated across five Program/Projects as follows (amounts shown are in the aggregate of all accounts funding the work):

- i. Homeland Security: Critical Infrastructure Protection - \$54 M
- ii. Homeland Security: Preparedness, Response, and Recovery - \$98 M
- iii. Homeland Security: Protection of EPA Personnel/Infrastructure - \$20 M
- iv. Homeland Security: Communication and Information - \$7 M
- v. Categorical Grants: Homeland Security - \$5 M

Themes: The predominant theme in the EPA Homeland Security program is the conduct of research and operations to better prepare the Agency to deal with emergencies associated with intentional releases of chemical, biological, and/or radiological agents. Most of EPA's offices are working on Homeland Security issues, among them the Office of Water, Office of Air and Radiation, Office of Research and Development, the Office of Solid Waste and Emergency Response, the Office of Prevention, Pesticides and Toxic Substances, and the Office of Administration and Resource Management. Efforts include the development, enhancement, and deployment of monitoring networks, data systems, and laboratory capacity to allow EPA to detect releases of agents and/or determine the levels and risk associated with released agents. EPA is also working to protect water infrastructure, evaluating and developing decontamination technologies, preparing responders to respond, assessing the efficacy of antimicrobial agents, and determining clean up guidelines for high priority agents. Two of these, Critical Infrastructure Protection and the Preparedness, Response and Recover Program/Projects are further summarized and commented upon below.

### **7.2. The Critical Infrastructure Protection Program**

EPA documents available to the SAB indicate that the Critical Infrastructure Protection Program aims are to lead and support state and water utility efforts to secure their water infrastructure from terrorist threats and other intentional harm. The overall program budget for FY 2007 is approximately \$54 million. Approximately \$45 million of this is S&T (an expansion of funding of about \$33 million S&T from FY 2006). This program supports the water sector by implementing protective measures directly and by improving such measures through an expanding pilot program known as WaterSentinel. Homeland Security Presidential Directive-7 "...designates EPA as the Sector-Specific Agency 'responsible for infrastructure protection activities' for the water sector (drinking water and wastewater utilities)." "HSPD-9 directs EPA to develop a 'robust, comprehensive, and fully coordinated surveillance and monitoring system'

for drinking water and a water laboratory network that would support water surveillance and emergency response activities. The overall goal of Water Sentinel is to design and demonstrate an effective system for timely detection and appropriate response to drinking water contamination threats and incidents through a pilot program that would have broad application to the nation's drinking water utilities." The WaterSentinel program provides the context for some of the research and development activities that are to be conducted by the Office of Research and development during 2007 and which are discussed in the next section of this report.

In FY 2007 EPA will expand the number and diversity of pilot projects initiated in the U.S. The pilots will integrate information from contaminant-specific sampling and laboratory analysis, on-line water quality monitoring, public health surveillance, customer complaints, and physical security to form a comprehensive contamination warning system. The WaterSentinel program is intended to prove the concept of an effective contamination warning system, so that drinking water utilities of all sizes and characteristics can adopt such a system. EPA will also provide critical tools, training, and exercises that will help utilities detect, prevent, and respond to threats. This program is largely implemented by the Office of Water with some support from the Office of Research and Development in at least the training aspect. It is not clear how much ORD involvement is planned for this program. Some of this work appears to have operational components, though the extent is not clear from the information available to the SAB.

### **7.3. Preparedness, Response, and Recovery**

EPA documents available to the SAB indicate that the goal of this program is to increase the Agency's preparedness, and its response and recovery capabilities for homeland security incidents involving chemical, biological or radiological threats through the conduct of research, development, and technical support activities. The total budget for ORD in this Program/Project is about \$40 million with most coming from the S&T account and \$2.0 million from the Superfund account.

Efforts in this program project are intended to increase EPA's knowledge of potential threats and its response capabilities by assembling and evaluating private sector tools and capabilities so that preferred response approaches can be identified and evaluated for future use by first responders, decision makers, and the public. There is a substantial collaborative nature to this program among EPA and other Federal institutions. EPA intends to focus its own activities on topics where EPA has unique knowledge and expertise.

It appears that much of the work in the Program/Project could at least indirectly support the work within the Critical Infrastructure Program/Project summarized above. The Program/Project is broken into areas of National Homeland Security Research Center (NHSRC), Radiation Monitoring, and Biodefense.

#### 1) National Homeland Security Research Center:

The NHSRC oversees research in preparedness, risk assessment, detection, containment, decontamination, and disposal associated with chemical, biological, and radiological attacks. The NHSRC work supports responsibilities assigned in HSPDs 7, 9, and 10. Specific programs address the following areas:

- Water infrastructure protection research directly supports the CIP by developing, testing, demonstrating, communicating and implementing enhanced methods for detection, treatment, and containment of biological and chemical warfare agents; certain radiological contaminants; and bulk industrial chemicals.
- Threat and Consequence Assessment focuses on risk assessment of decontamination byproducts, refining toxicology databases, developing fate/transport/dispersion/exposure parameters, and develop computer-based tools to aid decision makers in assessing risks from biological and chemical attacks and determining cleanup and/or guidance goals.
- Standardized Analytical Methods (SAM) efforts will expand the SAM document for Homeland Security and include development, validation, and testing of non-standard methods and additional methods for chemicals/biologicals/radiologicals in new matrices. Efforts also establish an applied measurement science research program to administer the activities of a national laboratory network that will manage methods development, validation, and application for contaminants resulting from terrorist attacks. This work appears to support the WaterSentinel program though it could also support other parts of EPA's Homeland Security program.
- Decontamination Systems efforts will do critical research to improve decontamination methods, and develop new ones for new contaminants in buildings/large structures/outdoor areas. Field studies will also be conducted to validate decontamination methods for anthrax. Efforts will also continue to develop decontamination methods for building materials
- Risk Characterization for Bio-Contaminants evaluates toxicity, infectivity, and mode of action for biological contaminants in order to develop dose-response information for cleanup guidelines. Technologies for in situ management of crops/animal carcasses contaminated with agents will also be evaluated..

