National Institute of Environmental Health Sciences | **Superfund Basic Research Program**

A LEGACY IN MULTIDISCIPLINARY RESEARCH

Charting a Course for Advancing Basic Research to Practice

VOLUME 1

Introduction to the SBRP

SBRP Technology Transfer and Information Transfer Tools

U.S. Department of Health and Human Services | National Institutes of Health | National Institute of Environmental Health Sciences

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Introduction to the SBRP
SBRP Technology Transfer and Information Transfer Tools

2003 SBRP External Advisory Group

A Working Group of the National Environmental Health Sciences Council

Research Triangle Park, N.C.

A PDF of Volume 1 can be accessed at the following link:

http://www-apps.niehs.nih.gov/sbrp/eag/eagvol1.pdf
Password: eag!2003

U.S. Department of Health and Human Services | National Institutes of Health | National Institute of Environmental Health Sciences

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A LEGACY IN MULTIDISCIPLINARY RESEARCH

VOLUME I

in VOLUME II:

3. **OVERVIEW OF SBRP-FUNDED SCIENCE AND OUTREACH**

in VOLUME III:

4. **SBRP CONTRIBUTIONS**

SECTION 1

INTRODUCTION TO THE SBRP

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1a. Introduction

The National Institute of Environmental Health Sciences' (NIEHS) Superfund Basic Research Program (SBRP) was created under the Superfund Amendments and Reauthorization Act (SARA) of 1986. It was established to provide a very broad university-based research program to address the wide array of scientific uncertainties facing the national Superfund program. The intent was that the research conducted by the SBRP would assist in the identification, characterization and clean up of the unknown number of abandoned or uncontrolled hazardous waste sites around the country. The Program has witnessed significant growth in its first 16 years. In 1987, the newly created Program was a $3 million program with four participating universities. Today, the SBRP is over $45 million a year with 19 grant programs that include 70 participating universities and institutions.

The SBRP was created as a multidisciplinary research program to address the broad, complex health and environmental issues that arise from the multimedia nature of hazardous waste sites. Historically, we have considered appropriate areas of study to include ecology, epidemiology, toxicology, molecular biology, hydrogeology, engineering and soil science, and we have required our grantees to include both biomedical and non-biomedical studies in their programs. Developing a multidisciplinary program often has been challenging to the participating universities, but in the long run it has proven to be a significant benefit to the universities and other program stakeholders.

In addition to supporting an innovative research program, the SBRP has also been proactive in developing outreach and technology transfer initiatives. To this end, the SBRP has taken advantage of a full variety of communication tools, which have resulted in the dissemination of the research results to a broad spectrum of academic and field practitioners. The SBRP has worked to promote the use of its research results within academia, the United States Environmental Protection Agency (USEPA), the Agency for Toxic Substances and Disease Registry (ATSDR), state health and environmental departments, as well as by industry and community groups.

Another important component of the SBRP is the ongoing internal review of science direction and accomplishments of each of the funded programs, and of the Program as a whole. Review is conducted at multiple levels. Each grantee has constituted its own external advisory board that convenes at least annually. On another level, the National Advisory Environmental Health Sciences (NAEHS) Council provides oversight to the NIEHS managers of the SBRP. In addition, the SBRP considers it a sound policy to periodically request an external group to review the program with a fresh perspective. The External Advisory Group (EAG) that you are currently participating in falls into this category.

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1b. Charge to the External Advisory Group

1b.i Objective of the External Advisory Group Process

The purpose of the EAG is to provide the SBRP with an independent and constructive assessment of the Program. Our expectation is that you, as members of the EAG, will identify how the Program has contributed to the nation's public health and advanced science to society's benefit. We also request that you identify opportunities for the future direction of the Program.

We have compiled a list of general questions (attached) that you may choose to incorporate into your assessment. It is hoped that these may serve as a starting point; however, you are not required to address these issues – they are only suggestions. However, we do request that you address two major aspects of the Program:

1. The areas where the Program has demonstrated strengths and greatest productivity
2. The efforts the Program has undertaken to communicate the science to the variety of academic, government and other stakeholder communities

We recognize that the assessment we are asking you to conduct could be an arduous task because the SBRP is a large, complex program. Furthermore, we realize that to achieve an in-depth review requires the assembly of professionals with diverse backgrounds. We believe that we have assembled such a team. You and your colleagues come from academia, industry, federal and state agencies or the community. In addition, the Group represents a cross-section of professional disciplines that encompass the full spectrum of the SBRP. Accordingly, as a group, you will be able to provide a strong assessment of the contributions made by this multidisciplinary program. We envision this to be a dynamic and creative process and look forward to your deliberations.

We are also pleased that Dr. Dan Baden from the University of North Carolina – Wilmington (UNCW) has agreed to chair this Group. Dan is the director of the UNCW Center for Marine Science Research. Previously, he served as the Center Director for Marine and Freshwater Biomedical Sciences Centers at the University of Miami. Specific to this advisory group, he has experience leading work groups and is a member of the NAEHS Council. He brings to the Group not only a strong background in the environmental health sciences, but knowledge and familiarity of NIEHS and its programs.

It is important to note that the EAG will function as a working group of the NAEHS Council and that the findings of the Group will be reported to Council in September 2003.

1b.ii Description of the External Advisory Group Product

The product requested of the EAG is the compilation of a summary report by June 2003. The EAG Report should document the major observations from your assessment of the Program's contributions and include any suggestions regarding potential future directions for the SBRP to consider. It is expected that in the Report you would highlight strengths, areas of improvement, and potential priority areas to be pursued in the future.

The Report should be a summary and geared towards use by a broad array of audiences. A listing of major observations and recommendations would be an appropriate format for this report.

As you develop the Report, you should include both general and specific observations that you have made regarding the products and impacts of the Program. To assist you with your assignment, we are providing you with materials that serve as a comprehensive introduction to the SBRP. Of course, it is not possible for us to demonstrate all the impacts of the Program due to lag times in being able to assess new science; the inability to track all research impacts in society; and the difficulty of quantifying the benefits of unexpected results. However, we encourage you to request any additional information that you require to conduct your assessment and prepare the Report.

1b.iii Uses of the External Advisory Group Assessment

The assessment being conducted by the EAG will be of great benefit and utility to the SBRP. We have already identified several uses. For example, first and foremost, the Report will be used internally, providing us with direct insight and guidance from a fresh perspective. As you will read in the following materials, we are currently in the process of revising the competitive cycle of the Program. This will allow our Program to be much more flexible and responsive to emerging areas of science. Your identification of emerging areas will assist us now and in the future, as we continually refine the Program's direction. More immediately, this summer we will be preparing our next Request for Applications (RFA), and areas that you identify as opportunities for growth will be considered for inclusion in the RFA. We continually strive to incorporate effective tools for information transfer. Your comments on our communication efforts will help us enhance our communication strategies. Each of you brings a special and unique background and expertise to the Group. As such, we hope that you will expand our understanding of who our clients are and how we should best access them.

We also intend to distribute information from the Report to a wide audience. We envision that this will serve to strengthen the Program as we work with our grantees and stakeholders. Accordingly, this Report will:

- Be made available to the Program Directors of the individual SBRPs – this will be a tool that they can use to shape their research to successfully accomplish our science and public health goals
- Be placed on the NIEHS SBRP web page so that the broader community of future potential Program applicants will be able to gain from your insights
- Be incorporated into communications that the NIEHS SBRP has with various stakeholder groups, including any potentially relevant future symposium or conferences, Congressional briefing materials, etc.
- Potentially be the basis for a future publication regarding the assessment of a multidisciplinary program

Of course, as mentioned above, the Report will be presented to the NAEHS Council. We hope that this presentation will engender thoughtful discussion about the progress and future of the Program.

In all these forums, SBRP would plan to use the Report to:

- Gain a better understanding of the Program's contributions to date
- Trigger a creative, constructive debate on how the Program can maximize its research findings to advance public health goals with regard to hazardous waste site characterization and clean up
- Gain insights on how the Program can further improve its outreach and knowledge transfer processes
- Stimulate the development of an innovative agenda for future research efforts

1b. Attachment A Potential Discussion Questions

The questions below are provided to stimulate thoughtful discussion of the Program. We are not requesting that you address each question; however, we believe that these questions may be a useful framework for developing productive discourse.

As you engage in your assessment and as you develop the EAG Report, we do request that you specifically address two major aspects of the Program:

1. The areas where the Program has demonstrated strengths and greatest productivity
2. The efforts the Program has undertaken to communicate the science to the variety of academic, government and other stakeholder communities

Our suggested questions are:

1. What are the major contributions of the SBRP with respect to the following key program features?
    - The scientific and technical advances of the Program
    - The efforts to transfer the scientific advances of the Program from basic research to:
        - the scientific community
        - site managers (e.g. USEPA, states, other federal agencies, industry)
        - the broader community of stakeholders
2. Is the multidisciplinary approach of the SBRP contributing to the Program?
    - Is the multidisciplinary approach still valid for SBRP?
    - Is the concept of multidisciplinary research evolving? For example, are there more scientific disciplines that should be included in the Program?
    - Is there more that SBRP, or the broader scientific community, can do to foster multidisciplinary collaboration and publication?
    - Are there other approaches that the SBRP can use to enhance our goal of prevention of adverse health effects through the multidisciplinary approach?
3. Is the SBRP using the right tools to achieve effective knowledge transfer? Are there additional tools that we should pilot, evaluate, or adopt? If so, are there successful examples of these innovative tools or processes that we can benchmark? Especially with regard to community involvement, is there more that the SBRP can do, within present resources or with more resources, to accommodate community scientific interests?
4. What insights would you offer as far as potential future directions for the SBRP?
    - Are there critical research needs or data gaps that we should factor into the future of our Program?
    - Are there research areas that the SBRP is presently supporting that appear to have the greatest scientific and public health merit and that we should, therefore, emphasize now and in the future? Conversely, are there areas that we should de-emphasize?
    - Are there emerging trends that we should evaluate for potentially significant impacts on the future direction of the SBRP's mission of advancing the science and improving the public health associated with hazardous waste?

1c. SBRP Descriptive Materials

1c.i Statutory Provisions

The statutory provisions establishing the SBRP are contained in Sections 311 (a)(1) through 311 (a)(6) of the Superfund Amendments and Reauthorization Act of 1986 (SARA). SARA charged the NIEHS within the Department of Health and Human Services with the responsibility of establishing and maintaining this research program to support the assessment and remediation goals of the statute.

The basic provisions call for "… basic research (including epidemiological and ecological studies) which may include …

- advanced techniques for detection, assessment, and evaluation of the effects on human health of hazardous substances;
- methods to assess the risks to human health … by hazardous substances;
- methods and technologies to detect hazardous substances in the environment and basic biological, chemical and physical methods to reduce the amount and toxicity of hazardous substances…"

This statutory language creates a broad mandate and set of goals for the NIEHS to pursue within the Superfund Basic Research Program. It is important that NIEHS maintain constant communication with its stakeholder communities to ensure that it is fulfilling these goals.

1c.ii SBRP Program at-a-Glance

NIEHS/EPA Superfund Basic Research Program

The Superfund Basic Research Program (SBRP) is a multidisciplinary program focused on acquiring new scientific and engineering knowledge that advances both society's understanding of the human and ecological risks from hazardous substances and the development of new environmental technologies for the cleanup of Superfund sites. The SBRP is a prevention program. The knowledge acquired in this Program not only serves as the basis for subsequent basic or applied research in these areas, but also provides a foundation for practical benefits such as lower cleanup costs on hazardous waste sites and improvements in human and ecological health risk assessment.

Brief Overview

- Authorized under the Superfund Amendment and Reauthorization Act of 1986
- Comprised of a university-based grants program that includes basic research, training of post docs and graduate students, and community outreach and K-12 education
- Focuses on integrating basic research in:
  - -biology
  - -chemistry
  - -engineering
  - -ecology

Mandates

To develop:

- Methods and technologies to detect hazardous substances in the environment
- Advanced techniques for the detection, assessment, and evaluation of the effects on human health of hazardous substances
- Methods to assess the risks to human health presented by hazardous substances
- Basic biological, chemical, and physical methods to reduce the amount and toxicity of hazardous substances in the environment

Outreach

The Superfund Basic Research Program encourages and supports outreach activities which are designed to communicate the Program's results to the communities and organizations most concerned with exposure to hazardous substances. The Program's outreach projects include collaborative partnerships between environmental researchers and a number of other parties actively involved with hazardous waste issues including government agencies, community groups, journalists, and industry.

Community Organizations, Teachers, Students, Public, Children, Professionals, Industry

Current Research Program

Boston University	New York University School of Medicine	University of California – San Diego
Columbia University	Oregon Health Sciences University	University of Cincinnati
Dartmouth Medical School	Texas A&M University	University of Florida
Duke University	University of Arizona	University of Kentucky
Harvard School of Public Health	University of California – Berkeley	University of North Carolina – Chapel Hill
Michigan State University	University of California – Davis	University of Washington
Mount Sinai School of Medicine		

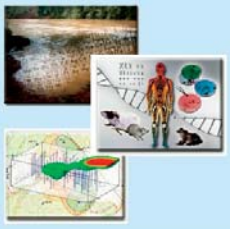
State-Based SBRP Activities

(Programs, Collaborating Institutions, and Research at Superfund Sites)

Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) Initiative

The Superfund Basic Research Program has been very successful in developing innovative technologies through the support of basic science. Innovative approaches being developed in biotechnology and bioengineering provide exciting opportunities for the development of novel remediation and monitoring strategies. However, there is a need to ensure that these processes and others are further developed, field tested and applied to real world situations. The SBIR/STTR initiative was designed to foster the commercialization of technologies, products, and devices developed by the SBRP and others that are relevant to the clean up and monitoring of hazardous waste. Recently 12 small businesses were awarded grants to conduct Phase I research in the areas of remediation and monitoring.

Research Briefs



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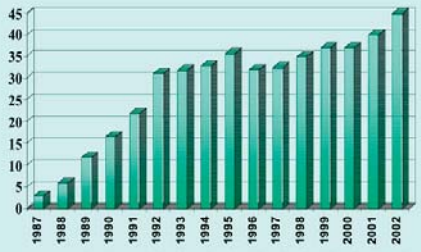
Training

The Superfund Basic Research Program supports the multidisciplinary training of graduate students and post-doctoral fellows in the setting of the research program. This results in well-trained scientists who are not bound by traditional disciplinary lines, but who understand that only with close collaborations can progress be made in the practical application of new scientific advances to the improvement of our environment, and ultimately, human health.

http://www-apps.niehs.nih.gov/sbrp/

Funding History of the Superfund Basic Research Program



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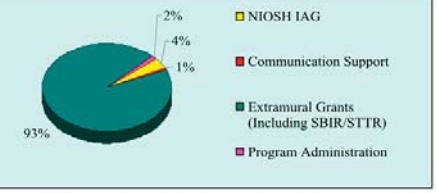
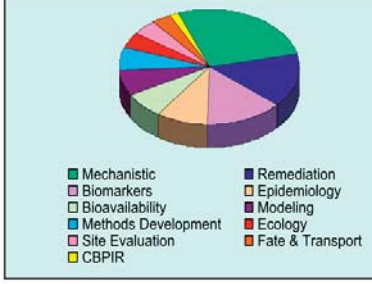
No. of Projects	27	44	72	110	142	142	142	142	134	134	138	138	138	127	137	137

Basic Elements of the Program

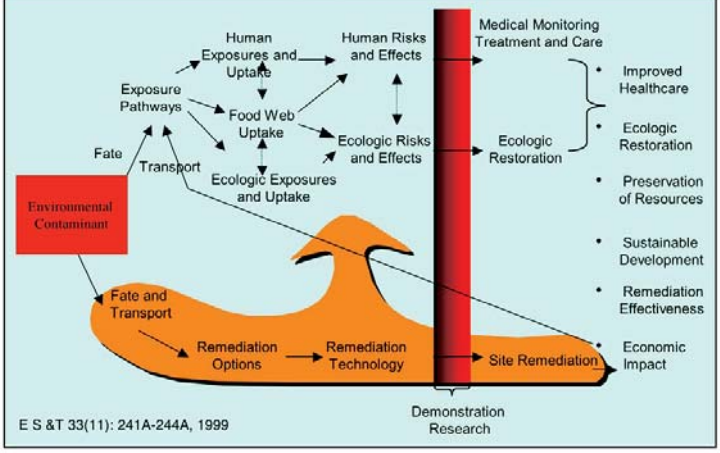


Research Categories 2000-2005

(By Number of Projects)



A Unifying Scientific Framework



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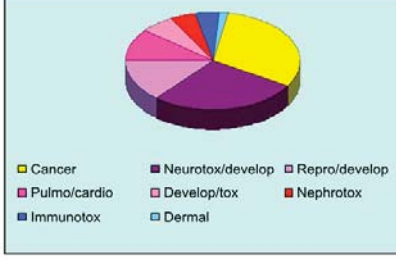
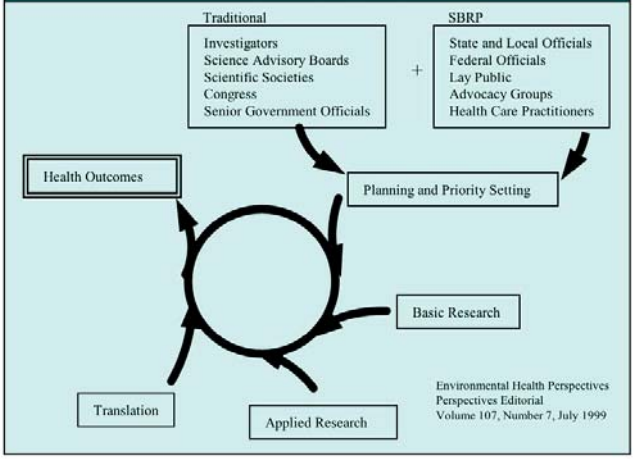
Research by Disease/Dysfunction

(By Number of Projects)



Research Process



Environmental Health Perspectives
Perspectives Editorial
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Research by Chemical Class

(By Number of Projects)

Program Director

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1c.iii SBIR and STTR Programs at-a-Glance

NIEHS/EPA Superfund Basic Research Program

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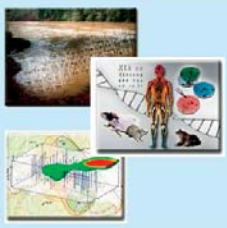

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http://www-apps.niehs.nih.gov/sbrp/

1c.iv Chronology of Program Growth

In response to the SARA legislation of 1986, the NIEHS undertook the development of a research program that would encompass the broad mandates outlined in SARA. To meet legislative requirements, a multidisciplinary program was envisioned that would include both traditional NIH biomedical research projects but would also require the inclusion of non-biomedical projects. And thus the SBRP was born. In the first year, 1987, we awarded four university based research programs with funds of $3 million. In the intervening four years, additional competitions were held and the SBRP added five new programs in 1989 and two programs in 1990. In 1992, we had a full and open competition, which further expanded the Program. All previously funded grantees submitted renewal applications and were successful in their recompetition. Moreover, research groups who had not previously been part of the SBRP were encouraged to submit grant applications. Seven of the new applicants were successful and were added to the SBRP. Accordingly, the SBRP experienced significant growth between 1987 and 1992, growing from 4 grants and $3 million to 18 grants and over $30 million. Not only did the size of the program grow, but the sophistication of the science being conducted within the program also became more advanced. During this timeframe, the SBRP did not experience turnover in grantees.

By 1995 the size and the funding of the SBRP had stabilized. Because the funding had stabilized, when we recompeted the Program in 1995, we were not able to increase the number of grants; however, as this was a full and open competition, new applicants were encouraged to apply. As a result of this competition, the Program experienced a 1/3 turnover of its grantees. Similar circumstances prevailed when the Program was recompeted in 2000. Although the funding for the Program had increased over the previous five years, this increase only allowed the Program to keep pace with the cost of science increases. Again in 2002, we were not able to increase the number of grants, and the recompetition resulted in an approximate 1/3 turnover of grantees. Currently, the Program is comprised of a mix of original and new grants.

As a result of the regular recompetitions, we feel that the SBRP is a healthy, vibrant program that has been successful in supporting highly meritorious science. It is a very competitive program as demonstrated by the scientific turnover.

Attachment A presents a timeline that chronicles the growth of the SBRP, and depicts the SBRP universities that have been part of the program during its history.

1c.v SBRP Grant Process

Introduction

In establishing the SBRP, NIEHS chose to create a network of multidisciplinary, interdisciplinary teams of researchers to provide a broad perspective on environmental health research. The goal of establishing multidisciplinary programs is to provide a more comprehensive understanding of the complex environmental issues in order to support state, local, and federal agencies, private organizations, and industry in making decisions related to the management of hazardous substances. Assembling researchers from diverse disciplines to focus on a unifying theme provides the opportunity to advance the science in a more effective manner than could be accomplished by single unrelated projects.

Presently, this Program supports peer-reviewed research in 19 university programs encompassing 70 collaborating institutions composed of 137 individual research projects and 94 support cores (support cores provide centralized facilities and expertise, thereby building the infrastructure of the individual grants).

This document presents an overview of the SBRP competition process and a brief discussion of the Program's plans to change its award cycle.

Mechanisms of Support

Until 2000, the SBRP received its funds as pass through dollars from USEPA. Because we did not receive the funds directly, in accord with National Institutes of Health (NIH) guidance, we considered it fiscally sound to limit the Program to a multiproject grant-in-aid (P42) award mechanism that was recompeted every five years. Accordingly, all applicants competed at one time. In 2000, Congress chose to provide the Program funds directly to NIEHS. Now funding for the SBRP comes from the VA/HUD/Other Independent Agencies Appropriation Subcomittee to NIEHS. This change is allowing the Program to be more flexible, both in use of funding mechanisms and in implementing changes to the award cycle.

Competitive Award Process

The SBRP competition cycle is a multi-step process that includes:

- the development of the Request for Application (RFA) by NIEHS staff
- the submission of grant applications
- the scientific peer-review of submitted grant applications

- the second level review by the NAEHS Council
- the grant award

RFA Development

In the development of the RFA for the Program, the NIEHS wants to be certain that the applicants have access to, are aware of, and consider the most relevant basic research needs. The NIEHS over the years has established a mechanism of surveying the scientific community for identifying cutting edge science and critical gaps in the various disciplines through its sponsorship of workshops and conferences. In addition to this, NIEHS seeks to solicit advice and recommendations from environmental and public health protection officials - including those from the USEPA and the ATSDR; scientists; engineers and technicians; health care providers; community representatives; and public policy experts. The intent of our outreach efforts in developing an RFA is to be able to provide prospective grant applicants with examples of the kinds of research needed for the effective and efficient remediation of hazardous waste sites, and to develop a heightened level of partnership between NIEHS and its Superfund research clientele.

The RFA is a document that provides information to prospective applicants as to:

- eligibility requirements,
- programmatic requirements,
- examples of research topics that are responsive to the Program's needs.

Eligibility Requirements

Section 311(a)(3) of SARA limits recipients of awards to "**accredited institutions of higher education**," which are defined in the Higher Education Act, 20 USC (annotated) 3381. However, grantees are permitted under the law, and encouraged by NIEHS, to subcontract as appropriate with organizations, domestic or foreign, public or private (such as universities, colleges, hospitals, laboratories, units of state and local governments, and eligible agencies of the federal government) as necessary to conduct portions of the research.

Programmatic Requirements

In order to be funded each applicant must successfully meet the following minimum requirements for a multi-project program:

- Three approved biomedical Research Projects (e.g., mechanistic based studies, epidemiology, human risk assessment, exposure assessment, genetic susceptibility, etc.)
- One approved non-biomedical Research Project (e.g., ecology, ecological risk assessment, fate and transport, hydrogeology, engineering, remediation, phytoremediation, etc.)
- An approved Administrative Core
- A minimum of one approved Research Support Core

Research Topics

The RFA provides potential applicants with an extensive list of suggested areas of research. Because the SBRP is a basic research program it places emphasis on hypothesis-driven research. However, the scientific needs of our "end users" frequently require more practical outcomes; Therefore, we encourage applicants to include research approaches that are more product or "use-oriented." By promoting a broad range of topics and research approaches and encouraging the application of state-of-the-art, cutting edge research tools, the science being conducted in response to the RFA is able to meet the needs of our "clients" at many different levels.

Scientific Peer-Review

Applications that are complete and responsive to the RFA are evaluated for scientific and technical merit by scientific and technical experts who have the necessary proficiency to adequately review the biomedical and non-biomedical science, as well as the essential characteristics of a SBRP.

NAEHS Council Review

The final review and recommendation on all scored applications is made by the NAEHS Council. The Council evaluates the adequacy and appropriateness of the initial review process and considers the significance of the application to the overall program goals of the NIEHS.

Upon consideration of these issues, the Council makes appropriate recommendations to the Director of the NIEHS. The Council does not function as a second scientific review body.

Award Criteria

Award criteria used to make award decisions include:

- Scientific merit
- Availability of funds
- Programmatic priorities

Anticipated Changes to the Competition of the SBRP

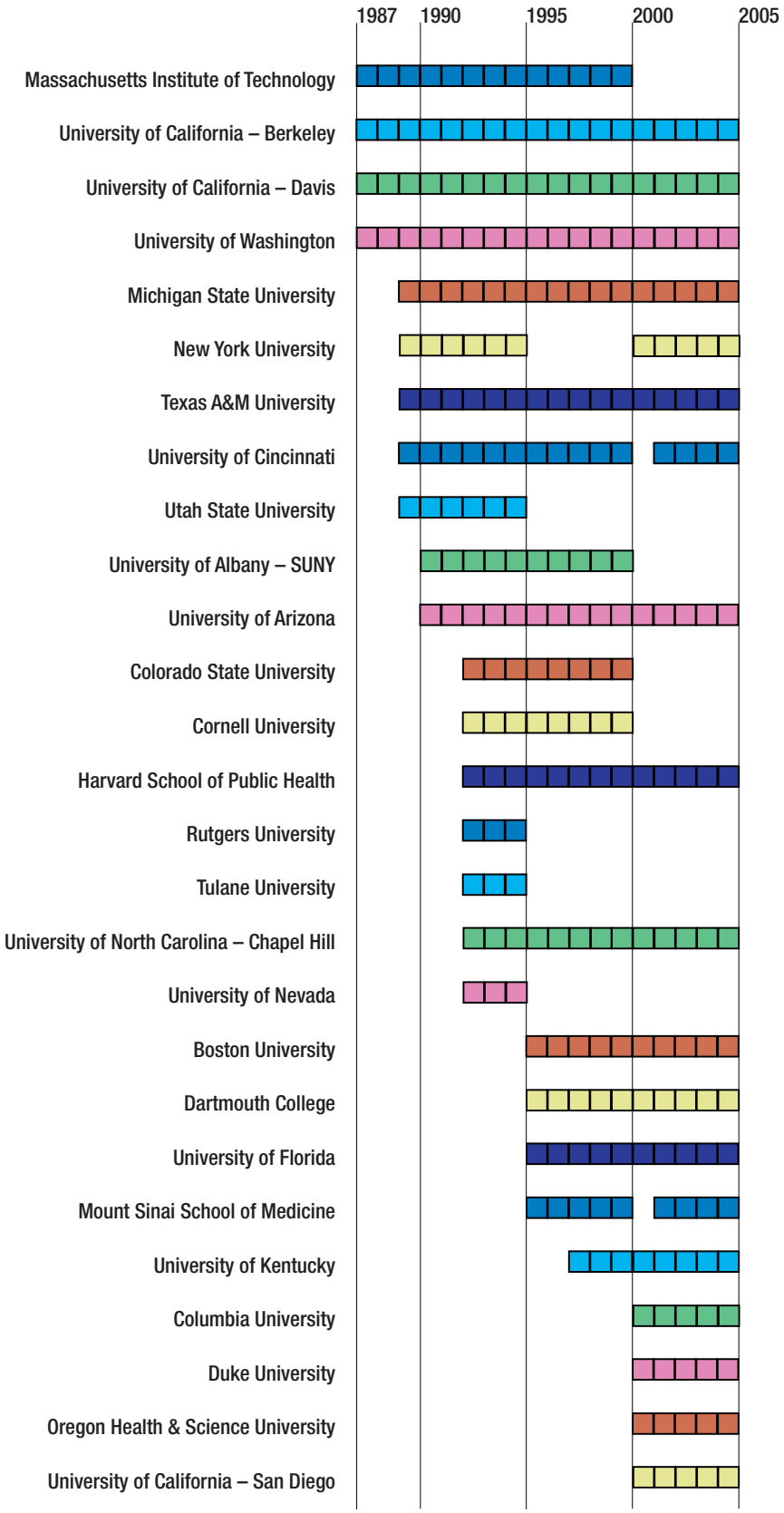
The competition of this program in past years has been a herculean task. Because the competition only occurred every five years, it was not uncommon to receive over 40 applications each time the Program was competed. Clearly this provided us with logistical challenges, as well as severely limiting the pool of available reviewers. Moreover, applicants that were unsuccessful in their bid to obtain grant funding had to wait five years before they could put in another application. Finally, we were limited to using the P42 grant mechanism. As a result of the SBRP receiving its funds directly, we now have the flexibility to make changes that will allow us to address these issues.

Plans are currently underway to compete the program annually. Furthermore, we have expanded our use of other NIH grant award mechanisms to advance the goals of the SBRP. Overall, we consider the advantages of implementing these changes to include:

- Strengthening the program scientifically
- Increasing the potential pool of applicants
- Increasing opportunities to compete for SBRP funding
- Increasing our flexibility to respond to emerging issues

In planning for the of the future program, the SBRP must continue to evolve and support programs that take full advantage of emerging technologies and scientific developments that are responsive to society's need. We must address these issues in an aggressive manner and utilize all available and appropriate award mechanisms. We believe we have developed such a plan.

1c. **Attachment A** SBRP Grantee Funding History 1987 – 2005



1d. Bibliometrics and Other Productivity Measures

1d.i Introduction

Although measuring the impact of a program can be a complex task, we feel that an analysis of the productivity of the SBRP can demonstrate how the efforts of the Program and its researchers have positively influenced and added to the scientific community's pool of knowledge. In addition, an analysis can be a useful vehicle to illustrate the quality of the researchers and even demonstrate that their efforts do assist risk assessors, policymakers, environmental managers, and other stakeholders by providing sound science to be used in the decision making process.

Since the inception of the program, SBRP staff has worked closely with its grantees to document and highlight the successes of the grantees' efforts. On the following pages, you will find several illustrations of the program's overall impact, including publication data, SBRP scientists' rankings in various scientific disciplines, and the highlights of SBRP technology transfer successes. Ideally we would provide you with like information from other programs for comparison; however, to our knowledge there are no other large research programs that cover such diverse disciplines as the SBRP. Nor have we identified appropriate models that evaluate the impact of multidisciplinary research in the context of its application to real-world issues. Another approach would be to analyze our Program's efforts in specific areas of science. This would be a large effort which is outside the scope of the EAG; however, the Program is considering how best to conduct such an analysis. Regardless of the limitations of tools and models available to do an in-depth analysis, we believe that the materials that follow provide meaningful data on the Program's productivity.

1d.ii Publications

Publication analysis is often used to measure the impact of a research program or the value of a scientist's work. One way in which to do this is by examining the total number of publications coming out of a particular research project, as well as assessing the influence of those journals in which investigators are publishing.

A review of the research publications emanating from the SBRP demonstrates that typically the Program generates over 500 peer-reviewed publications per year. This includes publications in a number of "high-impact journals" such as *Science*, *PNAS*, *FASEB Journal*, and *Cancer Research*.

Average Number of SBRP Publications per Year (1992-2001) = 534

YEAR	TOTAL SBRP PUBLICATIONS
1992	**443**
1993	**515**
1994	**596**
1995	**540**
1996	**549**
1997	**537**
1998	**597**
1999	**566**
2000	**553**
2001	**449**
2002	**269***

*2002 publication numbers not complete – Data available through May 2002.

Note: The "dip" observed in 2001 most likely reflects the fact that this was the first reporting year for the current funding cycle. Several factors probably contributed to this reduction in productivity: new grantees are not as productive in their first year; existing grantees often shift research direction for a recompetition – which also results in a lag period; and there were only 17 grantees submitting data in 2001.

Given the multidisciplinary nature of the program, SBRP scientists have published in a variety of journals targeting a range of scientific disciplines. These include journals on environmental health and science, toxicology, biomedical research, microbiology, chemistry, ecology, and engineering. Below is a table featuring those journals in which SBRP scientists have published articles most frequently since 1995.

Journals Most Frequently Published in by SBRP Scientists (1995-2002*)

TOTAL SBRP PUBLICATIONS by JOURNAL

- Environmental Health Perspectives – **156**
- Environmental Science & Technology – **136**
- The Toxicologist – **101**
- Toxicological Sciences – **93**
- Toxicology and Applied Pharmacology – **85**
- Environmental Toxicology and Chemistry – **79**
- Applied and Environmental Microbiology – **58**
- Carcinogenesis – **52**

* 2002 publication data not complete – data available through May 2002

In addition, a number of SBRP scientists have published their findings in "high-impact" journals – those considered to be highly influential in their fields. A journal's "impact factor" is a measure of the frequency with which an average article in a journal has been cited in a particular year. Attachment A is a featured list of publications since 1995 that have appeared in a few of these select high impact journals.

1d.iii Scientists' Rankings

Another significant measure of a program's impact is the rank of its investigators within given fields of science. The Institute for Scientific Information (ISI) has developed the Essential Science Indicator (ESI) database to do this. In this database, scientists are categorized into one of 22 fields of science. Their publication histories are also tracked. Based on this information, an indexing system calculates, on a per author basis, the quality of a journal and the number of citations each scientist's publications receive. Data are tabulated over the previous ten years. From this, the investigators in the top 1% of each field of science are determined.

The SBRP is pleased that it is well represented in the index of the Top 1%:

- Sixteen of the 19 currently funded SBRP university programs have scientists who rank in the "Top 1%" in at least one research field.
- SBRP-funded scientists rank in the "Top 1%" in 13 of the 22 research fields categorized in ESI. These fields are:
    - Agricultural Sciences
    - Biology & Biochemistry
    - Chemistry
    - Clinical Medicine
    - Environment/Ecology
    - Engineering
    - Immunology
    - Materials Science
    - Microbiology
    - Molecular Biology & Genetics
    - Multidisciplinary
    - Plant & Animal Science
    - Pharmacology & Toxicology
- 37 SBRP-funded scientists rank in the "Top 1%" in at least one research field.
- 12 SBRP-funded scientists rank in the "Top 1%" in at least two research fields.

One shortcoming to this analytical approach is that investigators who publish in multiple fields are not as well represented as those who specialize in one particular field of science. Considering that the SBRP strongly advocates cross-discipline research, it is possible that major contributors to the Program's goals are not well represented in this ranking system. Even considering that this type of analysis is not designed to recognize scientists conducting multidisciplinary research, these data demonstrate that SBRP investigators show leadership in fields that are important to the goals of the Program, and that the SBRP attracts top ranked investigators.

A detailed data summary of SBRP-funded scientists and their ISI Essential Science Indicator-ranked fields for the period 1992-2002 is located in Appendix B.

1d.iv Technology Transfer

The SBRP is focused on acquiring new scientific and engineering knowledge through the support of basic research. This research forms the foundation for applied research intended to advance society's understanding of the human and ecological risks from hazardous substances. What may not be immediately obvious to those familiar with the Program is the significant impact SBRP research has on the discovery and development of advanced technologies intended to decrease or eliminate contamination from soil, surface water, and ground water; and improve human and ecological health risk assessment models and methods.

While the pathway from discovery to application is often lengthy, it is important to recognize the accomplishments of the SBRP and the impact that the Program has had through the development, validation, and patenting of remediation technologies and health effects detection methods. Thus far, the SBRP has compiled a very impressive list of patents, resulting from the high quality of research being performed by its program-funded scientists. A list of reported and pending patents is attached.

In addition to the technologies that have been patented, there are some technologies that have not been patented but have advanced beyond bench scale. Examples of non-patented applications, small business start-ups, and SBIR grants that have emanated from SBRP funding are also included in the attachment.

Below are a few highlights to help illustrate SBRP technology transfer successes and the benefits these technological innovations bring to society.

Timothy Phillips, Ph.D., Texas A&M University

Dietary Clay for the Prevention of Aflatoxicosis: Molecular Mechanisms and Applications

1 patent received as a result of SBRP-funded research

Of the mold-derived chemicals frequently found as contaminants of food, those known as aflatoxins can be acutely toxic, suppress the immune system, and cause cancer as demonstrated in both laboratory and epidemiological studies. Dr. Timothy Phillips, a professor and SBRP-funded researcher at Texas A&M University, has developed a novel intervention strategy using a clay mineral called Novasil™ in the diet of farm animals to reduce aflatoxin exposure from food and feed.

Dr. Phillips' research indicates that Novasil™ acts as an enterosorbent to rapidly and preferentially bind aflatoxins in the gastrointestinal tract, resulting in decreased aflatoxin uptake and bioavailability. Specifically, tests have shown that Novasil™ routinely added to the diets of farm animals in the United States, Latin America, Asia, Africa, and Europe, can prevent the adverse effects of aflatoxins in young animals when included in their diets at a level as low as 0.25% (w/w). He is optimistic that this same technology may one day be applicable and sustainable for the protection of human foods decreasing human exposure to and disease from aflatoxins. Further applications of this work include the development and characterization of porous solids for the sorption of hazardous chemicals and microbes from water, and the development of field-practical remediation and diagnostic strategies.

The patent for the enterosorption of aflatoxin with Novasil™ clay is currently being applied on a worldwide basis – in countries including the United States, Japan, Taiwan, Thailand, India, France, Germany, Costa Rica, Mexico, and Brazil – as an animal feed additive. It is the cornerstone for an exclusive license and partnership between Texas A&M University and two companies that are responsible for processing, distributing and marketing the Novasil™ product.

Michael S. Denison, Ph.D., University of California – Davis

Commercial Application of the CALUX Bioassay for Use in Detecting Dioxin and Related Chemicals

1 patent received as a result of SBRP-funded research

SBRP-funded researchers have developed, validated, and patented a cell bioassay system (known as CALUX) that is sensitive, specific, quick, and inexpensive. This recombinant cell bioassay has been engineered to respond to dioxin-like HAHs and PAHs, with the activation of gene expression, specifically that of firefly luciferase. Xenobiotic Detection Systems (XDS), Inc., a biotech company in North Carolina, has combined the CALUX bioassay system with a rapid chemical extraction procedure to develop a sensitive combination system for the detection of dioxins and dioxin-like chemicals in extracts of biological, environmental, and food and feed samples.

After reviewing the validation results, the U.S. Food and Drug Administration (FDA) licensed the CALUX screening technology from XDS for critical evaluation as a rapid screening method for dioxins and related chemicals in food and feed. The FDA is in the initial phase of incorporating the bioassay into their food/feed screening program, and introducing such innovative techniques in FDA-sponsored laboratories. In addition, the technology has been licensed to companies in Japan and Belgium, and XDS is using it extensively to screen dioxins in a wide variety of matrices sent to them by governmental, commercial, academic, and public organizations. The USEPA has also expressed interest in licensing the CALUX screening technology. An application for USEPA approval of the assay will be submitted shortly. With USEPA approval, the bioassay should gain a significantly greater commercial and regulatory use.

Cass Miller, Ph.D., University of North Carolina – Chapel Hill
A New Method to Remediate DNAPL-contaminated Superfund Sites
2 patents received as a result of SBRP-funded research

SBRP-funded researchers have developed and patented two methods for remediating DNAPL contamination of a subsurface environment. Dense non-aqueous phase liquids (DNAPLs) are liquids that are heavier than water and have a low aqueous solubility. The concept behind both methods is simple – rather than fight the mass transfer limitations that exist in subsurface systems to remove DNAPLs, these techniques exploit the potential for mobilization. For the first approach, the density of water is altered by injecting brine solutions such that the DNAPLs become lighter than water and float to the surface. The second approach is similar, using a less dense brine barrier to funnel mobilized DNAPLs to a partially screened well or wells. Both processes can use surfactants, which improve DNAPL recovery in highly heterogeneous areas of the subsurface. High fractions of DNAPLs (exceeding 90% of the initial mass) are removed relatively quickly. Moreover, the remaining DNAPL has a high surface area to volume ratio, which makes the residual relatively easy to remove using existing methods.

The remediation of DNAPL-contaminated sites has proven to be one of the most difficult problems facing the Superfund program. Common remediation practices such as pump-and-treat, vapor extraction, gas stripping, and *in situ* biodegradation have been shown to be time-consuming, expensive, and inefficient when applied to these sites. UNC researchers continue to develop and implement new approaches to remove DNAPLs from the subsurface. If these novel approaches are successful and put into practice, more economical means of contaminant source-zone remediation will be available, resulting in reduced risk to human and ecological populations. Such an advance would have a profound effect on the Superfund program and the restoration of DNAPL-contaminated sites.

Kent S. Udell, Ph.D., University of California – Berkeley

Technology Transfer of Steam Injection for Soil and Groundwater Cleanup

Drs. Kent Udell and James Hunt of the University of California at Berkeley have successfully demonstrated that steam injection effectively removes trapped liquid solvents from soils at hazardous waste sites. Initial SBRP funding led to a very successful full-scale demonstration of Steam Enhanced Extraction at Lawrence Livermore National Laboratory, and then to a showcase industrial application at the Visalia Pole Yard in Visalia, California – one of the first sites placed on the National Priority List. The application of Steam Enhanced Extraction at that site decreased the financial liability of the site by $85 million for a cost of about $15 million, showing a clear financial incentive for publicly owned corporations to take a more aggressive approach to environmental restoration.

The transfer of NIEHS supported thermal technology has continued with applications at Superfund sites and other sites of national interest. Significantly, a unique application of Steam Enhanced Extraction at Cape Canaveral involved the co-injection of air with the steam. In principal, the co-injection of air provides conditions where the non-aqueous phase liquid vapors (NAPLs) do not condense with the steam at the condensation front. Instead, the NAPL vapors remain in the gaseous phase to percolate upward into the vadose zone where they are pulled to vapor extraction wells. In all cases, including controlled two dimensional laboratory experiments, the simultaneous injection of air and steam increases the NAPL compound removal rate beyond that which could be achieved by either pure steam injection or pure air sparging.

For another SBRP-supported project initiated at Loring Air Force Base in Maine, officials from the State of Maine and the USEPA are involved in the application and evaluation of the steam enhanced extraction to remediate fractured geologies. A pilot test using Steam Enhanced Extraction is also underway at the Wyckhoff Superfund site adjacent to Eagle Harbor near Seattle. Internationally, the Steam Enhanced Extraction method is being used routinely in the Czech Republic, including the first successful remediation of a fractured bedrock site, and has also been successfully demonstrated at the Pancevo site in the former Yugoslavia.

Milton Gordon, Ph.D., University of Washington, and Lee Newman, Ph.D., University of South Carolina and the Savannah River Ecology Lab

Phytoremediation of Organic Pollutants in Soil and Groundwater to Reduce Risk of Human Exposure

Trichloroethylene (TCE) is a common environmental contaminant that has been found in at least 852 of the 1,430 National Priorities List sites identified by the USEPA. Human exposure to TCE may cause nervous system effects, liver and lung damage, abnormal heartbeat, coma, and possibly

death. Conventional remediation technologies for TCE are expensive and time consuming, and may result in the formation of the potent carcinogen vinyl chloride as a by-product. Therefore, there is a need for an improved method for remediation of this ubiquitous contaminant.

Under the direction of Dr. Milton Gordon at the University of Washington and Dr. Lee Newman of the University of South Carolina, SBRP researchers have discovered such a method. Following more than a decade of basic, mechanistic research, investigators have developed and implemented phytoremediation techniques to cleanup sites contaminated with organic and inorganic pollutants, including TCE.

A three-year field trial to determine the efficacy of phytoremediation using hybrid poplar trees to remove TCE from groundwater has demonstrated that by simply planting the trees and letting them grow, over 95 % of the TCE was removed from test plots and the trees completely degraded TCE to nontoxic substances and did not release TCE into the air. The researchers are also developing additional transgenic plants capable of significantly higher rates of metabolism of specific contaminants. By introducing a mammalian metabolizing gene (cytochrome P450) into tobacco plants, they have engineered plants with profoundly increased rates of TCE metabolism. The gene raises enzyme levels to such an extent that the plants performed approximately 600 times the amount of metabolites as the non-transformed plants.

As a result of these innovative research findings, the use of phytoremediation to cleanup organic and inorganic contaminants is now being considered and tested at sites throughout the country. One stellar success story involved the installation of a poplar phytoremediation system to treat TCE contaminated groundwater at the Undersea Naval Warfare Center at Keyport. The application of phytoremediation on this site cost $3.3 million dollars, a significant cost savings to the Navy in comparison to the $10.5 million it would have cost if they had used conventional technologies.

SBRP researchers have now formed a biotechnology company, Verdant Technologies, and are applying their research findings to real world polluted sites. They are focused on the commercial development of phytoremediation technologies, and have designed systems that have successfully remediated sites contaminated with other persistent organics including carbon tetrachloride, methyl tertiary butyl ether (MTBE), trichloroethane, ethylene dibromide, and chlorobenzenes.

1d. Attachment A High-Impact SBRP Publications

***Science* (impact factor – 23.329)**

2002

Park, J.Mo, F. Greten, Z. Li, M. Karin. 2002. "Macrophage apoptosis by anthrax lethal factor through p38 MAP kinase inhibition." *Science*, 297: 2048-2051.

2001

LaCombe, B., D. Becker, R. Hedrich, R. DeSalle, M. Hollman, J. M. Kwak, J. Schroeder, N. Le Novere, H. Gil Nam, E. P. Spalding, M. Tester, F. J. Turano, J. Chiu, G. Coruzzi. 2001. "The identity of plant glutamate receptors." *Science*, 292: 1486-1487.