## 2) Radiation Monitoring:

EPA is responsible for maintenance and enhancement of the RadNet monitoring Network (previously known as ERAMS). EPA is responsible for personnel and asset readiness for radiological emergency responses and it will participate in responses and provide technical support. EPA will upgrade RadNet to get near real-time information to support decision making and build upon work already begun to augment EPA's existing applied science radiological labs to meet emerging Homeland Security needs and to serve as the EPA radiological reference lab.



### 3) Biodefense:

Efforts will continue to develop and validate methods for evaluating the efficacy of products employed against bioterrorism agents; address gaps in efficacy testing knowledge and knowledge of microbial resistance; begin to address viruses and emerging pathogens; and propose the development and evaluation of efficacy test protocols for products designed to control viruses during decontamination.

## **7.4. SAB Comments**

The SAB considered these issues in two ways. The first was in a recent 2006 SAB Homeland Security Advisory Committee meeting during which the SAB held an official consultation with EPA representatives on the WaterSentinel and Standard Analytical Methods programs associated with Homeland Security. That meeting was held as a closed meeting because it discussed aspects of the program that are considered to be sensitive in nature. Remarks that follow in this budget report reflect publicly available documentation from that meeting as well as additional open discussions between SAB members and EPA representatives during the Board's advisory meeting on the EPA research budget for FY 2007 (i.e., the SAB March 2-3, 2006 meeting) which did not involve sensitive information.

WaterSentinel Strategy and Priorities. The SAB is not able to comment on the underlying strategy, in terms of the allocation of resources to specific threats or approaches to address specific threats. Those strategic directions reflect determinations made largely outside of EPA, and they are at least partially based on sensitive information. As a result, the SAB cannot offer any opinion regarding whether any program passes a cost-benefit test (i.e., is it worth doing at all). We could only address the cost-effectiveness test, regarding how allocated resources are invested.

It is often the case that as programs begin to address critical issues with near-term needs, such as the development of technologies to monitor and respond to identified threats, they focus on adapting existing technologies to the new situation. While this is deemed to be a reasonable tactic, it can often have unintended consequences. For example, it could result in developing a technology that turns out to be useable only by highly specialized laboratories and persons with expertise far above that likely to be available in the new area of application. Thus, we are concerned that EPA might be investing in techniques that will not be useful to laboratories near an attack, at times when rapid response is essential. Even if some specialized laboratory equipment and personnel are available, the capacity for large throughput of many analyses may not be. The materials made available to the SAB did not allow it to make a confident assessment that a systems analysis had been conducted and produced a satisfactory result that provided guidance to EPA's currently planned activities in this area.

The SAB has commented over the last two years about the lack of significant investments in organizational or behavioral science. Behavioral science activity will be necessary as part of any Agency systematic evaluation of technology needs in this program. These issues go beyond just the physical sciences that are used in developing technologies and they include such issues as usability, first responder training and protection, decision rules for acting on signals from sensors (embedded in their social, political, economic context), risk communication, recovery, and acceptability of decontamination standards. EPA's program managers have stated to the SAB that these issues are not intended to be a focus of EPA's program. The SAB believes that EPA is aware of these issues, and that staff does the best that they can to address them in practical matters of design; however, that means relying on professional judgment, typically with professionals trained in other disciplines. The SAB has serious concerns about the threat to system design posed by this lack of the necessary behavioral sciences base.

The SAB understands the need for security that surrounds the Homeland Security program across government. Those needs are important and valid. However, the SAB is concerned with the lack of transparency in some aspects of the Homeland Security program. An example of such an issue is related to the "usability" issue discussed immediately above. During the March 2, 2006 discussions, the SAB questions concerning whether the products of this research would be publicly available were met with ambiguous statements. It is the SAB's opinion that much of the homeland security research would benefit from public input and participation, which would necessitate open discussion. Part of the need for the behavioral science activities noted above play out in the area of restoring public confidence in the ability of government to handle emergencies, whether natural, accidental, or intentionally triggered by a terrorist is essential to obtaining public cooperation. A strong investment in the social science component of homeland security projects will be of tremendous benefit to the Agency. For the FY2008 budget, the SAB hopes to see this aspect integrated into the Agency program.

Resource impacts to other programs. The SAB was concerned about potential impacts associated with the growth of the EPA Homeland Security program because of the substantial increase in its budget for FY 2007. The SAB was concerned that this growth in the budget reflected a redirection of funds from other critical EPA research activities including its important research on hazards other than terrorism (e.g., ecosystem protection, watershed preservation, economic evaluation of non-market goods). In addition to the SAB's concerns about the EPA research budget erosion over the last several years, the SAB has also observed a trend and preference for funding short term applied research over research that has a longer time horizon. It appears to the SAB that this shift toward short-term activities is being facilitated by the lack of appropriate procedures for measuring benefits of longer-term, core research programs. Homeland Security, with its urgency and perceived immediate need for concrete research and developmental products, appears to be exacerbating this trend to displace programs like ecological research or research fellowships that produce more diffuse results (even though those results are critical to the nation's human health and environmental goals). Agency staff assured the SAB that there was no "one for one trading" of longer term research focused on traditional EPA topics for shorter term applied research. Even so, it seems that this has been the practical result of increased funding for Homeland Security. A large portion of the increase in Homeland Security activities for FY 2007 under the S&T account (approximately \$42 million) had to come

at the expense of other traditional S&T activities). Though tradeoffs were not explicitly made, they seem to have occurred.