Senftleben, U., Y. Cao, G. Xiao, F. Greten, G. Krahn, G. Bonizzi, Y. Chen, Y. Hu, A. Fong, S. Sun, M. Karin. 2001. "Activation by IKKa of a second, evolutionary conserved, NF-k signaling pathway." *Science*, 293: 1495-1499.

1998

Biggs, M.L., R. Haque, L. E. Moore, A. H Smith. 1998. "Arsenic-laced water in Chile (letter)." *Science*, 281: 785.

1997

Ramamoorthy, K., F. Wang, I. Chen, J. D. Norris, D. P. McDonnell, K. W. Gaido, W. P. Bocchinfuso, K. S. Korach, S. H. Safe. 1997. "Potency of combined estrogenic pesticides." *Science*, 275: 405.

***PNAS – Proceedings of the National Academy of Sciences* (impact factor – 10.896)**

2002

Cervantes, R.B., J. Stringer, C. Shao, J. A. Tischfield, P. J. Stambrook. 2002. "Embryonic stem cells and somatic cells differ in mutation frequency and type." *Proceedings of the National Academy of Sciences of the United States of America*, 99: 3586-3590.

Davis, B.B., D. A. Thompson, L. L. Howard, C. H. Morisseau, B. D. Hammock, R. H. Weiss. 2002. "Inhibitors of soluble epoxide hydrolase attenuate vascular smooth muscle cell proliferation." *Proceedings of the National Academy of Sciences of the United States of America*, 99: 2222-2227.

Dennis, S., T. Kortvelyesi, S. Vajda. 2002. "Computational mapping identifies the binding sites of organic solvents on proteins." *Proceedings of the National Academy of Sciences of the United States of America*, 99(7): 4290-4295.

Liu, Z., J. Shen, J. M. Carbrey, R. Mukhopadhyay, P. Agre, B. P. Rosen. 2002. "Arsenite transport by mammalian aquaglyceroporins AQP7 and AQP9." *Proceedings of the National Academy of Sciences of the United States of America*, 99: 6053-6058.

Maser, P., Y. Hosoo, S. Goshima, T. Horie, B. Eckelman, K. Yamada, K. Yoshidi, E. P. Bakker, A. Shinmyo, S. Oiki, J. Schroeder, N. Uozumi. 2002. "Glycine residues in potassium channel-like selectivity filters determine potassium selectivity in four-loop-per-subunit HKT transporters from plants." *Proceedings of the National Academy of Sciences of the United States of America*, 99: 6428-6433.

Pickhardt, P., C. L. Folt, C. Y. Chen, B. Klaue, J. D. Blum. 2002. "Algal blooms reduce the uptake of toxic methylmercury in freshwater food webs." *Proceedings of the National Academy of Sciences of the United States of America*, 99(7): 4419-4423.

Roberts, S.A., A. Weichsel, G. Grass, K. Thakali, J. T. Hazzard, G. Tollin, C. Rensing, W. R. Montfort. 2002. "Crystal structure and electron transfer kinetics of CueO, a multicopper oxidase required for copper homeostasis in *Escherichia coli*." *Proceedings of the National Academy of Sciences of the United States of America*, 99: 2766-2771.

Wiemels, J.L., B. C. Leonard, Y. Wang, M. R. Segal, S. P. Hunger, M. T. Smith, V. Crouse, X. Ma, P. A. Buffler, S. R. Pine. 2002. "Site-specific translocation and evidence of postnatal origin of the t(1;19) E2A-PBX1 fusion in childhood acute lymphoblastic leukemia." *Proceedings of the National Academy of Sciences of the United States of America*, 99: 15101-15106.

2001

Liu, S.X., M. Athar, I. Lippai, T. K. Hei. 2001. "Induction of oxyradicals by arsenic: Implication for mechanism of genotoxicity." *Proceedings of the National Academy of Sciences of the United States of America*, 98(4): 1643-1648.

Miyashita, M., J. M. Presley, B. A. Buchholz, K. S. Lam, Y. Moo Lee, J. S. Vogel, B. D. Hammock. 2001. "Attomole level protein sequencing by Edman degradation coupled with accelerator mass spectrometry." *Proceedings of the National Academy of Sciences of the United States of America*, 98(8): 4403-4408.

Xie, W., A. Radominska-Pandya, Y. Shi, C. M. Simon, M. C. Nelson, E. S. Ong, J. D. Waxman, M. R. Evans. 2001. "An essential role for nuclear receptors SXR/PXR in detoxification of cholestatic bile acids." *Proceedings of the National Academy of Sciences of the United States of America*, 98(6): 3375-3380.

2000

Doty, S.L., T. Q. Shang, A. M. Wilson, J. Tangen, A. D. Westergreen, L. A. Newman, S. Strand, M. Gordon. 2000. "Enhanced metabolism of halogenated hydrocarbons in transgenic plants containing mammalian cytochrome P450 2E1." *Proceedings of the National Academy of Sciences of the United States of America*, 97: 6287-6291.

Huang, Q., Q. L. Deveraux, S. Maeda, G. S. Salvesen, H. R. Stennicke, B. Hammock, J. C. Reed. 2000. "Evolutionary conservation of apoptosis mechanisms: Lepidopteran and baculoviral inhibitor of apoptosis proteins are inhibitors of mammalian caspase-9." *Proceedings of the National Academy of Sciences of the United States of America*, 97: 1427-1432.

Malins, D., N. L. Polissar, G. K. Ostrander, M. A. Vinson. 2000. "Single 8-oxo-guanine and 8-oxo-adenine lesions induce marked changes in the backbone structure of a 25-base DNA strand." *Proceedings of the National Academy of Sciences of the United States of America*, 97(23): 12442-12445.

Shan, G., W. Huang, S. J. Gee, B. A. Buchholz, J. S. Vogel, B. Hammock. 2000. "Isotope-labeled immunoassays without radiation waste." *Proceedings of the National Academy of Sciences of the United States of America*, 97(6): 2445-2449.

Thomine, S., R. Wang, J. M. Ward, N. M. Crawford, J. Schroeder. 2000. "Cadmium and iron transport by members of a plant metal transporter family in Arabidopsis with homology to Nramp genes." *Proceedings of the National Academy of Sciences of the United States of America*, 97: 4991-4996.

1999

Argiriardi, M.A., C. Morisseau, B. Hammock, D. W. Christianson. 1999. "Detoxification of environmental mutagens and carcinogens: Structure, mechanism, and evolution of liver epoxide hydrolase." *Proceedings of the National Academy of Sciences of the United States of America*, 96: 10637-10642.

Morisseau, C., M. Goodrow, D. Dowdy, J. Zheng, J. F. Greene, J. R. Sanborn, B. Hammock. 1999. "Potent urea and carbamate inhibitors of soluble epoxide hydrolases." *Proceedings of the National Academy of Sciences of the United States of America*, 96: 8849-8854.

Smith, M. 1999. "Benzene, NQO1, and genetic susceptibility to cancer." *Proceedings of the National Academy of Sciences of the United States of America*, 96: 7624-7626.

1998

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Hahn, M.E., S. I. Karchner, S. A. Perera, M. A. Shapiro, 1997. "Molecular evolution of two vertebrate aryl hydrocarbon (dioxin) receptors (AHRI and AHR2) and the PAS family." *Proceedings of the National Academy of Sciences of the United States of America*, 94: 13743-13748.

Khrapko, K., H. A. Coller, P. C Andre, X. C. Li-Sucholeiki, J. S. Hanekamp, W. Thilly. 1997. "Mitochondrial mutational spectra in human cells and tissues." *Proceedings of the National Academy of Sciences of the United States of America*, 94: 13798-13803.

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Hayes, C.L., D. C. Spink, B. C. Spink, J. Q. Cao, N. J. Walker, T. R. Sutter. 1996. "17b-estradiol hydroxylation catalyzed by human cytochrome P450 1B1." *Proceedings of the National Academy of Sciences of the United States of America*, 93: 9776-9781.

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Chenna, A., B. Hang, B. Rydberg, K. Pongcracz, W. J. Bodell, B. Singer. 1995. "The benzene metabolite p-benzeoquinone forms adducts with DNA that are excised by repair activity from human cells that differs from an ethenoadenine glycosylase." *Proceedings of the National Academy of Sciences of the United States of America*, 92: 5890-5894.

Clauser, K.R., S. C. Hall, D. M. Smith, J. W. Webb, L. E. Andrews, H. M. Tran, L. B. Epstein, A. L. Burlingame. 1995. "Rapid mass spectrometric peptide sequencing and mass matching for characterization of human melanoma proteins isolated by two-dimensional PAGE." *Proceedings of the National Academy of Sciences of the United States of America*, 92: 5072-5076.

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***American Journal of Human Genetics* (impact factor – 10.542)**

2001

Lowe, X., B. Eskenazi, D. O. Nelson, S. Kidd, A. Alme, A. Wyrobek. 2001. "Frequency of XY sperm increases with age in fathers of boys with Klinefelter syndrome." *American Journal of Human Genetics*, 69: 1046-1054.

1999

Sloter, E., J. Nath, A. J. Wyrobek. 1999. "Correlation between numerical and structural chromosome damage in sperm from 13 healthy men using multicolor FISH." *American Journal of Human Genetics*, 65(4): A357.

1998

Lowe, X., B. Eskenazi, S. Kidd, A. K.B. Alme, K. Weisiger, M. Aylstock, D. E. Nelson, A. J. Wyrobek. 1998. "Sperm disomy 21 is associated with sex chromosomal aneuploidies but does not preferentially segregate with the Y chromosome: a study of 38 healthy fertile men." *American Journal of Human Genetics*, 63(4): A143.

Sloter, E., X. Lowe, J. Nath, A. J. Wyrobek. 1998. "A novel multi-color FISH method for human sperm demonstrates that post-meiotic chromosome breaks occur more frequently than duplications and deletions." *American Journal of Human Genetics*, 63(4): A150.

1996

Wiencke, J.K., M. Spitz, A. McMillan, K. Kelsey. 1996. "Lung cancer in Mexican-American and African-Americans is associated with the wildtype genotype of the NAD(P)H:quinone oxidoreductase polymorphism." *American Journal of Human Genetics*, 59: A294.

1d. Attachment B ISI Essential Science Indicators: Most Cited Scientists – The Top 1%

	Papers	Citations	Citations per paper
ME Hahn – Boston University			
Environment/Ecology	14	229	16.36
JJ Stegeman – Boston University			
Pharmacology & Toxicology	28	1,554	55.50
Plant & Animal Science	27	498	18.44
Environment/Ecology	30	446	14.87
DJ Waxman – Boston University			
Molecular Biology & Genetics	5	1,371	274.20
Biology & Biochemistry	44	2,394	34.41
Pharmacology & Toxicology	28	1,576	56.29
TA Slotkin – Duke University			
Pharmacology & Toxicology	29	611	21.07
DC Christiani – Harvard School of Public Health			
Clinical Medicine	122	1,169	9.58
KT Kelsey – Harvard School of Public Health			
Clinical Medicine	69	1,480	21.45
LM Abriola – Michigan State University			
Environment/Ecology	33	924	28.0
TJ Pinnavaia – Michigan State University			
Chemistry	59	2,897	49.10
Materials Science	31	1,192	38.45
WJ Weber – Michigan State University			
Environment/Ecology	54	1,776	32.89
Engineering	59	597	10.12
Materials Science	24	426	17.75

	Papers	Citations	Citations per paper
M Costa – NYU School of Medicine			
Clinical Medicine	85	1,122	13.2
DM Di Toro – NYU School of Medicine			
Environment/Ecology	20	614	30.7
JA Field – Oregon Health & Science University			
Microbiology	41	845	20.61
Environment/Ecology	41	419	10.22
SH Safe – Texas A&M University			
Pharmacology & Toxicology	17	820	48.24
Environment/Ecology	17	803	47.24
HV Aposhian – University of Arizona			
Pharmacology & Toxicology	32	674	21.06
RG Arnold – University of Arizona			
Environment/Ecology	18	239	13.28
ML Brusseau – University of Arizona			
Environment/Ecology	63	873	13.86
AJ Gandolfi – University of Arizona			
Pharmacology & Toxicology	46	427	9.28
IL Pepper – University of Arizona			
Microbiology	30	562	18.73
AH Smith – University of California-Berkeley			
Environment/Ecology	8	378	47.25
MT Smith – University of California-Berkeley			
Environment/Ecology	9	323	35.89

	Papers	Citations	Citations per paper
MS Denison – University of California-Davis			
Pharmacology & Toxicology	22	576	26.18
BD Hammock – University of California-Davis			
Biology & Biochemistry	53	909	17.15
Agricultural Sciences	26	437	16.81
Plant & Animal Science	50	600	12.0
DE Rolston – University of California-Davis			
Environment/Ecology	57	420	7.37
CK Glass – University of California-San Diego			
Multidisciplinary	2	145	72.5
Molecular Biology & Genetics	34	5,785	170.15
Biology & Biochemistry	28	4,161	148.61
Clinical Medicine	16	1,133	70.81
M Karin – University of California-San Diego			
Molecular Biology & Genetics	89	17,188	193.12
Immunology	9	930	103.33
Biology & Biochemistry	40	9,163	229.07
Clinical Medicine	26	2,947	113.35
P Russell – University of California-San Diego			
Molecular Biology & Genetics	73	3,575	48.97
Clinical Medicine	103	1,210	11.75
JI Schroeder – University of California-San Diego			
Plant & Animal Science	49	2,552	52.08
P Taylor – University of California-San Diego			
Biology & Biochemistry	72	1,642	22.81
Pharmacology & Toxicology	22	388	17.64

	Papers	Citations	Citations per paper
RY Tsien – University of California-San Diego			
Biology & Biochemistry	54	5,214	96.56
RH Tukey – University of California-San Diego			
Pharmacology & Toxicology	27	826	30.59
PL Bishop – University of Cincinnati			
Environment/Ecology	35	362	10.34
JA Caruso – University of Cincinnati			
Engineering	69	999	14.48
Chemistry	36	838	23.28
A Puga – University of Cincinnati			
Pharmacology & Toxicology	19	692	36.42
TS Gross – University of Florida			
Environment/Ecology	7	493	70.43
D Bhattacharyya – University of Kentucky			
Materials Science	36	217	6.03
CT Miller – UNC-Chapel Hill			
Environment/Ecology	33	508	15.39
LG Costa – University of Washington			
Pharmacology & Toxicology	35	404	11.54

1d. Attachment C Technology Transfer Successes

REMEDIATION PATENTS ISSUED: 31

Remediation of Contaminated Aquifers

UNIVERSITY OF NORTH CAROLINA – CHAPEL HILL

Miller; Cass T. 2001.
Density-enhanced remediation of non-aqueous phase liquid contamination of subsurface environments.
U.S. Patent 6,261,029.

Miller; Cass T. 2001.
Density-enhanced remediation of dense non-aqueous phase liquid contamination of subsurface environments.
U.S. Patent 6,190,092.

MICHIGAN STATE UNIVERSITY

Pinnavaia; Thomas J.; Wang; Zhen. 2001.
Method for the preparation of homostructured mixed proton and organic layered silicates.
U.S. Patent 6,261,640.

Pinnavaia; Thomas J.; Tanev; Peter T.; Zhang; Wenzhong; Wang; Jialiang; Chibwe; Malama. 2001.
Catalytic applications of mesoporous metallosilicate molecular sieves and methods for their preparation.
U.S. Patent 6,193,943.

Pinnavaia; Thomas J.; Zhang; Wenzhong; Pauly; Thomas R.; Tanev; Peter T. 2000.
Quasi crystalline inorganic oxide compositions prepared by neutral templating route.
U.S. Patent 6,162,414.

Pinnavaia; Thomas J.; Zhang; Wenzhong. 2000.
Porous aluminum oxide materials prepared by non-ionic surfactant assembly route.
U.S. Patent 6,027,706.

Pinnavaia; Thomas J.; Shi; Heng-Zhen; Lan; Tie. 1999.
Homostructured mixed organic and inorganic cation exchanged tapered compositions.
U.S. Patent 5,993,769.

Pinnavaia; Thomas J.; Shi; Heng-Zhen; Lan; Tie. 1999.
Homostructured mixed organic and inorganic cation exchanged tapered compositions.
U.S. Patent 5,866,645.

Pinnavaia; Thomas J.; Tanev; Peter T.; Zhang; Wenzhong; Wang; Jialiang; Chibwe; Malama. 1999.
Catalytic applications of mesoporous metallosilicate molecular sieves and methods for their preparation.
U.S. Patent 5,855,864.

Pinnavaia; Thomas J.; Tanev; Peter T. 1998.
Crystalline inorganic oxide compositions prepared by neutral templating route.
U.S. Patent 5,840,264.

Removal of SOx from Flue Gases and other Gas Streams

MICHIGAN STATE UNIVERSITY

Pinnavaia; Thomas J.; Chibwe; Malama; Amarasekera; Jayantha. 1998.
Process using recyclable sorbents for the removal of SOx from flue gases and other gas streams.
U.S. Patent 5,785,938.

Pinnavaia; Thomas J.; Guan; Jingjie. 1996.
Stable supergallery pillared clay compositions.
U.S. Patent 5,583,082.

Pinnavaia; Thomas J.; Amarasekera; Jayantha. 1996.
Method for the preparation of highly reactive clay composites for the removal of SOx from flue gas streams.
U.S. Patent 5,520,898.

Pinnavaia; Thomas J.; Amarasekera; Jayantha. 1994.
Process of using layered double hydroxides as low temperature recyclable sorbents for the removal of SOx. from flue gas and other gas streams.
U.S. Patent 5,358,701.

Pinnavaia; Thomas J.; Amarasekera; Jayantha. 1994.
Method for the preparation of highly reactive clay composites for the removal of SOx from flue gas streams.
U.S. Patent 5,334,564.

Pinnavaia; Thomas J.; Amarasekera; Jayantha. 1994.
Hydrated lime clay composites for the removal of SOx from flue gas streams.
U.S. Patent 5,298,473.

Pinnavaia; Thomas J.; Polansky; Christine A.; Amarasekera; Jayantha. 1993.
Composite clay materials for removal of SOx from gas streams.
U.S. Patent 5,234,877.

Pinnavaia; Thomas J.; Polansky; Christine A.; Amarasekera; Jayantha. 1993.
Composite clay materials for removal of SOx from gas streams.
U.S. Patent 5,225,384.

Pinnavaia; Thomas J.; Polansky; Christine A.; Amarasekera; Jayantha. 1993.
Composite clay materials for removal of SOx from gas streams.
U.S. Patent 5,219,536.

Pinnavaia; Thomas J.; Polansky; Christine A.; Amarasekera; Jayantha. 1993.
Clay composites for removal of SOx from flue gas streams.
U.S. Patent 5,160,715.

Pinnavaia; Thomas J.; Polansky; Christine A.; Amarasekera; Jayantha. 1992.
Clay composites for the removal of SOx from flue gas streams.
U.S. Patent 5,126,300.

Pinnavaia; Thomas J.; Amarasekera; Jayantha; Polansky; Christine A. 1992.
Layered double hydroxide sorbents for the removal of SOx from flue gas resulting from coal combustion.
U.S. Patent 5,116,587.

Pinnavaia; Thomas J.; Amarasekera; Jayantha; Polansky; Christine A. 1992.
Layered double hydroxide sorbents for the removal of SOx from flue gas and other gas streams.
U.S. Patent 5,114,898.

Pinnavaia; Thomas J.; Amarasekera; Jayantha; Polansky; Christine A. 1992.
Process using sorbents for the removal of SOx from flue gas.
U.S. Patent 5,114,691.

Pinnavaia; Thomas J.; Lin; Chi-Li. 1992.
Organoclay triphase catalysts.
U.S. Patent 5,099,054.

Pinnavaia; Thomas J.; Kwon; Taehyun; Dimotakis; Emmanuel D.; Amarasekera; Jayantha. 1992.
Polyoxometalate intercalated layered double hydroxides.
U.S. Patent 5,079,203.

Pinnavaia; Thomas J.; Moini; Ahmad. 1991.
Dried metal oxide and clay particle compositions and method for the preparation thereof.
U.S. Patent 4,981,825.

Dechlorination of TCE

UNIVERSITY OF ARIZONA

Fernando; Quintus; Muftikian; Rosy; Korte; Nic. 1998.
Dechlorination of TCE with palladized iron.
U.S. Patent 5,759,389.

Fernando; Quintus; Muftikian; Rosy; Korte; Nic. 1997.
Dechlorination of TCE with palladized iron.
U.S. Patent 5,616,253.

Fernando; Quintus; Muftikian; Rosy; Korte; Nic. 1997.
Dechlorination of TCE with palladized iron.
U.S. Patent 5,611,936.

REMEDIATION PATENTS PENDING

COLUMBIA UNIVERSITY

Van Geen; Alexander; Perona; Pietro.
Colormetric device and procedure to measure arsenic in natural and waste waters.

MICHIGAN STATE UNIVERSITY

Kukor; Jerome.
COBR: Combined oxidation and biotreatment for remediation of soils contaminated with low bioavailability hydrocarbons.

HEALTH EFFECTS PATENTS ISSUED: 12

Susceptibility to Lead (Pb) Poisoning

NEW YORK UNIVERSITY

Desnick; Robert J.; Wetmur; James G. 1998.
Methods for determining susceptibility to lead poisoning.
U.S. Patent 5,840,578.

Desnick; Robert J.; Wetmur; James G. 1997.
Method and kits for detecting a polymorphism in delta-aminolevulinate dehydratase gene which is associated with an altered susceptibility to lead poisoning.
U.S. Patent 5,639,607.

Biomarkers and Bioassays for Exposure Detection

UNIVERSITY OF CALIFORNIA – DAVIS

Denison; Michael S.; Brouwer; Abraham; Clark; George C. 1998.
Bioassay for detecting 2,3,7,8-tetrachlorodibenzo-para-dioxin and TCDD-like compounds and novel recombinant cell line useful therefore.
U.S. Patent 5,854,010.

Hammock, B.D., H. Kido and A. Maquieira. 2002.
Diagnostic microarray apparatus.
U.S. Patent 6,395,562 B1.

Hammock, B.D., H. Kido and A. Maquieira. 2002.
Compact assay system with digital information.
U.S. Patent 6,342,395 B1.

Hammock; Bruce D.; Moghaddam; Mehran F.; Cheek; Jeffrey M.; Borhan; Babak; Fergusson; James; Grant; David F.; Greene; Jessica F.; Matoba; Kazuhiko; Zheng; Jiang; Sisemore; Marlene F. 2001.
Epoxide hydrolase inhibitor methods.
U.S. Patent 6,174,695.

Hammock; Bruce D.; Morisseau; Christopher H.; Zheng; Jiang; Goodrow; Marvin H.; Severson; Tonya; Sanborn; James. 2000.
Epoxide hydrolase complexes and methods therewith.
U.S. Patent 6,150,415.

Jones; A. Daniel; Mitchell; Alyson E; Hammock; Bruce D.; Zheng; Jiang. 2000.
Inhibition of glutathione transferase by haloenol lactones.
U.S. Patent 6,103,665.

Jones; A. Daniel; Mitchell; Alyson E.; Hammock; Bruce D; Zheng; Jiang. 1998.
Inhibition of glutathione transferase by haloenol lactones.
U.S. Patent 5,767,147.

Hammock; Bruce D.; Szurdoki; Feren; Kido; Horacio. 1995.
Enzyme amplified, complex linked, competitive and non-competitive assays for the detection of metal ions.
U.S. Patent 5,459,040.

Hammock; Bruce D.; Grant; David F.; Beetham; Jeffrey K. 1995.
Recombinant soluble epoxide hydrolase.
U.S. Patent 5,445,956.

MICHIGAN STATE UNIVERSITY

Chang; Chia-Cheng (Okemos, MI); Trosko; James (Okemos, MI). 2000.
Expression of estrogen receptors in type I and type II human breast epithelial cells.
U.S. Patent 6,140,119.

HEALTH EFFECTS PATENTS PENDING

BOSTON UNIVERSITY

Vajda; Sandor.
Identification and Characterization of Functional Sites of Proteins by Computational Solvent Mapping.

UNIVERSITY OF CALIFORNIA – DAVIS

Hammock; B.D.
Cyanohydrin Ethers and Esters as High-Sensitivity Enzyme Substrates

NON-PATENTED APPLICATIONS

These examples demonstrate successful Technology Transfer outside the formal patent process.

Remediation

COLUMBIA UNIVERSITY

Somasundaran; Ponisseril.
Development of a foam floatation technique for efficient removal of arsenic species from water.

Health Effects

BOSTON UNIVERSITY

Callard; Ian.
Development of specific ELISA assay for vitellogenin in turtles, which can be used to measure potential exposure to xenoestrogens.

Ozonoff; David; Webster; Tom.
Development of methods that combine current software for manipulating geographic data (GIS) with advanced statistical methods to produce disease maps useful for investigating the role of environmental exposures in disease risk.

DARTMOUTH UNIVERSITY

Hamilton; Joshua.
Development of trace element analysis techniques for use with biological samples.

Hamilton; Joshua.
Development and use of stable isotope techniques for evaluation of movement of toxic metals through food webs and transmission to humans (for ecotoxicology and epidemiology studies).

MICHIGAN STATE UNIVERSITY

Trosko; James; Yotti; Larry; Chang; Chia-Cheng.
Description of a means to detect non-genotoxic, or "epigenetic" toxicants, which lead to the development of multiple assays to detect this type of toxicant.

Denison; Michael.
Use of CALUX (chemically-activated luciferase expression) as a screening assay for dioxin-like chemicals.

UNIVERSITY OF NORTH CAROLINA – CHAPEL HILL

Swenburg; James.
Development of GC/high resolution MS method for N2,3-ethonoguanine adducts that are formed by vinyl chloride, urethane and lipid peroxidation.

Swenburg; James.
Development of GC/high resolution MS method for N7-hydroxyethylguanine adducts formed by ethylene oxide, ethylene and lipid peroxidation.

Swenburg; James.
Development of a slot blot assay for abasic sites in DNA.

Swenburg; James.
Development a cleavage assay for abasic sites in DNA.

Swenburg; James.
Development of an immunoaffinity/LC/MS/MS method for 1N6 ethenodeoxyadenosine in DNA.

Swenburg; James.
Development of an LC/MS/MS assay for 1N2 propanodeoxyguanosine adducts of crotonaldehyde.

Swenburg; James.
Development of an LC/MS/MS method for M1G, the major DNA adduct of malondialdehyde.

Swenburg; James.
Development of a slot blot assay for oxidized purines in DNA.

Rappaport; Stephen.
Development and application of protein adducts as dosimeters of reactive metabolites of benzene.

UNIVERSITY OF WASHINGTON

Kavanagh; Terrance.
Development of a microtiter plate-based fluorescence assay for high-throughput analyses of glutamate-cysteine ligase activity.

Kavanagh; Terrance.
Development of a fluorescence assay for lipid peroxidation in tissues and cells using confocal microscopy and flow cytometry.

Kavanagh; Terrance.
Development of an in gel activity assay (zymography) for glutamate-cysteine ligase activity.

Kavanagh; Terrance.
Development of transgenic mice which can inducibly overexpress glutamate-cysteine ligase, and which are deficient in the modifier subunit of this enzyme.

SAMPLE END USERS OF SBRP-FUNDED RESEARCH

These examples demonstrate that SBRP research findings are being applied in field and laboratory settings.

Remediation

MICHIGAN STATE UNIVERSITY

Trosko; James; Yotti; Larry; Cheng; Chia.
Epigenetic toxicant study, which lead to the development of multiple assays to detect other non-genotoxic toxicants.
Users: Environmental engineers who need to remediate toxic dump sites, as well as those who want to screen for potential environmental epigenetic toxicants.

Kukor; Jerome.
COBR: Combined oxidation and biotreatment for remediation of soils contaminated with low bioavailability hydrocarbons.
Users: Site remediation contractors; engineering firms that provide or sub-contract remediation technologies; site owners who need to remediate soils, sediments, or aquifers contaminated with hydrophobic organic contaminants; exclusive license to Castus Corp, New Brunswick, NJ.

UNIVERSITY OF NORTH CAROLINA – CHAPEL HILL

Serre; Marc; Christakos; Kolovos; Alexandros; Lee; Seung-Jae.
Development of a numerical package implementing the powerful bayesian maximum entropy method of modern spatiotemporal geostatistics for field-based temporal geographical information systems (TGIS).
Users: Scientists and epidemiologists from over 15 countries worldwide; and environmental researchers.

Gleyzer; Simon; Farthing; Matthew; Miller; Cass.
Simulator models dissolution of entrapped non-aqueous phase liquids in heterogenous two-dimensional domains using high-resolution finite difference schemes at the cm scale.
Users: Researchers interested in the dynamics of dissolution of entrapped non-aqueous phase liquids into groundwater (example, Paul Imhoff at University of Delaware).

BOSTON UNIVERSITY

Callard; Ian.
Development of a specific ELISA assay for vitellogenin in turtles which can be used to measure potential exposure to xenoestrogens.
Users: Ecotoxicologists looking at biomarkers of xenobiotic exposure.

UNIVERSITY OF CALIFORNIA – DAVIS

Hammock; Bruce.
Transport, transformation and remediation of perchlorate and VOCs in the vadose zone and in groundwater.
Users: Remediation and engineering companies, drinking water districts, petroleum companies, local municipalities with contamination problems, and U.S. Department of Defense.

Health Effects

UNIVERSITY OF WASHINGTON

Woods; James.
Porphyrin synthesis biomarkers of mercury toxicity.
Users: The U.S. armed forces, NASA, drug companies, clinicians who require a highly sensitive indicator of mercury body burden in human subjects; the US Dept of Transportation, public and private institutions engaged in neurobehavioral assessments and research.

Hooper; Michael.
Wildlife/biomarker applications to remediation decision-making.
Users: USEPA – Dr. Dale Hoff, Region 8 Ecotoxicologist, Denver, Colorado.

SMALL BUSINESS START-UPS

Lee Newman and Milton Gordon (University of Washington) have established Verdant Technologies, Inc. which is focused on the commercial development of phytoremediation technologies.

Fred Pfaender (University of North Carolina – Chapel Hill) has established an ongoing relationship with Chatham Research, Ltd. and RETEC NC Inc.

SBIR GRANTS

Remediation

Fred Pfaender (University of North Carolina – Chapel Hill) is the lead researcher on the SBIR Phase I project Anaerobic Mobilization Technology for Remediation of Low Availability Hydrophobic Organic Contaminants

Patrick Larkin (University of Florida) is the lead researcher on the SBIR Phase I project Arrays to Measure Endocrine Disruption in Fish

Tim Phillips (Texas A&M University) is a partner on the SBIR Phase I project Sorbents for Removal of Arsenic and Heavy Metals

Paul Bishop (University of Cincinnati) is a partner on the SBIR Phase I project Microelectrodes for Environmental Monitoring

Biomedical

James Swenberg (University of North Carolina – Chapel Hill) is the lead researcher on the SBIR Phase I project Ultrasensitive Methods for Human DNA Adduct Quantitation

James Swenberg (University of North Carolina – Chapel Hill) is the lead researcher on the SBIR Phase II project Ultrasensitive Methods for Human Biomarker Quantitation

SECTION 2

SBRP TECHNOLOGY TRANSFER AND INFORMATION TRANSFER TOOLS

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2a. Introduction to the SBRP Website

2a.i History

The Superfund Basic Research Program (SBRP) recognized very early in the history of the world wide web that this tool would be ideal for dissemination of information on the research conducted by Program grantees. The low cost and wide availability of the Internet allowed the development of an SBRP website to communicate information about the Program to its various stakeholders. By 1993, the SBRP had designed and populated an electronic bulletin board system to provide access to basic descriptions and progress reports for each SBRP project. In 1994, the SBRP developed its first SBRP world wide website to provide more information, more attractive displays, and wider access to its audience. As the collection of documents and other information expanded, the SBRP converted the information to an Oracle database and used Cold Fusion to access the information for display on the website. The SBRP website is the primary tool for archiving and displaying Program information and receives 10,000 – 20,000+ hits per month.

2a.ii What is Available?

The SBRP website includes:

- SBRP description including background and annual research highlights
- Program news and features
- Descriptions and progress reports for each SBRP research and outreach project
- Publications, patents, and Superfund sites under investigation for each SBRP research project
- SBRP-funded conferences
- *Research Briefs*

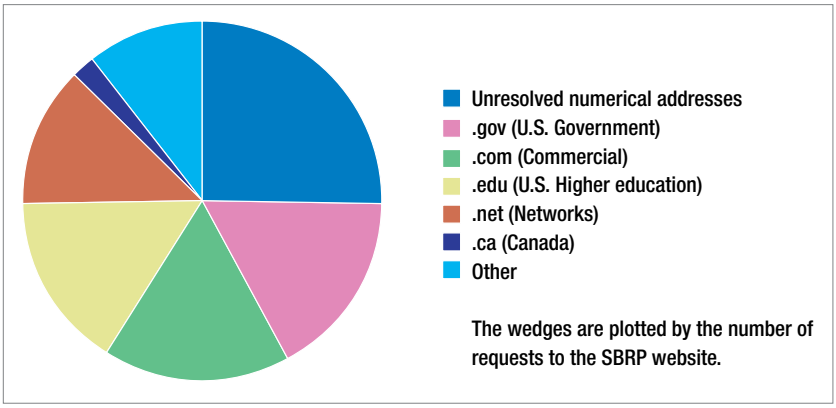
This system provides an ideal tool for information transfer from the SBRP to its various stakeholders.

2a.iii The Audience

SBRP website content is designed to communicate important research findings to those involved in Superfund hazardous waste research, site evaluation, remediation, regulations, and decision-making. The primary audiences for the SBRP website are:

- USEPA
- ATSDR, DOE, DOD and other federal agencies
- U.S. state departments of health and of environmental management
- SBRP grantees and other researchers
- NIEHS
- Environmental consultants and engineers
- Students

The graph below shows the breakdown of visitors to the SBRP website. Clearly, the SBRP website reaches a broad range of people interested in hazardous waste research.



2a.iv Future Plans

Future plans for the SBRP website are ambitious. A new organizational structure will provide more convenient browsing options in either of two large divisions: the SBRP-funded research and outreach programs will be organized by topic to provide quick access to and more useful descriptions of the projects. Resources available on the SBRP website will be expanded to provide useful information specific to the funded grantees and potential applicants. In addition to these major organizational changes, community outreach activities will be more prominently highlighted, and a broader base of hazardous waste research news and features will be included. An overview of each new section follows:

Research and Outreach:

- Project descriptions and progress reports categorized and available for browsing under specific topics
- The *Research Briefs* presented in a more user-friendly mode to allow browsing and searching of the entire series
- Information on community outreach
- Information on graduate and post-doc training funded by the SBRP

Resources:

- Administrative information for Program Grantees
- Searchable *Directory of Expertise* of SBRP investigators with customizable search criteria including area of expertise, media and contaminant under investigation
- *Calendar of Events* including conferences, workshops, the *SBRP Distinguished Lectures Series*, *RISKeLearning* web-based seminars, and other items of interest
- Information about SBRP funding opportunities

The SBRP will continue to develop this website to communicate more relevant, comprehensive information about the research and other activities conducted under the Program, in a format that is both useful and attractive to their audience.

2b. SBRP's Conference Support Mechanism

As part of the SBRP's strategy of communicating the research emanating from the Program to all appropriate audiences, the SBRP invests in conferences and workshops. Historically, the Program has provided support for eight to twelve meetings per year on topics that are timely and relevant to SBRP goals.

Our support for conferences can be through different mechanisms. The primary mechanism that we use is to encourage SBRP grantees to organize and host conferences in areas that are of high programmatic interest. Program investigators are invited to submit conference requests, which are then reviewed by an internal committee. For those approved, we provide funds. This mechanism allows us to highlight research from the Program, as well as foster the development and advancement of areas that are particularly important to the Program. Recent examples of grantee-sponsored conferences include an international workshop on PCBs, a multidisciplinary conference on arsenic, and a conference to explore biodegradation and bioremediation from a cross-disciplinary perspective.

Another very successful mechanism is the joint sponsorship of conferences and workshops with other agencies or institutions. Utilizing this mechanism has many benefits. It is an effective method of demonstrating collaboration. It can be an investment in a partnership with our counterparts in other agencies. Not to mention, it allows us to leverage our resources. Recently, we co-sponsored a major mixtures meeting with ATSDR, and an international meeting on children's environmental health with the World Health Organization.

Finally, we sponsor an SBRP annual meeting that is organized and hosted by one of the grantees. Each annual meeting is developed around a scientific theme that is cross cutting and designed to include the diverse disciplines that the Program supports. For example, the theme of the 2002 annual meeting was technology transfer. We invited investigators to discuss successful stories in transferring basic research into application. While the primary participants at these meetings are SBRP investigators, we also consider this to be an important opportunity to communicate research advances to our colleagues at USEPA and ATSDR. We actively seek their participation and attendance. Another important component of the annual meeting is the involvement of SBRP students. This meeting is an ideal opportunity for students to learn more about the Program from a multidisciplinary perspective; network with other students; and present their work to their colleagues.

Attachment A contains short reports on the SBRP Annual Meetings from 2000-2002, and Attachment B includes a comprehensive list of past SBRP supported conferences.

2b. Attachment A SBRP Annual Meeting Highlights (2000–2002)

Superfund Basic Research Program Annual Meeting 2000
Oxidative Processes: Stress to Remediation
Chapel Hill, NC
December 12-14, 2000

The 2000 Annual Meeting of the Superfund Basic Research Program focused on the physical and biological oxidation pathways as they relate to environmental exposures and environmental clean up. The agenda and format of the 3-day meeting mirrored the interdisciplinary nature of the SBRP and emphasized the critical role that interdisciplinary research plays in the advancement of the science base of NIEHS and the environmental health sciences. The concepts of the relation of oxidative mechanisms to the field of risk assessment and the role that translation of research findings plays in fulfilling the mission of the SBRP were also addressed.

Presentations on the basic mechanisms of oxidation and oxidative stress provided the groundwork for in-depth discussions of the biomedical, ecological, and remediation implications of these processes. As with all SBRP meetings, the 2000 Annual Meeting provided participants with an environment that promoted the free flow of ideas and encouraged the development and enhancement of partnerships with SBRP stakeholders.

In addition to technical presentations by prominent researchers, keynote addresses were presented by the Honorable David Price, Democratic Congressional Representative for North Carolina, and Dr. Ken Olden, Director of the National Institute of Environmental Health Sciences. Both expressed strong support for the SBRP and emphasized the importance of basic research to support sound public policy.

The Superfund Basic Research Program's emphasis on support for training students was demonstrated by presentations of two awards for outstanding student research. Angeline Andrew, a doctoral student in Dartmouth Medical School's Department of Pharmacology and Toxicology, was presented the 2000 Karen Wetterhahn Memorial Award in recognition of her exceptional contributions as a young scientist in the field of metals research. Naomi Custodia of Boston University and Ratan Kumar Dhar, a participant of the Columbia University SBRP, shared the First Annual "Best Student Poster" Award.

The meeting also provided program managers with an opportunity to network and discuss administrative issues. These sessions were designed to clarify and emphasize NIEHS' expectations with regard to reporting requirements, networking with USEPA, and information transfer. Program managers took advantage of this opportunity to share ideas and strengthen interactions across the Program.

Superfund Basic Research Program Annual Meeting 2001
Assessing Risks of Hormonally Active Agents
University of Florida
December 10-12, 2001

The 2001 Annual Meeting of the Superfund Basic Research Program, *Assessing Risks of Hormonally Active Agents*, focused on the group of Superfund chemicals that interact with endocrine systems to cause disturbances of normal physiological processes.

The meeting was attended by scientists and students from the 19 SBRP-funded programs at universities across the country, representatives of the NIEHS, USEPA, ATSDR, the Children's Environmental Health Network, and the U.S. Geological Service, as well as experts from the chemical and communications industries. Technical presentations on the scientific, regulatory, and risk assessment challenges of studying hormonally active chemicals provided the groundwork for in-depth discussions of the biomedical, ecological, and remediation implications of these compounds.

The Keynote Address, *Environmental Signaling: A Missing Piece in the Public Health Puzzle*, was presented by Dr. John McLachlan of Tulane University. Scientific presentations by prominent SBRP researchers addressed a broad spectrum of topics including:

- movement of hormonally active compounds through environmental media
- uptake in ecological systems and humans
- health effects in humans and wildlife
- methodologies used in assessing exposure and the risks associated with exposure
- development of methods for sensitive analysis and remediation of these chemicals
- mechanisms for the transfer of information and technology from the basic science laboratory to the public and industry

The symposium poster session provided graduate students and post-doctoral fellows with the opportunity to present their SBRP-supported research. In recognition of their efforts, the SBRP selects two students for "Best Student Poster" Awards. This year's awardees were Michael Mattie of Duke University and Angela Moore of the University of California – Davis. In addition, Blakely M. Adair, a doctoral student at Texas Technical University's Institute of Environmental and Human Health, Department of Environmental Toxicology, was presented with the 2001 Karen Wetterhahn Memorial Award in recognition of her exceptional contributions as a young scientist in the field of metals research.

For the first time, included in the Annual Meeting was an evening Outreach Core Session. The goal of this session was to establish an Outreach Core Network, discuss strategies to coordinate efforts to achieve outreach objectives, and to brainstorm about the content of the SBRP Outreach webpage. The session was highly successful and generated great interest in continuing as a coordinated group.

In addition to the science and outreach sessions, the SBRP Administrators meet to discuss NIH and NIEHS grant policy issues.

Superfund Basic Research Program Annual Meeting 2002
Transitioning Basic Science into Practical Applications to Meet Environmental and Public Health Challenges
University of Arizona
November 3-6, 2002

The theme of the 2002 annual meeting focused on the transfer of technology and the dissemination of information relevant to assessing, evaluating and remediating hazardous substances to reduce the toxicity and the uncertainty of risk. More than 200 participants, including students, staff and researchers from the 19 SBRP-funded university programs, gathered to learn about technology transfer activities that have evolved from basic laboratory research to practical applications, with discussion on the pathways that investigators have taken to achieve this. Representatives from the USEPA, the DOE, the Arizona Department of Environmental Quality, and independent commercial consultants and research institutes also joined in this year's conference discussions. Presentations provided an exciting glimpse of innovative tools that can be used to exploit rich data sets generated by genomic, proteomic, imaging and exposure assessment technologies.

A broad spectrum of research was presented during the sessions, providing a greater understanding of the work currently being performed by the program's researchers. Major themes from this year's presentations included:

- Transitioning phytoremediation and bioremediation techniques from the laboratory to the field
- Emerging biomarkers of toxic exposure and disease in humans
- Competing goals of researchers and end users when implementing innovative remediation technologies
- Communicating research results to relevant target audiences

Continuing its ongoing support for student excellence in science research and training, SBRP sponsored two student poster sessions during the conference, providing graduate and post-doctoral students with the opportunity to present their research findings. All of the research projects represented at the poster sessions were funded in part by the SBRP.

Two students were chosen from the total submission pool and presented with an award for outstanding student research. This year's winners were:

- Kenneth C. Carroll of the University of Arizona for his poster, *Characterizing the Physical Properties and Partitioning Behavior of a Diesel-PCE Non-aqueous Phase Liquid Mixture*.
- Kevin D. Reynolds of Texas Tech for his poster, *Heavy Metal and Arsenic Bioavailability and Bioaccumulation in Anaconda Smelter Site Small Mammals*.

In conjunction with the student poster award ceremony, the 2002 Karen Wetterhahn Memorial Award was presented to Elena S. Craft for her research on *Metal Induced Activation of Metallothionein Gene Expression*. Ms. Craft is a post-doctoral student at Duke University's Nicholas School of the Environment. The award recognizes her research examining the effect of heavy metals on biological processes and will support Elena's participation in one major upcoming scientific conference.

In addition to the conference's technical and student poster sessions, Administrators and Outreach Core staff from each SBRP university program met, concurrent with the scientific sessions, to review information relevant to their roles and responsibilities.

The Outreach sessions addressed subjects of particular interest to those involved in the task of communicating the SBRP's results to the communities and organizations most concerned with hazardous substances. Session topics included:

- Strengthening the SBRP Outreach Cores Network
- Community Partnerships
- Curriculum
- Measuring the Outcomes of Outreach Programs
- Beyond Publication: Technology and Information Transfer
- Applying Advanced Technologies to Outreach Programs

Administrators met to review details and updates regarding grant proposals and renewal submissions. Several key items were discussed at this year's meeting. Particular emphasis was placed on the new December submission date for annual updates. NIEHS staff also provided the Administrators with a description of the newly created SBRP External Advisory Group, which has been established to provide an independent constructive assessment of the SBRP's effectiveness, role and future directions. This group will provide a summary report of observations, recommendations and conclusions, which will be made available before next year's SBRP annual meeting.