Beyond just the notion of the need for a balance in longer term core research with shorter term problem driven research in ORD's program, is the notion that research funds should be applied to research and not to operations. This was stated in the SAB's report on the FY 2006 budget and it continues to be the case. It is of course difficult to assign parts of EPA's research program to core vs. problem-driven research categories. Further, at EPA it is possible that results from core research rapidly move to the applied arena because of EPA's need for data for use in decision making. However, it appears that core research is declining rapidly. Over the last several years, the SAB has observed that core research occupied some 50 to 60 % of ORD's budget. Now, it is closer to 30% core and 70% problem driven research. The SAB recommends that the EPA budget office adopt a transparent scheme for categorizing individual projects in terms of where they fall on the continuum for core research to operating the products, methods, and processes that are the product of research and development. We suggest considering the scheme proposed in the report of the committee chaired by Frank Press, former President of the National Academy of Science (NAS 1995<sup>3</sup>).

There is a further concern, then, when the SAB considers the general nature of research that goes beyond the core vs. problem driven issue. That is, many research programs transition into operating programs in the fast paced issues that EPA must address. The SAB has a longstanding concern for the former and a growing concern with the latter – funding operations with research funds. Many of the activities within the CIP appear to be at least transitional activities toward a routine operating program, if not frank operating programs themselves. It also appears that some of the activities within ORD's PR&R research and development program that supports the CIP, could also be operational. If that is correct, the SAB would be concerned that the trend toward diverting long-term research support to short-term applications support might finally be reaching its extreme and shifting research resources to operating programs which is the province of EPA's program offices which have funds that are appropriated for those purposes. As mentioned, the SAB is also concerned that the Homeland Security budget is itself disproportionately weighted toward short-term solutions, using existing technology, despite being a domain where the technology is changing rapidly and the threats may change as well.

Exacerbating the issues raised just above about including operational activities within a Science and Technology account is the clear recognition that some of the Homeland Security projects have equipment purchases in the first year. The SAB cautions the agency to consider the continuing costs, for equipment calibration, maintenance, and for training of individuals to use the equipment. With emergency response functions, there is a tendency to conduct one initial round of training, but if there are no opportunities to put the training into practice, skills deteriorate. Stable and predictable funding is needed for these homeland security projects so the equipment will be operable and there will be individuals skilled in using it when the need arises. The Agency also assured the SAB that an "all hazards" approach was embraced which would guarantee the use of the equipment and skills for natural disasters, as well as for terrorist incidents. The continuing need for operational funding to support these activities will only

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<sup>3</sup> NAS. 1995. *Allocating Federal Funds for Science and Technology*. National Academy Press. 1995. Frank Press, Chair.

further exert pressure on the budget process to continue to shift funds from basic to applied research and thence to operations. Stable and predictable funding suggests long-term commitments. This deviates from the defined role of “research” and moves to a program area.

There is serious concern that, once developed, these technologies will become the operational responsibility of the program that develops them. That will reduce the Agency’s capacity for future innovation, in an arena where the science is advancing and the threats may change. Three measures that could address this concern: (a) Explicit Agency commitment to transition, (b) research into usability (at the operation, organizational, and institutional levels), ensuring that transition is feasible; and (c) budgeting that explicitly characterized the research and development stage of specific projects. A proposal for (c), endorsed by the National Research Council can be found in *Allocating Federal Funds for Science and Technology* (see footnote 3).

It appears tht the Homeland Security portfolio has not been subject to PART review. If PART is viewed as a critical evaluative tool, it would be sound administrative policy to make it central to these new programs as early as possible in their development.

The SAB has several additional comments to offer about the efforts in this area. These include issues of dual application of research; program integration; local community involvement; compliance; and collaboration.

Dual Use of Research Results: The SAB sees a number of opportunities for the integration of projects which were initially funded and designed for homeland security purposes, to application in the regular goal areas of the agency. In particular, the monitoring systems such as WaterSentinel, RadNet, and Biowatch, the dispersion modeling, fate and transport modeling, analytical techniques, decontamination methods, and disposal options can be useful in the regular goal areas of the EPA.

Program Integration: A key component in the Critical Infrastructure and Preparedness, Response and Recovery programs is integration of systems. It is difficult to get a clear picture of the integration of functions across time frames and operating agencies (e.g., water utilities of different sizes). Although EPA staff expressed an all-hazards perspective, it is hard to see from the planning documents. An organizational science question is how to integrate new systems with existing operations, in order to ensure that they are properly used and exercised, so that they are not expected to attain peak performance the first time that they are used.

Local Community Involvement: The programs have not obviously budgeted for research ensuring their integration with local communities, environmental justice, etc. These will be critical for decontamination, among other things. There is no obvious consideration of impacts of contamination on ecosystems and their role in food supplies, amenities, etc.

Compliance and stewardship. Although the programs have some operational connections with government and industry, these are treated as matters of practice, rather than science. There is not an obvious place for understanding the impacts of changes on reporting, inspection, etc., on the prevention and detection of attacks.

Collaboration: The SAB has been told that there is good communication and coordination among EPA, Department of Homeland Security, and other federal agencies. For the EPA's four major areas of direct responsibility, there appears to be no duplication of effort. In fact, if the EPA does not receive full funding for these research areas (water infrastructure, decontamination/disposal, chemical/biological detection and laboratory capacity, and establishment of risk-informed clean-up levels, significant gaps in national preparedness will be left.