2b. Attachment B SBRP Supported Conferences

2002

Superfund Basic Research Program Annual Meeting: Transitioning Basic Science into Practical Applications to Meet Environmental and Public Health Challenges
Tucson, AZ
November 03, 2002 – November 06, 2002
Conference Report: http://www-apps.niehs.nih.gov/sbrp/conf/events.cfm?year=2002&confnum=185&view=

International Conference on Chemical Mixtures (ICCM) 2002
Atlanta, GA
September 10, 2002 – September 12, 2002
To Be Published

5th International Conference on Arsenic Exposure and Health Effects
San Diego, CA
July 14, 2002 – July 18, 2002
To Be Published

Bioremediation and Biodegradation: Current Advances in Reducing Toxicity, Exposure and Environmental Consequences
Pacific Grove, CA
June 09, 2002 – June 12, 2002
In Press: reference not available

Arsenic in New England: A Multidisciplinary Scientific Conference
Manchester, NH
May 29, 2002 – May 31, 2002
Publication information not available

PCB Workshop-2002, Health Effects and Environmental Contamination in Eastern Europe: Fate, Transport, Metabolism and Toxicity of PCBs
Brno, Czech Republic
May 07, 2002 – May 11, 2002
Publication information not available

International Conference on Environmental Threats to the Health of Children
Bangkok, Thailand
March 03, 2002 – March 07, 2002
In Press – *Environmental Health Perspectives*

2001

Assessing Risks of Hormonally Active Agents
Gainesville, FL
December 10, 2001 – December 12, 2001
Conference Report: http://www-apps.niehs.nih.gov/sbrp/conf/2001annualconf/speakers.html

Arsenic in Drinking Water
New York, NY
November 26, 2001 – November 27, 2001
Publication information not available

Mechanistic Issues in the Design and Interpretation of Molecular Epidemiology Studies
Lyon, France
November 14, 2001 – November 17, 2001
Publication information not available

18th International Symposium on Polycyclic Aromatic Compounds
Cincinnati, OH
September 09, 2001 – September 13, 2001
Publication information not available

Third International Meeting on Molecular Mechanisms of Metal Toxicity and Carcinogenicity
Stintino, Italy
September 02, 2001 – September 05, 2001
Environmental Health Perspectives, Volume 110, Supplement 5, October 2002.

Seventh International Congress on Combustion By-Products: Origins, Fate, and Health Effects
Research Triangle Park, NC
June 04, 2001 – June 06, 2001
Environmental Health Perspectives, Volume 110, Number 11, November 2002

Great Plains/Rocky Mountain Hazardous Substance Research Center's 2001 Conference on Environmental Management
Manhattan, KS
May 22, 2001 – May 24, 2001
Proceedings: http://www.engg.ksu.edu/HSRC/01Proceed/index.html

Application of Technology to Chemical Mixture Research
Ft. Collins, CO
January 09, 2001 – January 11, 2001
In Press – *Environmental Health Perspectives*

2000

Superfund Basic Research Program Annual Meeting--Oxidative Processes: Stress to Remediation
Chapel Hill, NC
December 12, 2000 – December 14, 2000
Conference Report: http://www-apps.niehs.nih.gov/sbrp/conf/events.cfm?year=2000&comfnum=163&view=

Organophosphate Pesticide Impacts on Neural Development: Integrating Molecular Mechanisms with Functional Consequences: Dish to Fish to Rodents and Humans
Durham, NC
December 04, 2000
No publication planned

Metals in Eastern and Central Europe: Health Effects, Sources of Contamination and Methods of Remediation
Prague, Czech Republic
November 08, 2000 – November 10, 2000
International Journal of Occupational Medicine and Environmental Health, Volume 14, Number 2: 151-155.

20th International Symposium on Halogenated Environmental Organic Pollutants and Persistent Organic Pollutants (POPs): Dioxin 2000
Monterey, CA
August 13, 2000 – August 17, 2000
Proceedings: *Organohalogen Compounds,* Volumes 45-49, 49s (2000).

Hazardous Waste Research: Environmental Challenges and Solutions to Resource Development, Production, and Use
Denver, CO
May 23, 2000 – May 25, 2000
Proceedings: http://www.engg.ksu.edu/HSRC/Proceedings.html

6th International Symposium on Metal Ions In Biology and Medicine
San Juan, Puerto Rico
May 07, 2000 – May 10, 2000
Metal Ions in Biology and Medicine. 2002. Lylia Kmassanova, et. al., eds. John Libbey Eurolext.

Workshop on Practical Issues in the Use of Probabilistic Risk Assessment
Tampa, FL
April 16, 2000 – April 18, 2000
Publication information not available

2000 Pacific Basin Conference on Hazardous Waste
Manila, Philippines
April 10, 2000 – April 14, 2000
Proceedings: reference not available

Environmental Threats to the Health of Children
Manila, Philippines
April 09, 2000 – April 11, 2000
Environmental Health Perspectives, Volume 108, Number 10, October 2000.

PCB Workshop: Recent Advances in the Environmental Toxicology and Health Effects of PCBs
Lexington, KY
April 09, 2000 – April 12, 2000
PCBs: Recent Advances in the Environmental Toxicology and Health Effects. 2002. Larry W. Robertson and Larry G. Hansen, eds. The University Press of Kentucky.

Workshop on the Effects of Endocrine Disruptors on Human Development
New York City, NY
March 16, 2000 – March 17, 2000
Publication information not available

1999

Workshop on Indicators of Ocean and Human Health
Bermuda
November 15, 1999 – November 19, 1999
Proceedings: *Marine Pollution Bulletin*, 40(5):461-462. 2000.

Environmental Toxicant-Induced Oxidative Stress, Signal Transduction and Altered Intercellular Communication
Ann Arbor, MI
October 17, 1999 – October 20, 1999
No publication planned

Organochlorine Contamination in Eastern and Central Europe
Balatonfoldvar, Hungary
September 19, 1999 – September 22, 1999
Publication information not available

Wildlife Applications to Remediation Decision-Making
Denver, CO
August 17, 1999 – August 19, 1999
Publication information not available

6th International Congress on Toxic Combustion Byproducts
Karlsruhe, Germany
June 27, 1999 – June 30, 1999
Publication information not available

Pediatric Environmental Health: Putting it into Practice
San Francisco, CA
June 04, 1999 – June 06, 1999
No publication planned

Great Plains Rocky Mountain Hazardous Substance Research Center 14th Annual Conference on Hazardous Waste
St. Louis, MO
May 25, 1999 – May 27, 1999
Proceedings: http://www.engg.ksu.edu/HSRC/Proceedings.html

Environmental Influences on Children: Brain, Development, and Behavior
New York, NY
May 24, 1999 – May 25, 1999
Environmental Health Perspectives, Volume 108, Supplement 3, June 2000.

Practical Issues in the Development and Use of Probabilistic Risk Assessment for Hazardous Waste Sites
Sarasota, FL
February 28, 1999 – March 02, 1999
Publication information not available

Drinking Water and Health Symposium
Sarasota, FL
February 26, 1999 – February 27, 1999
No publication planned

Protecting Children's Health with a Focus on Healthy Schools
Berkeley, CA
February 19, 1999
Publication information not available

1998

The 1999 SBRP RFA Applicant Information Meeting – EAST COAST
Research Triangle Park, NC
December 16, 1998
No publication planned

The 1999 SBRP RFA Applicant Information Meeting – WEST COAST
San Diego, CA
December 10, 1998
No publication planned

Bioavailability
Washington, DC
December 03, 1998 – December 04, 1998
Publication information not available

Genetic Susceptibility to Environmental Exposures: Scientific and Ethical Issues. A Conference from the NIEHS Environmental Genome Program and NIEHS Superfund Basic Research Program
Boston, MA
November 13, 1998 – November 14, 1998
Publication information not available

International Symposium on Environmental Engineering and Health Sciences
Cholula, Puebla, Mexico
October 26, 1998 – October 30, 1998
Proceedings of the International Symposium on Environmental Engineering and Health Sciences: A Joint Effort for the XXI Century. 2000. Jose A. Raynal, John R. Nuckols, Rene Reyes and Mary Ward, eds. Water Resources Publications, LLC, Englewood, CO.

Superfund Basic Research Program Annual Meeting: Tri-University/USEPA Region #9 Joint Program
Berkeley, CA
October 26, 1998 – October 28, 1998
No publication planned

Improved Communication Workshop: Remediation of PCB Contaminated Sites
Albany, NY
October 16, 1998 – October 17, 1998
No publication planned

United States/Mexico Conference on Hazardous Waste Management and Technologies
Tucson, AZ
August 09, 1998 – August 11, 1998
Publication information not available

Joint US – European Union Theoretical and Practical Course on Molecular Approaches for *In Situ* Biodegradation
New Brunswick, NJ
June 01, 1998 – June 14, 1998
No publication planned

Second International Symposium on Metals and Genetics
Toronto, Ontario, Canada
May 26, 1998 – May 29, 1998
Metals and Genetics. 1999. B. Sarkar, ed. Kluwer Academic/Plenum Publishers, New York.

13th Annual Conference on Hazardous Waste
Snow Bird, UT
May 19, 1998 – May 21, 1998
Proceedings: http://www.engg.ksu.edu/HSRC/Proceedings.html

Hazardous Substances and Male Reproductive Health
New York, NY
May 14, 1998 – May 15, 1998
Environmental Health Perspectives, Volume 108, Number 9, September 2000.

Pacific Basin Conference on Hazardous Waste
Honolulu, HI
April 20, 1998 – April 24, 1998
Proceedings: reference not available

Practical Issues in the Use of Probabilistic Risk Assessment and its Application to Hazardous Waste Sites
Sarasota, FL
March 29, 1998 – March 31, 1998
Human and Ecological Risk Assessment, 5(4):729-868. August 1999.

Hitch-Hiker's Guide to Outreach: Preparing for the 1999 Superfund Basic Research Program Solicitation– Day 3 of the "Superfund Communities: Who's Exposed and Who's at Risk?" Conference
Cambridge, MA
March 25, 1998
No publication planned

Superfund Communities: Who's Exposed and Who's at Risk?
Cambridge, MA
March 23, 1998 – March 24, 1998
No publication planned

Risk Considerations for Environmental Health & Safety Metals Symposium
Tucson, AZ
January 08, 1998 – January 09, 1998
Publication information not available

1997

The 7th Annual Meeting of the International Society of Exposure Analysis
Research Triangle Park, NC
November 25, 1997
No publication planned

Remediation of Hazardous Wastes: Technology and Health Effects
Prague, Czech Republic
November 16, 1997 – November 19, 1997
Central European Journal of Public Health, Volume 6, Number 2; Environmental Health Perspectives, Volume 106, Supplement 3, June 1998.

Arsenic: Health Effects, Mechanisms of Action and Research Issues
Hunt Valley, MD
September 22, 1997 – September 24, 1997
Environmental Health Perspectives, Volume 107, Number 7, July 1999.

Current Issues on Chemical Mixtures
Fort Collins, CO
August 11, 1997 – August 13, 1997
Environmental Health Perspectives, Volume 106, Number 6, June 1998.

Fifth International Congress on Toxic Combustion By-Products
Dayton, OH
June 25, 1997 – June 27, 1997
Publication information not available

Bioavailability: The Policy Impact of Emerging Science
Washington, DC
June 11, 1997 – June 11, 1997
Publication information not available

12th Annual Conference on Hazardous Waste Research
Kansas City, MO
May 19, 1997 – May 22, 1997
Proceedings: http://www.engg.ksu.edu/HSRC/Proceedings.html

TCE Symposium 1997
Tucson, AZ
February 28, 1997 – March 01, 1997
Publication information not available

Superfund Basic Research Program: A Decade of Improving Health through Multidisciplinary Research
Chapel Hill, NC
February 23, 1997 – February 26, 1997
Proceedings: *Environmental Health Perspectives*, Volume 106, Supplement 4, August 1998.

First National Research Conference on Children's Environmental Health – "Children's Environmental Health Research, Practice, Prevention and Policy"
Washington, DC
February 21, 1997 – February 23, 1997
Environmental Health Perspectives, Volume 106, Supplement 3, June 1998.

1996

Pacific Basin Conference on Hazardous Waste Research
Kuala Lumpur, Malaysia
November 04, 1996 – November 08, 1996
Proceedings: reference information not available

Modulation of Chemical Toxicity and Risk Assessment
Tucson, AZ
June 09, 1996 – June 12, 1996
Environmental Health Perspectives, Volume 105, Number 8, August 1997.

HSRC/ WERK Joint Conference on the Environment
Albuquerque, NM
May 21, 1996 – May 23, 1996
Proceedings: http://www.engg.ksu.edu/HSRC/hsrc_796.pdf

Environmental Pollution and Child Health: Critical Issues for Central and Eastern Europe
Sosnowiec, Poland
May 05, 1996 – May 09, 1996
Proceedings: *Central European Journal of Public Health*, Volume 5, Number 2:53-96. 1997.

Methodologies for the Detection of Individuals and Populations
Helsinki, Finland
March 17, 1996 – March 22, 1996
Publication information not available

Molecular Biology of Leukemia - Implication for Modeling
San Francisco, CA
February 11, 1996 – February 13, 1996
Publication information not available

Methodological Issues in the Use of Biological Markers of Exposure
Lyon, France
February 01, 1996 – February 01, 1996
Publication information not available

1995

Current Trends in Immunoassays for Residue Analysis
Honolulu, HI
December 17, 1995 – December 22, 1995
Chemical and Engineering News, 74:25-27.

Third International Symposium: Cytochrome P450 Biodiversity
Woods Hole, MA
October 08, 1995 – October 12, 1995
Publication information not available

Multiple Chemical Sensitivity: Controlled Exposure Studies
Princeton, NJ
September 20, 1995 – September 22, 1995
Publication information not available

The Role of the Environment on Parkinson's Disease
Research Triangle Park, NC
September 17, 1995 – September 19, 1995
Environmental Health Perspectives, Volume 104, Number 6, June 1996.

Neurotoxicants and Neurodegenerative Diseases
Port Orchard, WA
June 26, 1995
Publication information not available

International Congress on Hazardous Waste: Impact on Human and Ecological Health
Atlanta, GA
June 05, 1995 – June 08, 1995
Publication information not available

Fourth International Congress on Toxic Combustion Byproducts
Berkeley, CA
June 05, 1995 – June 07, 1995
Publication information not available

Tenth Anniversary Conference on Hazardous Waste Research
Manhattan, KS
May 23, 1995 – May 24, 1995
Proceedings: http://www.engg.ksu.edu/HSRC/Proceedings.html

1995 Pacific Basin Conference on Hazardous Waste
Edmonton, Alberta, Canada
May 09, 1995 – May 13, 1995
Proceedings: reference not available

21st Annual RREL Research Symposium
Cincinnati, OH
April 04, 1995 – April 06, 1995
No publication planned

Eighth International Symposium "Pollutant Responses in Marine Organisms" – PRIMO 8
Asilomar, CA
April 02, 1995 – April 05, 1995
No publication planned

Transfer of (Superfund) Basic Research Results to Waste Site Remediation
Vallejo, CA
March 22, 1995 – March 24, 1995
Publication information not available

1994

Mercury Contamination in Arid and Semiarid Landscapes
Denver, CO
October 30, 1994 – November 03, 1994
Publication information not available

Hazardous Wastes: Policy, Exposures and Remediations
Prague, Czech Republic
October 02, 1994 – October 07, 1994
Publication information not available

1994 International Society for Environmental Epidemiology
Research Triangle Park, NC
September 18, 1994 – September 21, 1994
Publication information not available

Workshop on Health and Hazardous Waste Issues Related to the U.S. – Mexico Border
Tucson, AZ
August 27, 1994 – August 29, 1994
Environmental Health Perspectives, Volume 104, Number 6, June 1996.

Prioritizing Hazardous Air Pollutants: Is There a Scientific Base?
Dedham, MA
July 06, 1994 – July 07, 1994
Publication information not available

9th Annual Conference on Hazardous Waste Remediation
Bozeman, MT
June 08, 1994 – June 10, 1994
Proceedings: *Journal of Hazardous Materials*, 1995.

International Symposium on Metals and Genetics
Toronto, Ontario, Canada
May 24, 1994 – May 27, 1994
Publication information not available

Workshop on the Sustainable Development in Urban Areas of the Americas
Santiago, Chile
April 05, 1994 – April 08, 1994
No publication planned

National Conference on Pediatric Environmental Health
Washington, D.C.
March 16, 1994 – March 18, 1994
Environmental Health Perspectives, Volume 103, Supplement 6, September 1995.

20th Annual RREL Research Symposium
Cincinnati, OH
March 15, 1994 – March 17, 1994
Publication information not available

Risk Assessment in Environmental Carcinogenesis
Whistler, British Columbia
January 17, 1994 – January 22, 1994
Publication information not available

1993

1993 Pacific Basin Conference on Hazardous Waste Research
Honolulu, HI
November 08, 1993 - November 12, 1993
Proceedings: reference not available

Napa Conference on Genetic and Molecular Ecotoxicology
Yountville, CA
October 12, 1993 – October 15, 1993
Environmental Health Perspectives, Volume 102, Number 12, December 1994.

Pediatric Environmental Research Workshop
Research Triangle Park, NC
June 24, 1993 – June 25, 1993
No publication planned

Third International Congress on Toxic Combustion By-Products
Cambridge, MA
June 14, 1993 – June 16, 1993
Publication information not available

International Congress on Human Health Effects of Hazardous Wastes
Atlanta, GA
May 03, 1993 – May 06, 1993
Publication information not available

Biodegradation: Its Role in Reducing Toxicity and Exposure to Environmental Contaminants
Research Triangle Park, NC
April 26, 1993 – April 28, 1993
Environmental Health Perspectives, Volume 103, Supplement 5, June 1995.

Fate, Transport and Interactions of Metals: A Joint US-Mexico Conference
Tucson, AZ
April 14, 1993 – April 16, 1993
Publication information not available

Second International Meeting on the Molecular Mechanisms of Metal Toxicity and Carcinogenicity
Madonna di Campiglio, Italy
January 10, 1993 – January 17, 1993
Environmental Health Perspectives, Volume 102, Supplement 3, September 1994.

1992

Thirty-First Hanford Symposium on Health and the Environment: The Development and Application of Biomarkers to the Study of Human Health Effects
Richland, WA
October 19, 1992 – October 24, 1992
Publication information not available

Anaerobic Dehalogenation and Its Environmental Implications
Athens, GA
August 30, 1992 – September 04, 1992
Publication information not available

Bioaccumulation of Hydrophobic Organic Chemicals by Aquatic Organisms
Leesburg, VA
June 28, 1992 – July 01, 1992
Publication information not available

1992 Pacific Basin Conference on Hazardous Waste Research
Bangkok, Thailand
April 06, 1992 – April 10, 1992
Proceedings: reference not available

1991

Utilizing Bioremediation Technologies: Difficulties and Approaches
Lawrenceville, NJ
July 12, 1991 – July 14, 1991
Publication information not available

Second International Congress on Toxic Combustion By-Products: Formation and Control
Salt Lake City, UT
March 26, 1991 – March 29, 1991
Publication information not available

1990

1990 Pacific Basin Conference on Hazardous Waste Research
Honolulu, HI
November 09, 1990 – November 17, 1990
Proceedings: reference not available

Health Effects of Combustion By-Products
Bethesda, MD
October 23, 1990 – October 24, 1990
Environmental Health Perspectives, Volume 102, Number 1, January 1994.

Assessment of Human Exposure to Chemicals from Superfund Sites
East Lansing, MI
June 05, 1990 – June 06, 1990
Environmental Health Perspectives, Volume 102, Number 1, January 1994.

Biodegradation of Hazardous Wastes
Logan, UT
April 09, 1990 – April 10, 1990
Environmental Health Perspectives, Volume 102, Number 1, January 1994.

Application of Molecular Biomarkers in Epidemiology
Research Triangle Park, NC
February 21, 1990 – February 22, 1990
Environmental Health Perspectives, Volume 102, Number 1, January 1994.

2c. Research Briefs

One of the key, unique ways that the SBRP reaches out to the stakeholder community is by electronically distributing summaries of major ongoing research projects. The monthly *Research Briefs* go out to over 2,100 individuals in 15 countries. Over half of the *Research Brief* subscribers are USEPA employees – many of whom forward the documents to their co-workers. Other subscribers include:

- Government employees in 17 federal agencies and 21 state agencies
- Staff members of the National Academies of Science, Engineering, and Medicine
- Researchers and students at 63 universities
- Environmental professionals at over 60 remediation/engineering firms
- Members of 10 not-for-profit organizations

Recently, we were quite surprised to be contacted by a high school Environmental Science teacher with a request that we add her students to the *Research Brief* distribution list. We are very pleased by the interest expressed by this unexpected and very important audience. A more detailed list of subscribers is included as Attachment A to this document.

The *Research Briefs* have been very well received by USEPA headquarters and regional staff as well as other members of the research community. The following are excerpts from comments we have received from our readers:

"We find the *Research Brief* series so useful that I save and catalog each one as part of the monthly new additions to the California Water Boards' Joint Intranet Technical Library. I put out the new-additions e-mail (which goes to a large fraction of Water Board staff, statewide) at the beginning of the month, after receiving your e-mail."

— Ed Wosika, Assoc. Eng. Geologist; Land Disposal Unit; California State Water Resource Control Board

"I just read your research brief and wanted to commend you for such excellent work!…I think most project managers at USEPA get the *Research Briefs*, but I typically forward the research briefs to friends and other colleagues in and outside USEPA, too. You'd be surprised how many folks want to learn the latest information and take whatever measures they deem appropriate. …Please keep up the good work and know that your findings are spread far and wide. And, thank you for caring about the health and environment in our nation and elsewhere!"

— Shelley Brodie; USEPA; Superfund Remedial Project Manager

"My colleagues and I very much respect the NIEHS people and appreciate all you do."

— Ed Pfau; Senior Scientist; Hull and Associates

RB 83: Removal of Arsenic from Domestic Drinking Water Supplies – "Thank you. This information on arsenic is very timely for issues at my site. Keep up the good work."
— Patty Wittemore; USEPA

"I receive your mails a long time but you don't know nothing about me…I'd like to present myself. My name is Jorge Peñaranda, I'm from Spain. I'm geologist and I work in Brazil in a international consulting company called ERM. I'm doing my best to learn and to study but (I don't know if you know) the consulting work spend to much time, one of the aspects of my learning are your papers. I really appreciate your concern to share this kind of information. Best Regards, Jorge"
— Jorge Peñaranda; Geologist; ERM

"We found your documents on the web and would like to be added to your e-mail list to learn more about environmental issues. We are a small group (Brooklyn NY) that formed to get better facilities at the neighborhood park and has evolved into an environmental group. This park, by drawing us to sewage treatment plant meetings, opened our eyes to a number of environmental and community issues. We are hoping to pass this acquired knowledge on to other park users."
— Laura and Mike Hofmann; Barge Park Pals

We select topics for the *Research Briefs* by (1) reviewing the annual update materials submitted by the grantee universities, which include commentary on significant research progress, and (2) conducting monthly literature searches to locate "hot-off-the-press" publications of interest to our audience.

In two or three pages, the *Research Briefs* summarize the major findings of the research – translating the science into language and format appropriate for diverse audiences; highlighting the particular research relevance to human and environmental health; and providing complete contact information in case the reader has specific questions. As a reference for our readers, we archive each *Research Brief* on the SBRP website at: **http://www-apps.niehs.nih.gov/sbrp/RB2000/RB.cfm**

Example *Research Briefs*, as well as a list of all the *Briefs* produced to date, are included as Attachments B and C, respectively.

2c. Attachment A Research Briefs Subscriber Data

Total distribution (January 2003) = 2,161

United States Government Agencies (17)

Air Force 6	Army 12
Bureau of Indian Affairs 1	Centers for Disease Control and Prevention 9
Defense Logistics Agency 1	Department of Energy 1
Environmental Protection Agency 1,170	Fish and Wildlife Service 9
Los Alamos National Laboratory 4	Lawrence Berkeley National Laboratory 1
Lawrence Livermore National Laboratory 10	Navy 3
National Institute of Environmental Health Sciences 33	National Oceanic & Atmospheric Administration 2
Pacific Northwest National Laboratory 3	Tennessee Valley Authority 1
US Geological Survey 5	

State Agencies (21)

Alaska	Alabama	Arizona	California
Connecticut	Florida	Georgia	Iowa
Kentucky	Massachusetts	Michigan	Minnesota
Missouri	New Jersey	New York	Ohio
Oregon	Texas	Utah	Virginia
Wisconsin			

.Org (10)

American Chemical Society	Battelle Memorial Institute
Children's Environmental Health Network	Institute for Agriculture and Trade Policy
Institute for Global Communications	National Wildlife Federation
Pacific Northwest Research Institute	RTI International
Wadsworth Center – NYS Department of Health	WPI (Waste Policy Institute)

Nations (15)

Australia	Brazil	Canada	Chile
Denmark	France	Hungary	India
Italy	Japan	Netherlands	Russian Federation
Sant Lucia	Sweden	USA	

Universities (63)

Albany
Auburn University
Boston University
Cal Poly University
Colorado School of Mines
Colorado State University
Columbia University
Cornell University
City University of New York
Dartmouth College
Duke University
Emory University
Fox Chase Cancer Center
Georgetown University
Georgia Tech University
Harvard University
Johns Hopkins University
Kent Law School
Michigan State University
Massachusetts Institute of Technology
Mount Sinai School of Medicine
Middle Tennessee State University
National Academies of Science, Engineering, & Medicine
New Jersey Institute of Technology
New York University
Oklahoma State University
Oregon Health & Science University
Oregon State University
Oswego University
Penn State University
Purdue University
Queens College
Research and Education Institute
Rensselaer Polytechnic Institute
Rutgers University
Scripps University
San Diego Supercomputer Center
Stanford University
Syracuse University
Texas Tech
Tulane University
University of Maryland
University of Michigan
University of South Carolina
University of Wisconsin
University of Arkansas for Medical Sciences
University of California – Berkeley
University of California – Davis
University of California – San Diego
University of Illinois at Chicago
University of Illinois at Urbana-Champaign
University of North Carolina – Chapel Hill
University Arizona
University of Cincinnati
University of Florida
University of Kentucky
University of Nevada, Las Vegas
University of Nevada, Reno
University of North Texas
Universidad de Puerto Rico
University of Tennessee, Knoxville
Woods Hole Oceanographic Institute
Wright State University

2c. Attachment B Sample Research Briefs

Research Brief 97:
The Harvard-Mexico Project on Maternal-Fetal Lead Exposure, Risks, and Prevention
January, 2003

Despite years of regulatory efforts and attention from public health authorities, lead remains a toxin of great concern. It is widespread in our nation's toxic waste sites, homes, and workplaces, with many opportunities for people to be exposed through water, food, and air. With respect to children, research shows lead has adverse effects on intelligence and other neurobehavioral attributes, even at very modest levels of exposure. Recent research has also demonstrated that these effects are not readily reversible, even with medical treatment, and are accompanied by effects that extend into adulthood, such as an increased risk of hypertension or kidney impairment.

A newly recognized but poorly understood aspect of lead toxicity stems from the fact that lead exposure results in large deposits of lead in bone (i.e., throughout the skeleton). These deposits persist for many years, even after exposure has ceased and blood lead levels have returned to normal. During pregnancy, the physiologic changes that prompt a pregnant woman's bones to resorb (i.e., partially dissolve) in order to provide calcium to the growing fetal skeleton also release the lead stored in bone into a pregnant woman's circulation.

To address questions regarding the potential impact of maternal bone lead on the fetus and lactating infant, Superfund Basic Research investigators led by Howard Hu at the Harvard School of Public Health have partnered with investigators at the National Institute of Public Health in Mexico and created the Harvard-Mexico Project on Maternal-Fetal Lead Exposure, Risks, and Prevention (the "Harvard-Mexico Project"). Mexico City was chosen as the location for this research because its unique environmental lead exposure profile – leaded gasoline was phased out beginning in 1992 – left many women with low blood lead levels but high bone lead levels.

To conduct these studies, the project team developed and validated new analytical techniques, including:

- K-x-ray fluorescence – a non-invasive and rapid method for measuring lead in bone
- A new method for estimating rates of bone resorption
- A new technique for measuring the ultra-low levels of lead that appear in blood plasma

The Harvard-Mexico Project has made a number of critical discoveries. Among these are:

- The bone lead levels of most women of reproductive age are easily measurable and are not low.
- These maternal bone lead levels are a major driving force of lead that appears in blood, plasma, and breast milk (luckily, despite this influence, most breast milk lead levels are low).
- Maternal bone lead levels can be used as biomarkers to predict lower newborn weight, head circumference, and body length.

- Maternal bone lead levels can be used as biomarkers to predict smaller weight gains from birth to one month of age, and lower measures of intelligence at age 2 years. This finding further confirms the importance of addressing lead exposure during pregnancy.
- Women who breast feed continue to have enhanced mobilization of lead from their bones into their blood, making potential lead toxicity an important issue to study in breast-feeding as well as pregnant women.

This SBRP-funded project has demonstrated that lead stores mobilized into the circulation of pregnant women pose a major threat to fetal development. Because bone lead stores, once accumulated, persist for decades, lead exposure can jeopardize the pregnancies of women even if their current lead exposures have subsided.

To address the public health challenge represented by the many thousands of women who have had lead exposure while growing up and who want to have healthy children, the Harvard-Mexico Project investigators have implemented a randomized trial of calcium supplementation as a low-cost strategy for reducing the toxic effects of maternal bone lead. Although the trial is still in progress, preliminary studies provide evidence that calcium supplements reduce bone resorption rates during pregnancy as well as maternal blood lead levels during lactation.

Because there is no known method to reduce bone lead stores, the successful identification of a safe and easily implemented dietary intervention would constitute a major advance in our ability to minimize damage caused by lead. The ultimate significance of these studies will be the optimization of the care of pregnant women who have had exposure to lead, and to minimize risk to their babies.

This research, which won a Progress and Achievement Award from the NIEHS in 1999, is a good example of a productive international research collaboration. Such collaborations will continue to become more important as globalization of industry and science continues to expand.

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To learn more about this research, please refer to:

M. Hernandez-Avila, T. Gonzalez-Cossio. J.E. Hernandez-Avila, I. Romieu, K.E. Peterson, A. Aro, E. Palazuelos, M.L. Kageyama Escobar, and H. Hu. 2003. "Randomized placebo-controlled trial of dietary calcium supplements to lower blood lead levels in lactating women." *Epidemiology* (In Press)

Hu H, Hernandez-Avila M. Dec 15, 2002. "Invited commentary: lead, bones, women, and pregnancy-the poison within?" *American Journal of Epidemiology,* 156(12):1088-1091

Gomaa A, Hu H, Bellinger D, Schwartz J, Tsaih SW, Gonzalez-Cossio T, Schnaas L, Peterson K, Aro A, Hernandez-Avila M. July 2002. "Maternal bone lead as an independent risk factor for fetal neurotoxicity: a prospective study." *Pediatrics*, 110(1 Pt 1):110-118

Tellez-Rojo MM, Hernandez-Avila M, Gonzalez-Cossio T, Romieu I, Aro A, Palazuelos E, Schwartz J, Hu H. March 2002. "Impact of breastfeeding on the mobilization of lead from bone." *American Journal of Epidemiology*, 1;155(5):420-428

Research Brief 95:
Multidisciplinary Studies of the Origins of Childhood Leukemia
November, 2002

The study of childhood leukemia is important because leukemia is the number one cause of cancer morbidity and mortality in children in the United States. The causes for 90% of childhood leukemias are unknown and the environmental and genetic contributions to this disease are not well characterized. In concert with the Northern California Childhood Leukemia Study (NCCL), Drs. Patricia Buffler and Martyn Smith at the University of California–Berkeley and Dr. Joseph Wiemels at the University of California–San Francisco have conducted research examining two critical aspects of the origins of childhood leukemia.

As part of ongoing SBRP-funded research, scientists led by Drs. Smith and Wiemels are using a sophisticated molecular technology to help unravel the origins of the mutations that lead to some childhood leukemias. Leukemia may arise following the abnormal fusion of two genes, which results in production of abnormal proteins. The research team studied leukemias stemming from the fusion of genes known as AML1 and ETO. This fusion, referred to as t(8;21)AML1-ETO translocation, is present in a type of childhood acute myeloid leukemia (AML), the most difficult type of leukemia to treat. The AML1 protein is a "master" regulator of gene activity for blood cell development from stem cells. If the AML1-ETO fusion occurs in just one out of the thousands of stem cells a person is born with, then the stage is set for a second gene mutation to trigger the leukemia, even if the second mutation occurs years later.

The research team examined both diagnostic blood samples and neonatal "heel prick" blood spots from children with AML, two of whom were older than 10 years of age at diagnosis. The scientists detected t(8;21)AML1-ETO in the "heel prick" blood samples for 5 individuals, showing that the translocation must have occurred in utero, providing unambiguous evidence of prenatal origin in these cases and suggesting that exposures of the fetus before birth could be critical in producing childhood leukemia.

The discovery of this "latency period" between the initiating genetic event and full development of leukemia suggests that even some adult leukemia may start in the womb. These results further implicate the fetal period as a distinctly susceptible period for chromosomal translocation, perhaps the usual period for such events among pediatric leukemias.

In addition to the current report of the in utero t(8;21)AML1-ETO translocation in leukemia patients, The research team has confirmed that two other mutations, the MLL and TEL-AML1 translocations, have prenatal origins. Childhood cancers besides leukemia, particularly sarcomas, are commonly associated with translocations. The t(8;21)AML1-ETO translocation biomarker has particular significance in that it is not merely associated with acute myeloid leukemia, but is on the causal pathway of the environmentally-induced cancer and as a result should be a better predictor of increased cancer risk than existing biomarkers.

By studying the similarities in the pregnancies that harbored the initial genetic mutation in this type of leukemia, the SBRP-funded scientists hope to identify the dietary, environmental or other causes for the potentially harmful mutation. As part of the NCCLS, Dr. Buffler and colleagues examined 162 children newly diagnosed with childhood leukemia (age 0-14 years) and 162 matched control subjects randomly selected from the birth registry. Cases and controls were similar with respect to age, gender, race, Hispanicity, maternal education, and maternal age.

This study is unique in that it focuses on residential exposure rather than parental occupational exposure. The research team conducted in-home personal interviews with the primary care givers to collect detailed information on household pesticide usage including the name of each product; intended purpose (such as cockroach control); frequency of use; and time windows of use – 3 months prior to pregnancy, pregnancy, and the first, second, and third years of life.

The results of this study:

- Provide strong support of previous observations indicating that exposure to household pesticides is associated with an increased risk of childhood leukemia.
- Indicate that insecticide exposures early in life appear to be more significant than later exposures, with the highest risk observed for exposure during pregnancy.
- Distinguish between the risks associated with different types of pest control, demonstrating a dose response relationship, and indicating the importance of the timing and location of exposure.
- Show a significant association between the use of professional pest control services with an increased risk of childhood leukemia. The magnitude of this association was larger than what was seen for general insecticide or indoor pesticide exposures.

This information may enable us to educate the public concerning possible risks associated with exposures to pesticides, with particular emphasis on the timing and location of exposure.

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To learn more about this research, please refer to:

Ma, X, PA Buffler, RB Gunier, G Dahl, MT Smith, K Reinier, and P Reynolds. September 2002. "Critical windows of exposure to household pesticides and risk of childhood leukemia." *Environmental Health Perspectives*, 110(9):955-960.

Wiemels, JL, Z Xiao, PA Buffler, AT Maia, BM Dicks, MT Smith, L Zhang, J Feusner, J Weincke, K Pritchard-Jones, J Kempski, and M Greaves. May 15, 2002. "In utero origin of t(8;21)AML1-ETO translocations in childhood acute myeloid leukemia." *Blood*, 99(10): 3801-3804.

Research Brief 87:
Application of Wildlife Biomarker Technologies in Remediation Decision-Making

March, 2002

Wildlife inhabiting chemically contaminated environments can serve as front line indicators of pollutant levels and potential health impacts. Wildlife biomonitoring at Superfund sites provides valuable data to support the design of remediation plans. These data can result in substantial savings of limited remediation resources while maximizing preservation of important natural areas and supporting effective remediation of the site. SBRP-funded researchers have developed biochemical, physiological, histopathological, and behavioral biomarkers in birds and mammals inhabiting contaminated sites to indicate chemical exposure and chemical effects.

As the science of biomarker technology evolves, researchers are finding additional and valuable applications. Researchers at Texas Tech University, a part of the University of Washington Superfund Basic Research Program, are applying biomarker methods developed in SBRP-funded projects to develop health-based exposure and effects data for wildlife. At a Superfund site in Alabama, contaminated with a mixture of DDT/DDE and mercury, they conducted field studies to test the hypothesis that certain biomarker levels are a function of contaminant concentrations. If true, this would allow remediation professionals to predict levels of contaminant residues and effects in resident wildlife populations based on concentrations measured in soil and diet samples.

The scientists conducted their research in a hardwood bottomland floodplain (a seasonal swamp) that is on the National Priority List. The site owners had conducted extensive soil analyses, and the SBRP researchers incorporated these data into a geographic information system (GIS) to develop a geographic distribution of DDT, DDT metabolites and mercury soil contamination. The scientists placed approximately 200 nest boxes throughout the study site. Birds, as indicator species in waste site assessments, can yield significant information on trophic (food chain) transport and toxicity of contaminants for use in remediation decision-making. Cavity nesting species occupy a variety of trophic positions and habitats, and allow direct monitoring of adults and developing young. The SBRP researchers studied prothonatory warblers (Protonotaria citrea), using radiotelemetry to triangulate specific foraging positions and ranges for both male and female adults. The scientists collected diet, egg, and nestling tissue samples and analyzed each for DDT, DDT metabolites, and mercury. These data were then added to the GIS program for comparison with soil contaminant distributions.

The study site has heterogeneous contaminant levels as the result of seasonal flooding and topography modifying the original contaminant deposition areas. The unique design of this project allowed the researchers to control for variables that often confound this type of study. The scientists were able to match foraging areas to specific nesting pairs and use only soil concentration data from the appropriate foraging locations in their analyses of trophic-level transfer of contaminants. The researchers learned that while male and female prothonatory warblers fed at similar rates, the females tended to use larger foraging ranges. They therefore corrected their data to incorporate the feeding areas of both the adult male and female warblers.

The results of this study suggest that residue concentrations in bird tissues can be reasonably predicted from residue concentrations in the soil. The study demonstrated that warblers accumulated renal mercury from their diet at levels that correlated with soil and sediment levels. The researchers also found that soil concentrations of DDT and its metabolites were effective in describing the variation of contaminants in adipose tissues.

The project is an example of the technology transfer process that SBRP strives to promote. Basic experimental methods developed and characterized in the course of SBRP-funded research were successfully deployed in a real world application. The findings of this research were incorporated into ecological risk assessments used in the remedial investigation and the record of decision process prior to the completion of the actual site remediation planning process.

For her critical role in this research and a similar study at the Anaconda Smelter Site in Montana, Ms. Blakely Adair received the 2001 SBRP Karen Wetterhahn Memorial Award which recognizes an outstanding student who studies the environmental or health impacts of metal contamination and best demonstrates the qualities of scientific excellence exhibited by Dr. Wetterhahn. Ms. Adair presented the results of her studies at the 2001 SBRP Annual Meeting.

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To learn more about this research, please refer to:

Reynolds KD, Rainwater TR, Scollon EJ, Sathe SS, Adair BM, Dixon KR, Cobb GP, McMurry ST. December, 2001. "Accumulation of DDT and mercury in prothonotary warblers (Protonotaria citrea) foraging in a heterogeneously contaminated environment." *Environmental Toxicology and Chemistry*. 20(12):2903-2909.

Research Brief 83:
Removal of Arsenic from Domestic Drinking Water Supplies
November, 2001

Arsenic is ubiquitous in the environment and ranks twentieth in abundance among the elements in the earth's crust. Arsenic is released into drinking water supplies by natural processes, such as the weathering of arsenic containing minerals, and through anthropogenic activities, such as mining and application of arsenic containing pesticides. The U.S. Geological Survey (USGS) has analyzed water from nearly 20,000 wells across the United States and determined that in 24% of the counties where data were available, at least 10% of samples had arsenic concentrations exceeding 10 micrograms per liter (µg/L). Refer to http://co.water.usgs.gov/trace/arsenic for additional information.

On October 31, 2001, U.S. Environmental Protection Agency Administrator Christie Todd Whitman announced that the administration will adopt the 10 µg/L Maximum Contaminant Level (MCL) for arsenic in drinking water. This reduction of the MCL for arsenic will likely require additional treatment processes at approximately 5% of U.S. community water supplies. New, more cost effective arsenic removal technologies are needed to achieve the new lower standard. Researchers at the University of Arizona (UAZ) are developing and testing a new low-cost, low-maintenance method to remove arsenic from municipal water supplies or individual well-head units.

The most commonly used method for removing arsenic in water treatment plants involves chemical precipitation using iron salts. This process requires large treatment basins for contacting the iron salts with the water. Therefore, it cannot be easily implemented without large capital expenditures and is impractical for small-scale treatment systems. The UAZ scientists are investigating a simpler and less costly method of removing arsenic via reaction with metallic iron filings.

The new method employs canisters packed with scrap iron filings that serve to filter arsenic from the water. The researchers are investigating the mechanisms controlling the removal process and determining how the removal efficiency depends on the water chemistry. They are also evaluating the long-term performance of the iron filters so that estimates of treatment costs can be made.

In well-oxygenated water and sediments, nearly all arsenic is present in the thermodynamically stable pentavalent state – arsenate or As(V). To date, the UAZ researchers have shown that the removal mechanism involves complex formation of arsenate with iron oxides. They determined that the binding of arsenate with the iron oxides serves as a removal mechanism as the iron oxides do not dissolve in the treated water. Electrochemical experiments have shown that sustained performance of the filings for arsenic removal is dependent on sustained iron corrosion. The electrochemistry studies also showed that the arsenic compounds do not oxidize the iron, but rather decrease its corrosion rate. The UAZ team conducted X-ray absorption spectroscopy (XAS) studies and showed that the iron becomes coated with magnetite and another Fe(II)/Fe(III) iron oxide phase. These mixed valent oxide phases are not passivating (i.e., they do reduce the chemical reactivity of the metal surface) and permit sustained iron corrosion and continuous generation of new sites for As(V) adsorption. The XAS results also showed that was no measurable reduction of As(V) to As(III) (arsenite). This is important because at drinking water pH values, arsenite is not bound as strongly to iron oxides as arsenate.

The UAZ scientists operated column reactors consisting of packed beds of iron filings for more than 1 year of continuous use. These studies validated the long-term performance of the iron media for arsenate removal. For all environmentally relevant concentrations of arsenic (i.e., <5,000 µg/L), the canisters removed arsenate to below the detection limit of 1 µg/L. The researchers determined that the kinetics of the arsenate removal process are sufficiently fast to be employed in both small and large-scale treatment systems using hydraulic residence times less than 1 minute. The research also indicates that freshly formed iron oxides have a greater adsorption capacity per unit mass than aged oxides. Therefore, the advantage of zero-valent iron over other iron oxide media may be that its corrosion continuously generates high specific surface area oxides that are more reactive than aged, crystalline materials.

These studies demonstrate the effectiveness of zero-valent iron filings for removing arsenate from aqueous solutions to levels below 1 µg/L. Canister treatment units packed with zero-valent iron filings are low cost, require no electric power, and require no operational supervision. This technology is therefore well suited for treating contaminated water in the United States as well as in developing nations such as Bangladesh, where arsenic contamination of drinking water is a major health issue. The knowledge gained from this research is essential for evaluating the applicability and limitations of zero-valent iron media for arsenic removal.

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To learn more about this research, please refer to:

J. Farrell, J. Wang, P. O'Day, and M. Conklin. 2001. "Electrochemical and spectroscopic study of arsenate removal from water using zero-valent iron media." *Environmental Science and Technology*, 35(10):2026-2032.

Research Brief 80:
Mechanisms of Chlorpyrifos Developmental Neurotoxicity
August, 2001

Chlorpyrifos is the most commonly used insecticide in the United States – an estimated 20 to 25 million tons are applied annually. The organophosphate pesticide is sold in more than 800 different products, but is most commonly known as Dursban® (home and commercial use) and Lorsban® (agricultural use).

Domestic use accounts for nearly 50% of chlorpyrifos applications. People use it in and around their homes to control termites, lawn insects, ants, cockroaches, fleas, ticks, and mosquitoes. Farmers use chlorpyrifos on more than 50 types of crops including corn, apples, tomatoes, oranges, grapes, cotton, alfalfa, and berries. Chlorpyrifos is so popular in part because its chemical stability and persistence reduce the need for repeated application. However, this persistence also enhances the likelihood of prolonged exposure.

Like all organophosphates, chlorpyrifos kills insects and other animals by impacting the function of the nervous system. Chlorpyrifos inhibits the activity of acetylcholinesterase (AChE), an enzyme which breaks down the neurotransmitter acetylcholine. Without AChE, acetylcholine accumulates. As a result, a nerve that is firing will continue to fire – causing rapid twitching of involuntary muscles, convulsions, paralysis, and ultimately death.

In June, 2000, the USEPA announced restrictions on chlorpyrifos use based on new scientific information indicating that the insecticide is more toxic to infants, children, and pregnant or nursing women than was previously understood. The regulatory modifications will remove chlorpyrifos from retail sale and restrict most residential and professional uses by the end of 2001. However,

because the ban permits existing stocks to be sold to consumers and allows limited use by certified applicators, chlorpyrifos will continue to be used in large quantities. Equally important, its agricultural use will remain for the foreseeable future, and there are increasing problems concerning storage and disposal – chlorpyrifos is included as one of the pesticides designated for problems involving Superfund sites.

Scientists at Duke University are conducting extensive, multidisciplinary research on chlorpyrifos. Their work spans all levels of biological organization – from the cellular and molecular events underlying the toxic mechanisms, through the morphological assembly of the nervous system, to the eventual behavioral outcomes.

To identify the mechanisms by which chlorpyrifos disrupts brain development, the Duke scientists focused on the basic processes controlling cell division and differentiation. The researchers studied several test systems including cell-free systems (fractionated cell extracts that maintain biological function), neuronal cell cultures, and newborn rats treated with apparently subtoxic doses of chlorpyrifos. They identified three different types of effects:

- Interference with the replication of DNA required for cell division.
- Alterations in the expression and function of the specific molecules that control cell development (nuclear transcription factors). Specifically, researchers noted changes in two transcription families that are essential to cell replication and differentiation: AP1 and Sp1.
- The generation of reactive oxygen species, compounds that produce oxidative damage.

These findings are important because they indicate that the mechanisms of chlorpyrifos developmental neurotoxicity are clearly different from its "standard mechanism" of systemic toxicity – the inhibition of cholinesterase.