## **8. ECONOMICS, DECISION SCIENCES, AND SUSTAINABILITY**

### **8.1. Economics and Decision Sciences**

Economics and Decision Sciences Research (EDS) is designed to improve our understanding of human and organizational environmental behavior. Since its inception, this program has contributed many articles to the literature on this behavior and thus supported policy-making at both the Federal and State levels. Research is guided by the Environmental Economics Research Strategy that outlines the research needs and priorities in this area. The program is proposed to receive \$2.5 million in FY 2007 a small increase from 2006. The EDS program is a part of EPA's Goal 5 program area of Sustainability which seeks to minimize or eliminate environmental liabilities, integrate management of problems across media; and change traditional methods of creating and distributing goods and services.

In FY 2007 EDS research will focus on three long-term goals: identifying and reducing uncertainties and potential biases associated with benefits transfer methods; improving our understanding of decision making with respect to compliance behavior and environmental performance in response to interventions; and identifying regulated entities response to market mechanisms and incentives. Benefits transfer research will work toward methodological advances on existing datasets and thus enable faster attainment of results. Research will be conducted to help design practical trading programs for local and new markets (e.g., water quality trading programs; pesticide trading; and local air pollution trading programs).

Research will be carried out through STAR EDS Requests for Applications as well as other activities.

SAB comments on this area are summarized below and expanded upon in the following sections.

- The scope of Economics and Decision Sciences seems not to be fully appreciated in the EDS section of the budget information given that component issues of this area are pervasive across almost all other categories in the budget justification (e.g., 66 quotes can be extracted from other categories of the budget justification document that refer to economics and decision sciences issues).
- The resources of the National Center for Environmental Economics are increasingly strained by the requirement that all "large" regulations be subjected to a benefit-cost analysis, whenever such an assessment is requested. In addition, the ORD STAR is inadequately funded to cover all basic research needs in Economics and Decision Sciences. As a consequence, the STAR program for economics has been unable to offer funding to a full complement of RFAs in each cycle (some have been skipped).

- It is inappropriate to categorize practical exercises in benefit-cost analyses, especially those based solely on benefit-transfer methods, as “basic research.” Benefits transfer will continue to be necessary, however, so basic research that will actually broaden the inventory of available benefits estimates/functions for use in benefits transfer is essential. Research on how to do benefits transfer is not a substitute for research on benefits, since the existing inventory of benefits is not yet sufficiently comprehensive.
- Data, especially for longitudinal analyses, are critical to researchers in Economics and Decision Sciences—i.e. the TRI and the PACE data must be maintained; there are also many smaller and unique datasets (some of which have been funded by the EPA) that could be archived in a form that makes them more widely available.
- Economics and Decision Sciences within the Agency continues to be hampered by a long-standing emphasis on risk assessment and safe minimum standards as endpoints. These approaches do not necessarily provide information in a form that is useful for benefit-cost analysis.
- Risk communication and an understanding of public risk perceptions are critical to the Agency’s mission and these topics require expertise beyond the purview of environmental economists and decision scientists. Other social science disciplines have expertise in these areas, yet they remain under-represented and underutilized in the Agency’s research portfolio.

**1) Pervasiveness of Economics and Decision Sciences:** Economics and decision science are more pervasive across the Agency’s Science and Technology programs than many people may realize. Among the 32 other sub-categories of the budget justification, beyond the document’s very limited 2.5 page discussion devoted specifically to the topic of “Research: Economics and Decision Sciences (EDS),” at least 66 different discussions of economic/decision-science issues can be found.

The only portion of the Agency’s Economic and Decision Sciences activity that is officially funded as part of the S&T budget is the STAR grants (extramural) program. Given how pervasive economics and decision sciences issues are, across all of the Agencies science activities, it is unreasonable to expect that extramural research can completely fulfill the Agency’s needs in this area. As in other disciplines, the Agency has internal expertise in Economics, collected within the National Center for Environmental Economics. While these researchers represent a pool of expertise for basic research, it appears that their energies are devoted mostly to benefit-cost analysis for other units within the Agency.

**2) NCEE Staff Involvement in OMB-Required Benefit-Cost Analysis:** The resources of NCEE are increasingly strained by the requirement that all “large” regulations be subjected to a benefit-cost analysis. The SAB finds it appropriate that the Agency should be able to demonstrate that its policies and activities produce improvements in net social benefits. However, an increasingly large share of NCEE staff seems to be is devoted to reviewing or assisting with economic analyses for other programs within the Agency (e.g. over 20 economic analyses were dealt with in the last year). These benefit-cost analyses increasingly rely upon

benefits transfer, which typically amounts to the application of existing research, rather than the undertaking of new research. Basic research under the S&T budget amounts solely to the STAR grant program.

**3) Benefits Transfer:** In the past, basic (and very expensive) research concerning society's willingness to pay for improved environmental quality in some contexts was occasionally stimulated by large legal cases. Now, in the face of restricted budgets, the Agency is often forced to rely on benefits transfer, i.e., to assess benefits essentially by using interpolation or extrapolation methods, based on an existing inventory of benefits estimates. This strategy may be viable for some types of human health effects (e.g. sudden mortality from accidents). However, existing research that covers a wide range of risks, with different latencies, that affect a wide range of subpopulations, is still sparse. Even more problematic are the challenges involved in measuring ecosystems benefits. Ecosystems are far more heterogeneous than humans and there is not much depth at all in the inventory of established and robustly measured values for ecosystems endpoints. The Agency will need to continue to fund basic research in both human health and ecosystem benefits.

**4) Data for Research in Economics and Decision Sciences:** The development and maintenance of crucial environmental data sets for cross-sectional and longitudinal analysis is fundamental to research in Economics and Decisions Sciences. At least three data-related issues deserve attention:

a) The **Pollution Abatement and Control Expenditures (PACE)** survey. Several years ago, the Environmental Economics Advisory Committee argued that the EPA should step in to reinstate the PACE survey. (The Bureau of the Census had discontinued the collection of these data.) NCEE's budget for FY06 apparently includes \$650K for the PACE survey, and significant expenditure for this item will continue. The PACE is the main source of data related to the costs of environmental regulation. The SAB notes that other data collection activities are not charged against the "research" budget of the Agency.

The PACE data represents a large share of the budget for the NCEE. It may be necessary to demonstrate that this expenditure is justified by the nature and results from the research that uses it. Should this program be subjected to a PART analysis, it will be useful for the Agency to be queuing up some appropriate "outcome" measures that document the social value of the PACE data.

b) **The Toxics Release Inventory (TRI).** The TRI represents a very important public good, not just to communities under EPCRA, but also to intra- and extramural Economics and Decision Sciences researchers concerned with the causes and consequences of such releases. Recent proposals involve changes in TRI reporting requirements, including changes in which firms will report and what they will report, as well as a plan to cut back from annual to bi-annual reporting. These changes (the proposed "Toxics Release Inventory (TRI) Burden Reduction Proposed Rule") would jeopardize the value of this database for longitudinal research. The SAB shares the concern of its Environmental Economics Advisory Committee (EEAC) that substantive



changes in reporting requirements for the TRI have the potential to seriously compromise its usefulness for longitudinal analyses. Maintenance of databases that support a significant category of research in Economics and Decision Sciences should be a significant concern for the Agency. However, it is not clear that funding to preserve collection of these data should be allocated away from basic research activities.

c.) Preservation and distribution of various unique data sets. EPA-funded research in economics and decision science often creates specialized data unique to each study. Funding should be made available so that it would be possible to further develop these original data sets so that they are widely accessible and useful for replication or for new studies. There is presently no requirement that Agency-funded data collection be made publicly available, and no incentive for individual researchers to do so. The only grant-related requirement is that the Agency be provided with a plan to make the data available.

SAB Economists have argued that it would be appropriate for the Agency to assist in establishing a national clearinghouse for specialized data relevant for environmental economics and decision analysis. The Inter-university Consortium for Political and Social Research (ICPSR) Archive housed at Michigan might perhaps be an appropriate home for these data. EPA-funded data, in particular, represent public goods that could sometimes be exploited much more thoroughly in many cases. Like the major databases that have traditionally been widely used by labor economists—for example, the Panel Study on Income Dynamics (PSID), the National Longitudinal Survey (NLS), and the Health and Retirement Survey (HRS)—the existence of accessible and well-documented environmental databases could do much to foster more environmental economic research without incurring large fixed costs for data every time.

**5) STAR Program RFA's:** The SAB notes that the Agency has lately been forced to skip some of its three regular RFAs in the Economics and Decision Sciences area. In its review of the budget last year, the SAB noted the Agency's interest in reliance upon voluntary programs but emphasized that our understanding of the potential for success of these programs was still limited. The SAB called for more research into incentives and constraints. This year, approximately one-quarter of current STAR funding for Economics could be characterized as research to increasing our understanding of "voluntary programs" (i.e. programs that do not involve Agency enforcement).

In response to the President's FY06 budget, the SAB also called for the Agency to spend more of its own research money to conduct research on market mechanisms and incentives directed at pollution prevention. There has been no RFA for Market Mechanisms and Incentives (MMI) since 2003. For FY 2007, STAR programs appear to devote about \$1 million for research on trading programs and about \$1 million for benefits transfer studies. Additional money to support extramural research could go a long way towards supporting the basic research needs of the Agency.

**6) Risk Assessment versus Benefit-Cost Assessment:** It must be noted that the Agency has traditionally been far more concerned with risk assessment (predicting the sizes of existing risks and the risk reductions to be expected from environmental policies) than with

understanding the social values of risk reductions and thus society's willingness to pay for environmental management. Unfortunately, traditions change only slowly. At present, it seems that these traditions are definitely not changing quickly enough to keep up with the demands for benefit-cost assessments.

**7) Risk Communication and Risk Perceptions:** Social science research and genuinely interdisciplinary efforts that span multiple social sciences and integrate with physical and life sciences continue to be under-funded and under-utilized. Before a society is willing to incur the costs associated with environmental risk reductions, its members must recognize, understand and appreciate the risks in question. Much of the risk perception and risk communication research upon which the Agency currently relies predates the Internet Age. Risk communication has changed dramatically with this new technology. The relevant disciplines include more than just Economics and Decision Sciences. Also relevant are other behavioral and cognitive sciences, including (but not limited to) psychology, sociology, and anthropology. Information—how it is perceived, processed, and utilized—is critical to an understanding of social preferences and choices with respect to environmental policies.

While EPA enjoys reasonable staff expertise in the areas of economics and decision science, it has far less capability in the area of behavioral social science. The SAB has noted this gap on a number of occasions in the past (and in the discussion above of the new programs in Homeland Security). The Agency needs to continue to work to find ways to fill this gap, both with new staff and through external collaborations (such as the now defunct collaborative research program that was conducted with the National Science Foundation (NSF-DRMS)).