To identify which types of brain cells are targeted by the pesticide, the Duke scientists compared the effects of chlorpyrifos on neuronal cells, which receive and conduct electrical impulses, and glia cells, which are the supportive tissue of the brain, but which provide important guidance enabling the brain to "wire up" correctly during development. The Duke investigators found that glia cells are more sensitive to chlorpyrifos than neurons. Because glia cells develop much later than neurons, and are specifically involved in allowing neurons to make the proper connections to their targets, these findings indicate that the developing brain is likely to be vulnerable to chlorpyrifos exposure at least through early childhood.

When evaluating neurotoxicity, it is important to determine if adverse effects at the cellular level impact behavioral function. The Duke scientists conducted a series of standard behavioral tests with adolescent and adult rats following neonatal exposure to subtoxic doses of chlorpyrifos. They assessed activity, learning, and memory and noted both immediate and long-term gender-selective behavioral abnormalities, with males showing greater sensitivity to chlorpyrifos exposure in some

tests. Females were not spared however – for some tests, their responses were "masculinized," that is, their behaviors resembled those of males instead of females.

Additionally, the Duke scientists have been successful in designing an invertebrate system for a rapid screening method to evaluate the developmental neurotoxicity of chlorpyrifos and related pesticides. They based the system on the knowledge that the chemicals which facilitate sea urchin nerve cell growth (neurotrophins) are the same compounds that have been identified as the targets of chlorpyrifos neurotoxicity during mammalian development. Therefore, processes that result in biochemical or behavioral effects in mammalian neurodevelopment will result in visible abnormalities in the developing sea urchin. Following exposure to chlorpyrifos, the researchers observed marked abnormalities in the sea urchins, appearing exactly at the developmental stage expected if the neurotrophins were impacted. This work represents a major step towards development of a rapid screening tool that can be used to predict eventual, adverse effects specific to neural development, but that does not require the use of vertebrate animals.

The findings of the Duke University studies represent significant progress towards a more complete understanding of the developmental toxicity of chlorpyrifos, and by implication, of the entire class of organophosphate pesticides. The identification of three mechanisms of chlorpyrifos neurotoxicity that do not involve inhibition of cholinesterase indicates that classic methods used to predict organophosphate-induced toxicity (quantification of cholinesterase inhibition) is inadequate to predict the developmental neurotoxicity of chlorpyrifos. This highlights the importance of examining endpoints other than cholinesterase inhibition to evaluate pesticide toxicity and establish safe exposure levels for pregnant women and children.

The discovery that the period of vulnerability to chlorpyrifos exposure extends into early childhood has important implications, in terms of basic neurotoxicology as well as in regulatory issues. Chlorpyrifos is a semi-volatile compound; it can vaporize and be re-deposited on surfaces in treated rooms for weeks after application. As a result, it may adhere to objects such as children's toys that are brought into the room hours or days after the pesticide is applied. Young children with high frequency mouthing behavior may be at risk of acute exposure to chlorpyrifos residues. This research indicates that apparently non-toxic childhood exposure to pesticides, which can go undetected because of the lack of overt symptoms, may have long-term impacts on behavior, and emphasizes the necessity to conduct long-term evaluations to identify later-emerging behaviors.

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To learn more about this research, please refer to:

Garcia, S.J., F.J. Seidler, T.L. Crumpton, and T.A. Slotkin. 2001. "Does the developmental neurotoxicity of chlorpyrifos involve glial targets? Macromolecule synthesis, adenylyl cyclase signaling, nuclear transcription factors, and formation of reactive oxygen in C6 glioma cells." *Brain Research*. 891:54-68.

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Auman, J.T., F.J. Seidler, and T.A. Slotkin. 2000. "Neonatal chlorpyrifos exposure targets multiple proteins governing the hepatic adenylyl cyclase signaling cascade: implications for neurotoxicity." *Developmental Brain Research*. 121:19-27.

Crumpton, T.L., F.J. Seidler, and T.A. Slotkin. 2000. "Developmental neurotoxicity of chlorpyrifos in vivo and in vitro: effects on nuclear transcription factors involved in cell replication and differentiation." *Brain Research*. 857:87-98.

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Dam, K., F.J. Seidler, and T.A. Slotkin. 2000. "Chlorpyrifos exposure during a critical neonatal period elicits gender-selective deficits in the development of coordination skills and locomotor activity." *Developmental Brain Research*. 121:179-187.

2c. Attachment C SBRP Research Briefs

1 **August 7, 1997**
Denison, University of California – Davis
Bioassay Developed for Detection of Dioxin-Like Chemicals

2 **August 20, 1997**
Pfaender, University of North Carolina – Chapel Hill
Advances Made in Determining Fate and Bioavailability of PAH in Soil

3 **September 3, 1997**
Sinclair, Dartmouth College
Low Levels of Arsenite Found to Decrease Hepatic Cytochrome P450 Activity

4 **September 17, 1997**
Miller, University of Arizona
Use of Microbial Surfactants for Enhanced Removal of Metals from Contaminated Soils

5 **October 1, 1997**
Hu, Harvard School of Public Health
Studies Determine Factors That Contribute to Bone Lead Accumulation and Release

6 **October 15, 1997**
Shiverick, University of Florida
Studies Investigate Effects of TCDD and Benzo(a)pyrene of Placental-Uterine Function

7 **October 29, 1997**
Ozonoff, Boston University
New Methods of Spatial Analysis Are Developed for Environmental Epidemiological Data Using a GIS

8 **November 11, 1997**
Smith, University of California – Berkeley
Possible Explanation for Disease Susceptibility to Benzene Exposure

9 **November 26, 1997**
Bishop, University of Cincinnati
Scientists Investigate the Properties and Structure of Biofilm Treatment Systems

10 **December 10, 1997**
Gierthy, University of Albany – SUNY
Structural Requirements for PCB-Induced Estrogenic Activity

11 **January 7, 1998**
Boyd, Michigan State University; Phillips, Texas A&M University
Advances Made in Developing Organoclays for Use in Hazardous Waste Remediation

12 **January 21, 1998**
Thilly, Massachusetts Institute of Technology
Mutational Fingerprinting to Find Causes of Mutations in Humans

13 **February 10, 1998**
Scrudato, University of Albany – SUNY
Research Points to Need for Reassessment of PCB Volatility

14 **February 18, 1998**
Johnson, University of Arizona
Studies Examine Cardiac Teratogenicity of a Common Drinking Water Contaminant

15 **March 4, 1998**
Lasley, University of California – Davis
Urinary FSH Assay Developed to Assess Reproductive Health of Both Men and Women

16 **March 18, 1998**
Gordon, University of Washington
The Use of Poplar Trees to Remediate Chlorinated Organic Contaminants

17 **April 1, 1998**
Korrick, Harvard School of Public Health
In Utero PCB Exposures and Infant Development

18 **April 15, 1998**
Simpson/Bopp, Mount Sinai School of Medicine
Characterization of New York City Contaminants

19 **April 29, 1998**
Hooper, University of Washington
The Use of Wildlife Biomonitoring at Hazardous Waste Sites

20 **May 13, 1998**
Christakos, University of North Carolina – Chapel Hill
The Use of Space/Time Analysis for Improved Exposure Assessment

21 **May 27, 1998**
Hahn, Boston University
Mechanisms of Dioxin Sensitivity

22 **June 10, 1998**
Gandolfi/Fernando, University of Arizona
The Role of Bacterial Gene Transfer in Cleaning Up Metal and Organic Contaminated Soils

23 **June 24, 1998**
Folt, Dartmouth College
Bioaccumulation and Biomagnification of Metals in Lakes

24 **July 8, 1998**
Scrudato, University of Albany – SUNY
New Oxidative Technology Shows Promise for Treating Organic Chemical Contaminants in Groundwater

25 **July 22, 1998**
Stacpoole, University of Florida
Comparative Metabolism Studies of Dichloroacetate

26 **August 5, 1998**
Warshawsky, University of Cincinnati
Microbial Degradation of Polycyclic Aromatic Hydrocarbon Mixtures

27 **August 19, 1998**
Beaty, Colorado State University
Identification of Metal Responsive Genes in Aquatic Arthropods

28 September 2, 1998
Spink, University of Albany – SUNY
The Alteration of Estrogen Metabolism by PCBs

29 September 16, 1998
Bopp, Mount Sinai School of Medicine
The Persistence of Polychlorinated Biphenyls in Hudson River Sediments

30 September 30, 1998
Hamilton, Dartmouth College
Understanding the Molecular Basis for Metal-Induced Cancers

31 October 14, 1998
Criddle, Michigan State University
In Situ Bioremediation of Groundwater Contaminated With Carbon Tetrachloride

32 October 28, 1998
Nepf, Massachusetts Institute of Technology
Understanding the Physical Processes Involved in Metal Transport in the Upper Mystic Lake

33 November 11, 1998
Alexander, Cornell University
The Effect of Contaminant Aging in Soils on Bioavailability

34 November 25, 1998
Aposhian, University of Arizona
Advanced Analytical Technique Developed for Detecting Metals in Biological and Environmental Samples

35 December 9, 1998
Grandjean, Boston University
Organochlorine Exposure and Breast Cancer Risk

36 December 23, 1998
Donnelly, Texas A&M Univerity
Improving the Health Risk Assessment of Chemical Mixtures

37 January 13, 1999
Koshland, University of California – Berkeley
Promising Developments are Made in the Real-Time Analysis of Combustion Emissions

38 January 27, 1999
Kelsey, Harvard School of Public Health
Genetic Susceptibility to Lead Toxicity

39 February 10, 1999
Waxman, Boston University
Tracking Down the Mechanisms of Trichloroethylene-Induced Toxicity

40 February 24, 1999
Hinton, University of California – Davis
The Effects of Organophosphates on the Developing Eye

41 March 10, 1999
Clements, Colorado State University
Molecular, Population, and Community Responses of Aquatic Insects to Heavy Metal Contamination

42 March 24, 1999
Ganey, Michigan State University
Mechanisms and Consequences of Neutrophil Activation by Polychlorinated Biphenyls

43 April 7, 1999
Hemond, Massachusetts Institute of Technology
Fate and Transport of Metals in the Aberjona Watershed

44 April 21, 1999
Dixon, University of Cincinnati
Studies Examine the Mechanisms of Chromium Mutagenesis

45 May 5, 1999
Lion/Ghiorse, Cornell University
Improving the Understanding of Contaminant Bioavailability in Soils

46 May 19, 1999
Swenberg, University of North Carolina – Chapel Hill
Improving Health Risk Assessment Through Mechanistic Research

47 June 2, 1999
Abriola, Michigan State University
Investigating the Mass Transfer and Persistence of Nonaqueous Phase Liquids in the Subsurface Environment

48 June 16, 1999
Godleski, Harvard School of Public Health
Mechanisms of Vanadium Toxicity in the Respiratory System

49 June 30, 1999
Carpenter, University of Albany – SUNY
Exploring the Mechanisms of Neurotoxicity Caused by Exposure to Polychlorinated Biphenyls

50 July 14, 1999
James, University of Florida
Bioavailability of Chlorinated Hydrocarbons in the Diet

51 July 28, 1999
Aposhian, University of Arizona
Diversity of Inorganic Arsenic Metabolism

52 August 11, 1999
Hennig, University of Kentucky
The Effects of Nutrition on Polychlorinated Biphenyl-Mediated Endothelial Cell Activation – Implications in Atherosclerosis

53 August 25, 1999
Tavlarides, University of Albany – SUNY
Supercritical Fluid Technology for Remediation of PCBs

54 September 8, 1999
Christiani, Harvard School of Public Health
Investigating the Human Health Effects of Vanadium – Recent Studies Show Significant Acute Respiratory Effects in Occupationally-Exposed Workers, Even at Permissible Exposure Limits

55 **September 22, 1999**
Hammock, University of California – Davis
Potent Inhibitors are Discovered for Soluble Epoxide Hydrolases, Enzymes That Have an Important Role in the Metabolism of Environmental Contaminants

56 **October 6, 1999**
Arnold, University of Arizona
Electrolytic Strategies for Remediation of Chlorinated Solvents in Groundwater

57 **October 20, 1999**
Eskenazi, University of California – Berkeley
Development of Biomarkers for Male Reproductive Toxicity and Their Implications for Male-Mediated Developmental Toxicity

58 **November 11, 1999**
Barchowsky, Dartmouth College
Investigating the Mechanisms Underlying Arsenic-Induced Vascular Disease

59 **November 17, 1999**
Ozonoff, Boston University
New Mapping Method is Developed for Analysis of Environmental Epidemiological Data

60 **December 1, 1999**
Malins, University of Washington
The Development of DNA Biomarkers for Ecological Risk Assessment

61 **December 15, 1999**
Miller, University of North Carolina – Chapel Hill
Developing Methods for the Remediation of Dense Nonaqueous Phase Liquids

62 **January 5, 2000**
Loch-Caruso, Michigan State University
Understanding the Effects of Polychlorinated Biphenyls on the Uterus

63 **February 2, 2000**
G. Callard, Boston University
Stage-specific Actions of Cadmium During Spermatogenesis

64 **March 5, 2000**
Ford, Harvard School of Public Health
The Use of Bacterial Diversity as a Biomarker for Ecological Health Assessment

65 **April 5, 2000**
Kalman, University of Washington
Toxicokinetics of Volatile Organic Compounds

66 **May 3, 2000**
Folt, Dartmouth College
Development of a Biomarker to Detect Arsenic in Aquatic Ecosystems

67 **June 7, 2000**
Denison, University of California – Davis
Optimization of the CALUX Bioassay for Use in Detecting Dioxin and Related Chemicals in Serum

68 July 12, 2000
Conklin, University of Arizona
Investigating the Transport of Heavy Metals in a Polluted Aquifer

69 September 6, 2000
Ferguson, University of Washington
Anaerobic Transformations and Bioremediation of Chlorinated Solvents

70 October 4, 2000
Bishop, University of Cincinnati
Distribution of Microorganisms in Biofilms Surrounding Soil Particles

71 November 1, 2000
Schell, University of Albany – SUNY
A Partnership Study of the Effects of PCBs on Akwesasne Mohawk Youth

72 December 6, 2000
Strupp, Cornell University
An Investigation of the Behavioral Toxicity of Lead

73 January 3, 2001
Shan, University of Cincinnati
Plant Root Exudates Facilitate Phytoremediation

74 February 7, 2001
Masten, Michigan State University
In-situ Ozonation of PAHs - Feasibility, Pathways, and By-Product Identification

75 March 7, 2001
Brusseau, University of Arizona
An Advanced Characterization Study of a Chlorinated Solvent Contaminated Aquifer

76 April 4, 2001
Karagas, Dartmouth College
Epidemiology of Arsenic

77 May 2, 2001
Reardon, Colorado State University
Modeling the Biodegradation of Contaminant Mixtures

78 June 6, 2001
Hei, Columbia University
Role of Oxyradicals in Genotoxicity of Arsenic

79 July 3, 2001
Daunert, University of Kentucky
A Cellular Biosensor to Detect Chlorocatechol

80 August 1, 2001
Slotkin, Duke University
Mechanisms of Chlorpyrifos Developmental Neurotoxicity

81 September 5, 2001
G. Callard, Boston University
Developmental Neurotoxicity of Xenoestrogens in Zebrafish

82 October 3, 2001
Tiedje, Michigan State University
Microbial Degradation of PCBs

83 November 7, 2001
Farrell, University of Arizona
Removal of Arsenic from Domestic Drinking Water

84 December 5, 2001
Denslow, University of Florida
Molecular Mechanisms of Endocrine Disruption

85 January 2, 2002
Miller, University of North Carolina – Chapel Hill
Remediation of DNAPL-Contaminated Subsurfaces

86 February 6, 2002
Rappaport, University of North Carolina – Chapel Hill
Development of a Biomarker of Exposure to Benzene

87 March 6, 2002
Hooper, University of Washington
Application of Wildlife Biomarker Technologies in Remediation Decision-Making

88 April 3, 2002
Ganey, Michigan State University
Investigating Tools to Improve Risk Assessment for PCB-Induced Immune Dysfunction

89 May 1, 2002
Folt, Dartmouth College
Clues to Methylmercury Levels in Freshwater Fish

90 June 5, 2002
Kennedy, University of California – Davis
The Impact of Chlorine on Hexavalent Chromium Emissions

91 July 3, 2002
Tebo, University of California – San Diego
The Role of Bacteria in Bioremediation of Metals

92 August 7, 2002
Sabri/Spencer, Oregon Health & Science University
Biomarkers of Neurotoxicant Exposure and Neurodegeneration

93 September 4, 2002
Alvarez-Cohen, University of California – Berkeley
Monitoring In Situ Bioremediation of TCE

94 October 2, 2002
Karin, University of California – San Diego
Anthrax Invades and Evades the Immune System to Cause Widespread Infection

95 November 6, 2002
Buffler/Smith, University of California – Berkeley
Multidisciplinary Studies of the Origins of Childhood Leukemia

96 December 4, 2002
Swenberg, University of North Carolina – Chapel Hill
DNA Adducts as Biomarkers of Exposure and Effect

97 January 2, 2003
Hu, Harvard School of Public Health
The Harvard-Mexico Project on Maternal-Fetal Lead Exposure, Risks, and Prevention

2d. RISKeLearning Series

Communication of important findings and results is a critical component of scientific research. However, we recognize that publications and seminars, which are traditional approaches for communicating scientific advances, do not reach all of our potential audiences. The Internet, on the other hand, offers exciting opportunities to transfer research advances to interested parties and to communicate with our targeted audiences. To take advantage of this powerful communication technology, the SBRP – in collaboration with the USEPA Office of Solid Waste and Emergency Response's (OSWER) Office of Technology Innovation (TIO) and Office of Emergency and Remedial Response (OERR) – initiated a series of web-based seminars. These are live, two-hour events hosted on the Hazardous Waste Clean-Up Information (CLU-IN) website (**http://clu-in.org**). Each seminar consists of a brief introduction followed by two presentations by NIEHS and/or USEPA scientists. Question and answer periods follow each presentation to promote audience interaction with the presenter. This innovative format for delivering information on SBRP-funded research results was titled *RISKeLearning*.

The target audience for this interactive seminar format is USEPA risk assessors and regional project managers, state and local regulatory agencies, environmental engineering/consulting firms, and academia. Each seminar is publicized to a variety of potential participants via USEPA's *TechDirect* newsletter (15,000+ subscribers) and other email distribution lists that target specific audiences such as students at grantee institutions. After each event, feedback is solicited from participants regarding the current seminar as well as suggested future topics.

The Fall 2002 *RISKeLearning* series focused on SBRP research on PCBs. Topics included bioremediation technologies, congener analysis, biosensors, and neurodevelopmental and reproductive effects of PCB exposure. Each event is archived for future reference at the following web page, **http://www-apps.niehs.nih.gov/sbrp/risk_elearning/** The archives from each event include seminar abstracts, presenter biographies, PowerPoint presentations, and links to additional resources. Individual seminar participation ranged from approximately 150 to 400 – stretching the capacity of both the Internet streaming audio and the audio conference calling systems.

Overall, participants were from 44 states and 9 countries and represented the following organizations:

- USEPA and other federal agencies
- State and local governments
- DOD/DOE
- Consulting/engineering firms
- Universities
- Site owners
- Community stakeholders
- Technology vendors

Not only was each of the PCB seminars well attended, but the participants were very engaged. Audience members asked well-informed, pertinent questions of each speaker – resulting in in-depth, relevant discussions between the speakers and the audience. Comments received from participants were generally positive:

- **92** % said the presenters were knowledgeable of the subject matter
- **92** % said they would recommend this seminar to other environmental professionals
- **89** % said they could easily follow the instructor's slides
- **73** % said they learned a great deal from the presentations

Plans are being made for the 2nd series for the Spring/Summer of 2003 to focus on metals. The abstracts for each event in the Fall 2002 *RISKeLearning Series* are included as Attachment A.

2d. Attachment A Fall 2002 RISKeLearning Seminar Abstracts

PCBs – Remediation (10/9/02)
Dr. Jim Tiedje, Michigan State University
Dr. Richard Bopp, Rensselaer Polytechnic Institute (in collaboration with Mount Sinai School of Medicine SBRP)

This seminar, sponsored by the SBRP and the USEPA Office of Technology Innovation, was designed to introduce USEPA risk assessors and others to recent research findings regarding remediation issues for PCBs at Superfund sites. PCBs are chemically and thermally stable, and complex PCB mixtures generally are resistant to biodegradation. The USEPA has clear evidence that PCBs have significant toxic effects in animals, including effects on the immune system, the reproductive system, the nervous system, and the endocrine system. These chemicals pose a special risk to the health of children. Bioremediation strategies for PCBs are often only partially successful, and may leave toxic intermediates that present similar health hazards as the original compounds. The latest advances in PCB bioremediation research presented by Dr. Jim Tiedje, of Michigan State University, involve genome sequencing and other genomic tools to evaluate the consequences of pollutant exposure on the overall bacterial community genome. The health of this community is critical for effective bioremediation of PCBs to a biologically acceptable form for consumption within the global carbon cycle. In addition, Dr. Richard Bopp, of the Rensselaer Polytechnic Institute, examined the lessons learned from PCBs found in dated sediment cores taken from the Hudson River in New York and New Jersey. Cores from depositional areas have been used to determine the history of PCB contamination, the progress of in situ dechlorination of PCBs, the extent of influence of the General Electric PCB inputs to the upper Hudson, and the relative importance of other PCB sources.

PCBs – Detection and Monitoring (11/13/02)
Andy Beliveau, USEPA Office of Environmental Measurements and Evaluation
Sylvia Daunert, University of Kentucky

"PCBs – Detection and Monitoring" examined the limitations of Aroclor (commercial PCB mixture) analysis and why congener analysis provides for better decision-making with regards to human health and ecological risks of exposure to PCBs. Andy Beliveau, of the USEPA's Office of Environmental Measurements and Evaluation, focused on how congener analysis can be used to detect total PCBs, WHO congeners, as well as environmentally modified PCBs. The pros and cons of each type of congener analysis will be discussed as well as the costs. The major uses of each type of analysis will be put in a historical framework, as well as presenting the state-of-the-art current applications. In addition to the discussion of congener analysis, Dr. Sylvia Daunert, of the University

of Kentucky SBRP, presented her team's current work on development of genetically engineered cell-based biosensing systems. Both PCBs and their breakdown products have been shown to have significant effects on human health. The researchers are developing optical sensing systems for the detection of PCBs and their breakdown products found in hazardous waste sites. Current work includes the development of biosensing systems for chlorocatechols, which are toxic intermediates often produced by the breakdown of PCBs.