## **8.2. Sustainability Research**

EPA has considered sustainable and preventive approaches to health and environmental problems since the Pollution Prevention Act of 1990. Sustainable approaches require innovative design and production techniques that minimize or eliminate environmental liabilities; integrated management of air, water, and land resources; and changes in the traditional methods of creating and distributing goods and services. The defining characteristic of sustainability research is the need to evaluate impacts of the flows of material and energy on future generations, a practice that has not been a common feature of past societal and industrial development. In addition to conducting research related to human health and environmental threats, EPA is committed to promoting sustainability—achieving economic prosperity while protecting natural systems and quality of life. The Sustainability research program is proposed to receive about \$21 million in FY 2007 (a decrease of about \$4 million from 2006 levels).

Specific areas of sustainability research include:

**Pollution Prevention Tools** for improved environmental decision making (e.g., P2 Tools will develop Life Cycle Impact Assessment analytical techniques that are cost effective and take less time and provide high priority life cycle benchmark data).

**Small Business Innovation Research (SBIR) Programs** that develop and commercialize new environmental technologies.

**National Environmental Technology Competition** that funds a student competition to develop solutions to sustainability challenges.

**Sustainable Environmental Systems** research to develop methodologies for understanding and managing large, complex environmental systems such as metropolitan areas and watersheds.

This program emerged from the former “Pollution Prevention and Technology for a Sustainable Future” program. The topic is of great importance, and research on technology for sustainability creates opportunities for reducing pollution, reducing costs, and increasing economic competitiveness. Technological innovation has the potential to provide substantial environmental and economic gains. By working with major industrial partners and by addressing new designs, technologies and processes, we can avoid problems before they start. Sustainability research offers the opportunity to take a strategic approach to environmental protection which should also help to improve the international competitive position of U.S. industry involved in “green” technology. Research in this area needs to become a priority for EPA.

The Board stated in the “Technology” section earlier in this report, that the goals and objectives of the Resource Conservation Challenge are consistent with the EPA’s Sustainability Research Program. The SAB will soon review EPA’s Sustainability Research Strategy and the Board will have more to say on it in the future. However, we believe that among the important topics to include in a sustainability program would be things such as: re-engineering processes, research on the implications of new products for commerce, and the need to provide meaningful incentives for maintaining and improving environmental performance. The SAB believes that it is possible to articulate—RCC and sustainability research budgets, strategies, and plans in a way that shows their relationships, and their individual focus, e.g., the RCC might provide the basis for the kinds of research needed as drawn from connections with EPA’s partners, and Sustainability research might focus on using the best and most appropriate tools. The RCC would then serve the dual purpose of mining information from its partners for relevant research needs, and then to the extent possible transferring the results of Sustainability research efforts to the field.

A small-business focus is appropriate, but EPA should also give major attention to leveraging EPA’s efforts with major industrial partners, and with emerging technology companies. The current emphasis appears to stress recycling at the local level, which is important, but does not appear to address the increasing globalization of economies, industrial design, and the evolution of main-stream industrial processes.

During the discussions with EPA, and in the documents and presentations provided to the SAB, there seemed to be no sense of urgency or high priority associated with this program.

A revised program, once designed and in its initial stages, could be subject to PART review as noted in the “Technology” section of this report; so that it could be used as a tool for program design and documentation, as well as post-hoc evaluation.

## **9. STAR FELLOWSHIPS**

The Agency acknowledges the importance of the “White House Report ‘Science for the 21<sup>st</sup> Century” that articulates the Administration’s top priorities for maintaining and enhancing the scientific enterprise of the nation. The Office of Research and Development has for the majority of the past decade pursued the goals of this report through the Graduate Research Fellowship Program of its Science to Achieve Results (STAR) efforts. This program awards fellowships to leading science graduate students throughout the United States. However, the agency has identified the STAR Graduate Fellowship program as an area for declines in each of the last several years’s budgets. The program has been funded at nearly \$9.5 million from 2004 through 2006, mostly because the Congress has increased the requested levels each year. Again, EPA proposes the lowered level of \$5.9 million for the Fellowships program.

The Agency’s adoption of the White House goals for education and workforce development can not be met with the level of resources requested for this program. Even at a full funding level of \$10 million, the program would not meet the full need. At the requested level this deficiency is even bigger. This is inconsistent with the articulated goals, and nearsighted in view of EPA’s looming loss of an aging population of scientists to retirement. The Board recommends that the STAR Graduate Fellowships program be restored to its full funding level of \$10 million.

**ATTACHMENT A: STATEMENT OF DR. M. GRANGER MORGAN, CHAIR  
U.S. ENVIRONMENTAL PROTECTION AGENCY SCIENCE ADVISORY BOARD  
BEFORE THE SUBCOMMITTEE ON ENVIRONMENT, TECHNOLOGY AND  
STANDARDS COMMITTEE ON SCIENCE, U.S. HOUSE OF REPRESENTATIVES  
MARCH 16, 2006**

Good morning Mr. Chairman and members of the Subcommittee on Environment, Technology and Standards. My name is Granger Morgan. I chair EPA's Science Advisory Board (SAB or Board). I am a faculty member at Carnegie Mellon University where I am a University Professor, hold the Lord Chaired Professorship in Engineering, and am Head of the Department of Engineering and Public Policy, a department in the Engineering College.

Thank you for this opportunity to present the SAB's views about the Agency's 2007 Science and Research Budget Request. The Board is completing approval of its final report, and with the permission of the Chairman, we will submit that report for the record.

Over the past few years, the Board has been working with EPA to review the Agency's science and research programs and budget on a systematic and ongoing basis. The Agency now presents that information to the Board in ways that correlate with EPA's Strategic Plan.

Between 2004 and the proposal for 2007, the inflation adjusted<sup>4</sup> budget for EPA's Office of Research and Development has declined by just over 16%. Yet, the environmental challenges that face the Agency have grown and EPA will face increasingly complex and difficult science challenges over the coming decades. It will also face opportunities to improve our environmental and international competitiveness with new technologies – but, to paraphrase the microbiologist Louis Pasteur, opportunity favors those who are prepared.

We all want environmental decision-making to be based on sound science. However, our nation is not investing adequately in producing that sound science.

I know a number of people who argue that this lack of investment reflects a hope that if the science is not there, somehow additional regulation will not follow. A much more likely outcome is that, if we don't do the needed research we will simply get poorer regulation – which could end up costing the nation a great deal more in the long run.

In my view we all need to work harder on explaining the importance of investing in R&D at EPA if we want to ensure that America will enjoy a clean, safe, healthy and sustainable environment in the years to come.

You have specifically asked if the Agency's overall level of Science and Technology funding is appropriate and whether its research priorities are adequately balanced among core research, mission-driven research, emerging issues, and homeland security. I will elaborate below, but the short answer is no.

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<sup>4</sup> Computed using the NASA Gross Domestic Product Deflator Inflation Calculator, available at <http://cost.jsc.nasa.gov/inflateGDP.html>

You have also asked what impacts the proposed budget reduction may have on the Office of Research and Development's ability to use the latest scientific methods and information in its regulatory decisions, and to build strong ties to the external scientific research community and foster graduate student work in the environmental sciences. Again, while I'll elaborate below, the short answer is these impacts will be serious and negative.

In the discussion below I elaborate on these, and related points, in three contexts:

1. The need for government-wide, systematic tracking of environmental research;
2. Some specific aspects of EPA's proposed 2007 research budget; and
3. The critical problem of continuing reductions in long-term, more fundamental environmental research at EPA.

### **1. Need for a Government-wide View of Environmental Research and Development**

EPA is not the only federal agency that collects environmental data or performs environmental research. The Departments of Agriculture, Energy, Homeland Security, and Interior, as well as the CDC, NASA, NIEHS, NIH, NSF, USGS, and a number of other Federal entities all make significant contributions. Some of these organizations work on topics that may sound similar; in many cases the details turn out to be different in important ways.

In many specific areas of research, there are examples of excellent coordination and cooperation between some of these programs.

But today, across the Federal system as a whole, it is virtually impossible to develop an informed understanding of what research is being done; where it is being done; where there are duplications; and where there are critical gaps. A simple list of topics is not sufficient. Just because the same noun appears in two agency lists of research topics does not mean that they are doing the same thing, or that there is duplication.

Before we on the Science Advisory Board, or you in the Congress, can hope to determine if the U.S. has a balanced and comprehensive national strategy for environmental research, we need a clear picture of what is being done in the form of concise substantive descriptions of all the environmental research programs across the federal system. Conceivably, things could be better than they look from the isolated EPA's budgetary perspective. I suspect that they are worse. However, we need a comprehensive picture.

I urge the Committee to work with the executive and independent agencies to realize the development of such a comprehensive description of all our nation's environmental research. Such a summary would assist everyone involved in ensuring: that needed federal environmental research is being done efficiently; that the different federal agencies involved are sharing information; and that the results are readily accessible to the scientific community, the public, and environmental decision-makers.

## **2. Comments on Several Proposed Changes in Individual EPA Programs**

Now I'd like to offer four examples of how the proposed cuts to the EPA 2007 research budget will adversely impact the Agency's mission to protect human health and the environment as well as offer some brief comments in response to your question about the expansion of the Agency's program related to Homeland Security.

First, I will address mercury research. While some of the mercury in our food and water comes from power plants and other human activities, much comes from natural sources or is carried across the Pacific from natural and anthropogenic sources in Asia. On a global scale, science cannot yet accurately tell us where all the mercury in the U.S. comes from, where it goes, or in what chemical forms it exists. If we are going to be able to assess the adequacy and effectiveness of the costly mercury controls that EPA regulation is imposing on U. S. industry, we need to understand those planetary flows. However, last year's EPA research budget for mercury was reduced approximately 35% to \$3.4 million. This year's budget proposes only a slight increase. Funding at these levels is too small to even adequately address the issues that EPA-ORD has been addressing, let alone to allow any work on the key problem of planetary flows of mercury.

A second important and undervalued area of research, that the Board is especially concerned about is Ecology and Ecosystems Research which has been systematically cut for several years. While we all value and marvel at the beauty and complexity of natural ecosystems, it is easy to forget that every year these systems also provide us with billions of dollars worth of services that are critical to our way of life.

As an example, the salt-water marshes of the Gulf Coast provide more than wildlife habitat. They also provide protection against erosion, and they buffer the effect of storms on coastal lands. How are we to protect such vulnerable natural systems as the salt-water marshes of the Gulf Coast, the Great Lakes, the Chesapeake Bay, the Mississippi River Basin, and countless other smaller natural systems in every state in the country, if we don't adequately invest in understanding them?

The \$79.2 million for ecological research in the proposed 2007 amounts to just 15% of the overall ORD research budget. For well over a decade the Board has called on both the Agency and the Congress to revitalize, raise the profile, and increase the funding of ecological research at EPA. Since 2004, the Board has watched budgetary support for ecological research decline by 26%. This is not the route to a clean and healthy future for either us, or for our air, land and waters.

Third, I will say a word about research in human health. The SAB was delighted to see a proposed increase of just under \$3-million in Computational Toxicology. This work holds great potential to streamline the process of assessing the safety of chemicals, speed approval of new products, and in so doing, enhance the productivity and competitiveness of American industry.

However, to make effective use of these powerful new computational tools, researchers also need data to put in the computer models. The Board is deeply troubled by proposed cuts in human health research areas that are needed to provide the data necessary for computational toxicology to be effective. These cuts include a proposed 13% reduction for work on endocrine disruptors, a proposed 14% reduction for pesticides, and an increase of only 3% for other core programs in human health research.

Finally, the Board is concerned about research in Global Change and Sustainability. For each of the past two years, research support for global change has declined by roughly one million dollars. The current budget proposal of \$17.5 million will only allow the agency to meet its impact assessment obligations under the government-wide Climate Change Science Program. The Agency will be forced to terminate, in midstream, research vital to understanding ongoing changes in temperature, precipitation, flooding, snow pack, and other factors will affect water quality across the U.S. To our knowledge, no other federal agency is supporting such work on a national scale.

Following \$9.6 million dollar reduction in 2006, sustainability research is slated for further reduction of \$4.4 million in 2007. These reductions are coupled with the termination of the Superfund Innovative Technology Evaluation Program and Environmental Technology Validation Program. This means that the Agency will lose much of its ability to test and verify new environmental technologies. This loss harms American industry's competitive position for environmental technology in world markets, at a time when other nations treat these technologies as opportunities.

I turn now to your questions about appropriate science priorities and needs for Homeland Security. The proposed 2007 budget calls for an increase of almost 25% to \$39.5-million for Homeland Security research in ORD, and an increase of just under 30% to \$58.1 million for work in other parts of the Agency. These increases will support research and other activities related to increased preparedness and better response for water security, analytical methods, decontamination, clean-up goals, radiation monitoring and biodefense. Clearly improving our ability to deal with terrorist and other threats is a critical national need and the SAB has been most favorably impressed by the dedication and hard work of the staff addressing these important national priorities. However, while all of us on the SAB agree that this is an important area of national need, we are concerned that it not be met through serious erosion of support for the Agency's core research needs in health and environmental research.

I would like to offer two other cautions regarding the Agency's current research program in homeland security research. First, there is some risk of focusing too much at the level of individual devices and sub-systems, without first understanding at a broad level such key issues as how effective alternative approaches can hope to be in providing needed protection, and whether the nation can afford them. Second, we are concerned that current programs are not sufficiently informed by the behavioral and social sciences, which are crucial to effectively organizing the complex systems needed to manage these technologies and communicating research results and risk to the general public.



You also asked about sole reliance on Science and Technology funding for the WaterSentinel pilot program expansion, and if EPA has adequate plans for transitioning WaterSentinel to an operational program. The SAB understands the need for WaterSentinel, but EPA's strategy for allocating resources to this program is unclear. Science and Technology funding is probably appropriate for developing the scientific aspects of WaterSentinel, but other aspects of the program appear to be operational. Accordingly, the SAB believes that operational aspects of WaterSentinel should be funded by appropriate operational funds. The SAB Panel that reviewed WaterSentinel recommended development of a plan to transition WaterSentinel from research and development to an operational program. The SAB is concerned that WaterSentinel funding comes at the expense of the Agency's other responsibilities.

### 3. Longer-term More Fundamental Research

EPA is a mission-oriented agency, charged with assuring that America enjoys, and will continue to enjoy, a clean and healthy environment. Earlier I paraphrased Louis Pasteur. Don Stokes, the former dean at Princeton's Woodrow Wilson School wrote a wonderful little book<sup>5</sup> that argues that research cannot simply be sorted out along a line between basic and applied. Some important real world problems, such as those that lead Pasteur to understand how to preserve milk, can only be addressed by doing fundamental research that is *motivated* by real-world needs. Many environmental problems fall into this category – what Stokes termed "Pasteur's quadrant." Much of the knowledge that is needed to assure continued success in EPA's mission requires research of this kind – research which is not being done anywhere else across the Federal system.

In our meetings with agency research managers, we were deeply troubled when we were told that the basic or "core" portions of ORD's research budget have shrunk from roughly 40% to 25% of current research investments. Environmental issues are complex, and often subtle. If EPA does not continue to invest in a significant amount of basic environmental science, we will likely find ourselves making costly regulatory mistakes in the future. We also run the risk of paralyzing innovative industries, like nanotechnology, uncertain about the regulatory rules that they will face.

The SAB is especially troubled by the ongoing difficulty that EPA has had with the application of the OMB Performance Assessment Review Tool or "PART" process. My own view is that both the agency and the OMB need to work harder to resolve this issue, especially in the context of ecosystem research. On the one hand, OMB needs to recognize the need for a portion of EPA's research to be fairly fundamental in nature. As I have argued above, not all EPA research has immediate short-term applications – nor should it have. Long-term investments in developing basic understanding of environmental and ecological science are very important if we are to achieve sensible and efficient environmental protection. At the same time, EPA needs to do a better job of refining and communicating several of its research programs, especially those in ecosystem research, a topic whose importance has been stressed by both the SAB and National Academy of Sciences. Simply continuing to cut the budget is not a viable strategy for achieving future improvement.

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<sup>5</sup> Donald E. Stokes, *Pasteur's Quadrant: Basic science and technological innovation*, Brookings Institution Press, 180pp, 1997

Looking back at the analyses that the SAB has done of EPA's science and research budgets over the past several years, the SAB has become convinced that the Agency is in danger of losing core scientific expertise in both conventional and emerging environmental issues. A number of the agency's research programs are in need of major rejuvenation and modernization, but this is almost impossible in the face of ever shrinking resources. On top of this, a significant number of retirements is anticipated over the coming decade. If proposed cuts in the STAR Doctoral Fellowship program are not restored, where will the next generation of U.S. environmental scientists come from?

Thank you again for the opportunity to testify about EPA's science and research budget request. My colleagues and I would be pleased to answer your questions.