PCBs – Health Effects (12/4/02)
Susan Korrick, Harvard School of Public Health
Rita Loch Caruso, University of Michigan (in collaboration with the Michigan State University SBRP)

Health Effects is the last in a series of three seminars examining current research on PCBs sponsored by USEPA and the NIEHS. PCBs were used widely for many years in various commercial applications, and due to improper disposal practices and environmental persistence, PCBs are common environmental contaminants found in many designated Superfund sites. This event highlighted the cutting edge research being conducted by NIEHS scientists into the non-cancer endpoints of exposure to PCBs. Recognition of PCBs and related compounds as potential human neurodevelopmental toxicants was largely a consequence of two mass poisonings in Japan (1968) and Taiwan (1979). Dr. Susan Korrick, of Harvard School of Public Health, reviewed findings from the population-based epidemiologic studies for which prenatal PCB exposure measures are available. The particular emphasis was on findings related to growth and neurocognitive development in infancy and later childhood. Additionally, Dr. Rita Loch Caruso, of the University of Michigan, discussed her findings that acute in vitro exposures to commercial PCB mixtures and microbially dechlorinated commercial PCB mixtures increase the frequency of spontaneous contractions of uteri from pregnant rats. Increased uterine stimulation was observed with PCB mixtures containing increased abundance of lesser-chlorinated, ortho-substituted congeners. By showing that PCBs stimulate uterine contraction in vitro, these studies provide a biologically plausible mechanism by which PCB exposures could decrease gestation length.

2e. SBRP's Distinguished Lecturer Seminar Series

The *SBRP Inaugural Distinguished Lecturer Seminar Series* began in May 2002 to highlight cutting edge science being conducted by Program investigators. This seminar series was developed primarily as an "inreach" program. The SBRP encourages students and scientists of all disciplines within NIEHS to attend the seminars and meet with the lecturers; however, we also invite the local scientific community. Plans are currently being made for the 2003 series.

The following is a list of the 2002 Distinguished Lecturers:

Structure, Catalytic Mechanism and Role of Epoxide Hydrolase in Vascular Disease
Dr. Bruce Hammock
Professor of Entomology and Cancer Research Center
University of California, Davis
Friday, May 24, 2002

Investigating the Risks of Skin and Bladder Cancer at Environmental Levels of Arsenic Exposure in New Hampshire
Dr. Margaret R. Karagas
Professor of Community and Family Medicine
Section Chief of Biostatistics and Epidemiology
Dartmouth Medical School
Friday, June 14, 2002

Zebrafish as a Model: Tales of Two Pathways
Dr. Elwood Linney
Professor of Molecular Genetics and Microbiology
Environmental Sciences and Policy Division
Nicholas School of the Environment and Earth Sciences
Duke University
Thursday, October 31, 2002

IKK and NF-kB: Master Regulators of Stress Responses, Innate and Adaptive Immunity
Dr. Michael Karin
Professor of Pharmacology
Department of Pharmacology
University of California, San Diego
Monday, November 18, 2002

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2f. Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) Initiative

The SBRP has been very successful in developing innovative remediation technologies through the support of basic science. For example, SBRP-funded researchers have developed:

- Bioremediation strategies based on the use of naturally occurring and engineered microbes to reduce or eliminate the toxicity of hazardous substances
- Phytoremediation strategies to remove volatile organics and metals from aquifers and sediments
- Physical/chemical methods such as novel sorbents, supercritical fluid technologies, and electrochemical methods to reduce the burden of exposure to hazardous substances

The SBRP recognizes that additional mechanisms are needed to ensure that the findings and technologies that come out of basic research are further developed, field tested, and applied to real world situations. As a consequence of the direct appropriation of the SBRP budget to NIEHS, recently we incorporated the NIH Small Business Innovation Research/Small Business Technology Transfer Research (SBIR/STTR) granting mechanism as a new component to the Program. The SBIR/STTR program is mandated by Congress, and federal agencies are required to set aside a certain percentage of their extramural research budgets for grants to small businesses. We will continue to utilize this mechanism in support of SBRP goals.

The SBRP considers the SBIR/STTR an ideal mechanism for fostering the commercialization of technologies, products and devices developed in basic research settings and for stimulating the development of innovative remediation products to clean up hazardous substances commonly found at Superfund sites. The first SBIR/STTR initiative undertaken by the SBRP identified the following focus areas:

- The development and validation of newer and cheaper approaches to remove hazardous substances from environmental media such as soil, sediment and aquifers
- The development and validation of monitoring strategies to assess the amount and extent of contaminants at a site or monitor the effectiveness of a remediation technology in both the short and the long term

As a result of this initiative in the fall of 2002, SBRP awarded 12 grants totaling $1.9 million to support product development of innovative treatment technologies, novel monitoring and measurement devices, and refinement of treatment technologies that are currently under development. Four of the grants awarded represent partnerships between our existing SBRP grantees and small businesses. These awards demonstrate the successful progression from basic research to application. A listing of these four recipients and brief summaries of all 12 SBRP SBIR/STTR projects are included as Attachment A.

2f. Attachment A Overview of SBRP SBIR/STTR Projects

Partnerships between existing SBRP Grantees and Small Businesses

- **AquaGene, Inc.**
  Arrays to Measure Endocrine Disruption in Fish
- **Emerging Concepts, Inc.**
  Microelectrodes for Environmental Monitoring
- **ADA Technologies**
  Sorbents for Removal of Arsenic and Heavy Metals
- **Chatham Research, Ltd.**
  Anaerobic Mobilization Technology for Remediation of Low Availability Hydrophobic Contaminanats

Future SBIR/STTR initiatives will be developed as required to generate commercial opportunities in other areas of research that are important to the goals of the SBRP.

Brief Descriptions of each SBRP SBIR/STTR Project

ECOCHEM Research, Inc.
Trichloroethylene Bait-and-Switch Immunoassay
Program Director: Robert Eric Carlson, Ph.D.

Halogenated solvents are a significant source of contamination at Superfund sites. Among the most important of these solvents is trichloroethylene (TCE).

TCE is a commodity solvent, with reported production levels in the United States alone as high as 300,000 tons per year. The pharmacology and toxicology of TCE have been extensively studied: it is a carcinogen, a hepatic toxin, and a ubiquitous environmental contaminant.

The primary sources of human exposure to TCE are in the workplace and through contaminated soil, sediment and groundwater, especially near contaminated waste sites. Currently available methods for TCE determination are typically based on Gas Chromatographic analysis. These methods require dedicated instrumentation and are not readily adapted to field or quick response applications. Enzyme ImmunoAssay, in comparison, has repeatedly been demonstrated to have significant advantages over instrument-based methods in terms of simplicity, speed, and cost for field, high throughput and/or worksite monitoring.

The immediate goal of this research project is the commercial development of a TCE Bait-and-Switch Immunoassay which will be used for hazardous waste site monitoring and will serve as the prototype for subsequent development of Bait-and-Switch strategy immunoassays for the halogenated solvent class of environmental contaminants.

AquaGene, Inc.
http://www.aquagene.com/
Arrays to Measure Endocrine Disruption in Fish
Program Director: Patrick M. Larkin

Endocrine disruption refers to the disruption of normal endocrine systems by exposure to environmental chemicals that mimic hormones, or alter the synthesis, metabolism, and activity of hormones. Widespread public concern about chemicals in the environment that may act as endocrine disruptors had mandated a concerted effort to monitor the cleanup of Superfund sites contaminated with endocrine disrupting compounds (EDCs) and to determine the extent of exposure and the physiological consequences in fish.

Given the profound environmental impact and direct and derivative human health consequences caused by EDCs, the US Government has mandated the USEPA to develop assay systems for more than 70,000 chemicals, including EDCs. Currently, there is no single commercial test for these compounds that is reliable and robust for these chemicals. The screening assays that are currently commercially available either fail to report accurately on the physiological outcomes of exposures, or are expensive and too lengthy to be employed routinely as monitoring tools.

The goal of this project is to develop an array that is responsive to several EDCs in largemouth bass, a fish that is a sensitive indicator of endocrine disruption. Researchers plan to define gene expression fingerprints specific to these EDCs and use them to monitor the presence or disappearance (indicating successful cleanup) of endocrine modulating chemicals at a specific Superfund site, namely Lake Apopka and its surrounding muck farms.

More broadly, researchers on this project are working to develop an array technology to identify and monitor bio-available EDC levels, initially in Superfund sites and ultimately as a standard testing system for research and commercial systems that use compounds that can disrupt the endocrine systems. This array technology will be applied in an effort to provide an assay that is relatively easy to perform, requires only short exposure times and portrays accurately the events that happen at the molecular level. An assay system that can monitor the impact of many of these EDC compounds is also appropriate to the problem the USEPA is trying to solve, since hundreds of thousands of genes can be spotted onto a single chip. The array fabrication process can be automated, which may allow for mass production at a reasonable price. Researchers also believe the assay system can be extended to other fish species relatively easily, extending its commercial and environmental value.

Chatham Research Ltd.

Anaerobic Mobilization Technology for Remediation of Low Availability Hydrophobic Organic Contaminants

Program Director: Frederic K. Pfaender

A major contaminant at over 8,000 sites in the United States are polynuclear aromatic hydrocarbons (PAHs) - a class of organic compounds containing two or more fused aromatic rings of carbon and hydrogen atoms. Many of these compounds are both toxic and carcinogenic. This contamination results from almost all combustion processes, the creosote treatment of wood, and the use of organic pesticides, among others. It has been observed that these highly hydrophobic compounds bind tightly to soil by a number of possible interactions between the soil mineral matrix, the organic fraction of soil, and the compounds. Microbes in the soil appear to mediate these processes in some circumstances. Most of the PAHs are biodegraded by microorganisms, at least partially, but data suggests that a major fraction of the compound associated with the soil is not biologically available to be toxic or to be biodegraded by microorganisms, thereby impeding cleanup of the many PAH contaminated sites.

Research conducted by the grantee has revealed that the incubation of soil in microcosms under anaerobic conditions leads to a change in the soil organic matter such that the PAHs previously unavailable are made available to microbes capable of degrading the compound. This microbially based process may also have the potential to mobilize other hydrophobic chemicals from the soil.

This project seeks to expand these findings by testing soils with a variety of properties to determine how broadly applicable the technology may be for site remediation. Further, it will examine a number of approaches for efficiently and cheaply establishing highly reducing conditions in soil so the PAH will be released. Finally, the project will develop and test several potential methods for biodegrading the released PAH.

A subsequent phase of this project will involve conducting a field test of the method at an actual PAH site.

ADA Technologies, Inc.

http://www.adatech.com/

Sorbents for Removal of Arsenic and Heavy Metals

Program Director: John Stanley Lovell

In January of 2001, the USEPA adopted a new national standard for maximum arsenic content in drinking water of 10 parts per billion (ppb). This replaced the old standard of 50 ppb and became effective in February of 2002. Systems must comply with this new standard by January 23, 2006. In response to the adoption of the 10 ppb standard, ADA Technologies proposes to develop and

commercialize a novel, low-cost sorbent for the removal of arsenic and other heavy metals from drinking water.

The sorbent will combine novel technology from ADA to chemically amend a substrate clay material to increase its capacity for arsenic with emerging technology from Texas A&M University to bind the clay to sand or other materials that increase the porosity of the sorbent and allow its use in water treatment. Preliminary tests conducted by ADA have shown that this new class of sorbents has extremely high arsenic adsorption capacities, and is capable of reducing the arsenic levels in drinking water to less than 10 ppb from starting concentrations as high as 7,000 ppb. Further, they have nearly 60 percent more capacity for arsenic than activated alumina, and are expected to be much cheaper than activated alumina sorbents, costing approximately $.25 per pound compared to $.50 per pound for the alumina material and $.85 per pound for iron modified AA.

In this project, ADA proposes to demonstrate the effectiveness of its new arsenic removal sorbents both in the laboratory and in field tests on actual well water. The ultimate goal is to produce a new class of sorbents that are significantly cheaper to use than the current approaches yet produce waste residuals that are not hazardous, thus being easily disposed.

Lynntech, Inc.
http://www.lynntech.com/index.htm
New Electroosmotic Pulse Process for Phytoremediation
Program Director: Tom D. Rogers

The decontamination of soils and wastes polluted with heavy metals presents one of the most difficult problems for soil cleanup. Recently, a new technology that uses metal-accumulating plants has been explored for its ability to remove, contain, or render harmless various metals from contaminated soil. This new technology – phytoremediation – is an attractive approach for cleanup of soil because it is a low-cost and low-maintenance technology that can be applied for the treatment of a variety of contaminants. However, it also has a distinct limitation. Because the cleanup depth is strictly determined by the length of the plant roots, the application of phytoremediation is limited to surface contamination only.

Another soil remediation technique – electrokinetic soil processing – is an *in situ* technique where the contaminants are mobilized by the application of an electric field between strategically placed electrode wells, resulting in electroosmotic flow in the pore fluid within the soil structure. This technique also has its drawbacks. Treating over an extended period of time results in the formation of chemical species such as protons and hydroxide ions that interfere with the charged surface of the soil, causing flow reversal that severely limits the mobility of the metals and destroys the plants.

In this project, Lynntech aims to demonstrate a new approach to soil remediation and cleanup using a combination of electrokinetics and phytoremediation to concentrate, then bioaccumulate toxic heavy metal contaminants. Lynntech's advanced electrokinetic processes have been proven to mobilize metals through electroosmosis, electromigration and electrophoresis induced transport. Metal contaminants are mobilized into the root ozone where they can be accumulated in the plants as they grow.

The first phase of this project will demonstrate Lynntech's technology in a series of post field test beds before performing a 14-month field demonstration at Fort George Meade, MD. Phase two will utilize information gathered in phase one to perform a full-scale site decontamination study.

Stratum Engineering, Inc.
A Novel Permeable Barrier for Groundwater Bioremediation
Program Director: Fatemeh R. Shirazi

To date, the most common approaches for large-scale in situ biotreatment of contaminated groundwater have been by biostimulation or bioaugmentation processes. Biostimulation relies on external factors to encourage the growth of indigenous microbes. Bioaugmentation relies on the addition of microbes to enhance biodegradation of organic contaminant in groundwater. Experience has found that both of these methods have major disadvantages that limit the potential of these remediation technologies.

Stratum proposes to overcome these disadvantages by using an innovative and cost effective technology called Biological Permeable Barrier, or BPB technology (U.S. Patent No. 09/432,092). This technology uses acclimated microorganisms, encapsulated within a unique polymetric matrix, to degrade contaminants. BPB offers many advantages over today's more commonly used in situ bioremediation treatments, such as protection of viable cells from shock contaminant loads and environmental stresses, increased bacterial mass per unit volume, and a semi-passive treatment. BPB also has the potential for design to co-treat several organic compounds.

This project aims to demonstrate BPB technology to biodegrade TCE, perchlorate, and a mixture of the two non-toxic end-products under field operating conditions. Following appropriate treatability studies in the laboratory, a field pilot study will be designed and installed in the groundwater contaminated zone at the Longhorn Army Ammunition Plant in Karnack, Texas to demonstrate its effectiveness to biodegrade TCE and perchlorate contaminants.

OPOTEK, Inc.

A Real-Time System for Volatile Toxin Measurements

Program Director: Eli Margalith

The characterization of hazardous air pollutants (HAPs) plays a crucial role in confronting the unknowns and challenges of hazardous waste sites, including Superfund sites. Some of the more recognized volatile organic compounds most commonly found at Superfund sites include benzene and toluene, as well as polycyclic and halogenated aromatic hydrocarbons (PAHs/HAHs).

A major pathway for volatile HAPs released from Superfund sites is through the air. As direct vapors or as adsorbents on particles, these can be inhaled by humans, causing both short and long-term adverse health effects. Current methods for detection of these compounds are rather expensive and slow.

In response to the need for a novel monitoring and measurement device, OPOTEK proposes to develop a field-ready system for real-time concentration measurements of vapors from volatile hazardous compounds over contaminated sites. To do so, OPOTEK will couple its compact tunable UV laser system with a compact jet-REMPI time-of-flight mass spectrometer technique. The current Jet-REMPI measurement system, developed and tested by SRI International, has already proven a powerful technique for measuring a variety of hazardous air pollutants with excellent sensitivity and chemical specificity in the laboratory.

Specifically, this project will test the current performance of the Jet-REMPI technique using a smaller, field-ready package to compare the effect of the reduction in mass and spectral resolution in the compact system on sensitivity and selectivity performance when compared to the current laboratory-based system. The compact system will also be tested on a number of additional chemicals on the ATSDR list.

CHA Corporation

Microwave Technology for Superfund Site Remediation

Program Director: Chang Yul Cha

The dual extraction method, commonly applied in hazardous site remediation, uses a vacuum sweep, air stripping and catalytic oxidation. Catalytic oxidation, however, not only requires a significant amount of supplemental fuel but also produces secondary air pollutants including nitrogen oxides and dioxins. As a result, this method may not be acceptable to the public as an appropriate technology used to cleanup hazardous substances at Superfund sites. The need exists for an innovative technology that will recover chemicals in soil vapors and in the air from the air stripper without using the catalytic oxidizer.

CHA Corporation proposes considering a microwave energy solution, which can be used to desorb organic contaminants from granular activated carbon (GAC). The CHA Corporation has focused on the use of microwaves to induce or enhance chemical reactions for the past ten years, and has developed a microwave-based air purification technology that can be effectively used to recover chemicals from soil vapors produced during hazardous site remediation without using a catalytic oxidizer.

The first phase of this project will focus on the design, construction, and testing of a field-ready prototype microwave treatment system in the laboratory. Once this testing has been completed, the prototype system will be brought to a Superfund site for a field demonstration. The results of this demonstration will be examined to assess the technical and economic feasibility of the technology as a cost-effective method for recovering chemicals from soil vapors.

Emerging Concepts, Inc.
http://www.emergingconceptsinc.com/
Microelectrodes for Environmental Monitoring
Program Director: Lauri Ann Olivier

Remediation of Superfund and other hazardous waste sites, particularly those using bioremediation techniques, requires the use of monitoring procedures to ensure that environmental conditions required for bioremediation of specific toxicants are present, and to verify that pollutant removal is occurring. In most cases, microscale in situ measurement of various constituents in aqueous and soil environments is essential for proper monitoring of environmental conditions at a specific location and to determine impacts of environmental stressors. Many of these measurements are currently made using electrodes of various types. Over the past decade, microelectrodes have been developed, but their fragility, susceptibility to electrical interference, and difficulty to manufacture and operate have limited their use to lab settings.

The first phase of this project aims to develop a suite of self-contained microelectrodes that can be used in the environment to monitor a variety of constituents in contaminated soils and sediments. The devices will contain a new type of microelectrode connected to a microelectronic circuit for amplifying, processing, and transmitting microelectrode signals. Procedures for production of an appropriate suite of microelectrodes will be developed, which will initially be for dissolved oxygen (amperometric), pH and ammonium (potentiometric) and ORP (conductimetric). The techniques will then be modified for phase two of the project to make a variety of other microelectrodes that can be used at Superfund sites to monitor the remediation progress, to verify that proper operating conditions are in place, and to ensure that the toxic chemicals are being effectively removed or detoxified.

KSE, Inc.
Novel Catalysts for Photocatalytic AIR Emissions Control
Program Director: James R. Kittrell

The cost to remediate hazardous substances at abandoned or uncontrolled waste sites is estimated at billions of dollars annually over the next several decades. It is therefore imperative that more cost-effective technologies be developed to moderate the societal and monetary cost of these cleanups.

Photocatalysis is an emerging technology that offers the potential of significantly reducing these treatment costs. This new remediation technology treats contaminated effluent air resulting from the application of traditional "pump and treat" or soil vapor extraction operations. However, photocatalysis of contaminants such as chlorinated hydrocarbons can produce phosgene and chloroform byproducts. To capture the full potential of photocatalysis in Superfund site remediation, photocatalysts with improved selectivity are needed.

The overall goal of KSE's project is to perform the research necessary to develop photocatalysts with high activity and high selectivity to oxidation of chlorinated hydrocarbons, without producing significant levels of byproducts. Project research will will include the development of novel photocatalysts and reactor systems for an Adsorption-Integrated-Reaction (AIR) technology capable of adsorbing and concentrating air pollutants, from a dilute air stream, on the surface of a catalytic adsorbent. It is projected that the AIR technology will provide a simple, inexpensive approach for destruction of chlorinated hydrocarbons at high selectivity for Superfund applications.

Dynaflow, Inc.
http://www.dynaflow-inc.com/
Development of Cavitating Liquid Jets for Oxidation Remediation of Contaminated Aquifers
Program Director: Kenneth M. Kalumuck

A wide variety of toxic substances in aquifers at many Superfund sites pose serious problems to the nation's fresh water supply. Contaminated groundwater is a particular threat to the health of those relying on well water. Typically, contamination is present in very large volumes of water at dilute concentrations such that efficient, rapid, and inexpensive processing is critical.

Project researchers at Dynaflow aim to develop a novel process for the removal of organic contaminants from groundwater using jet-induced cavitation. Cavitation produces sonochemically activated reactions in water resulting in the creation of highly effective oxidizing hydroxyl radicals and promotes a wide range of reactions including oxidation of organic compounds. Recent work at the company has demonstrated jet-induced cavitation oxidation of selected aqueous compounds in the laboratory and has achieved two orders of magnitude greater energy efficiency than ultrasonic cavitation devices.

The first phase of this project will investigate the feasibility of oxidizing selected compounds of high priority for groundwater remediation using special cavitating jets. It will also involve a design and scaling study for a practical scale system for groundwater remediation. Subsequent project efforts will expand the number of compounds investigated, refine scaling laws, and address larger and practical scale implementation issues.

Dakota Technologies, Inc.
http://www.dakotatechnologies.com/
Implanted Membranes for Characterization and Monitoring
Program Director: Daniel S. Engebretson

More than 100,000 monitoring wells are installed each year to characterize sites with petroleum, solvent, and methyl tertiary-butyl ether (MTBE) contamination; for long-term and legacy monitoring; and for tracking the progress of remediation, among other uses. These wells are costly to install and develop. Further, because the water in the well is exposed to the atmosphere, volatile compounds are easily lost into the headspace over the water. Over the past several years, alternative methods such as the use of "mini-wells," micropurging techniques, and diffusion samplers have grown in acceptance over traditional monitoring wells.

Dakota Technologies, Inc.'s research intends to offer a sampling method that requires far less operator involvement (and therefore less potential for operator error) than any of the aforementioned techniques. Project researchers aim to demonstrate that the proposed membrane samplers can be productively substituted for monitoring wells for the purposes of sampling volatile organic compounds (VOCs) in groundwater. These samplers are passive devices that can be easily deployed in the subsurface using either state-of-the-art direct push technology or conventional drilling.

During the first phase of this project, laboratory studies will be conducted to characterize permeation rate for various prototype samplers. Studies will also be performed to determine the ease of manufacture and installation of the samplers, repeatability of sampler performance, and long-term durability. Field data will also be collected to validate performance and costs relative to conventional approaches.

2g. SBRP Partnership Efforts

As managers of the SBRP, we recognize that in order for the SBRP to achieve a full measure of success, we must actively engage with our colleagues in other government organizations. Establishing ongoing communication channels with our counterparts has many advantages; the primary ones being, improving our ability to address societal needs and leveraging resources. With these ends in mind, we have reached out to USEPA, ATSDR and state agencies with the intent of promoting the use of the Program's research results and to identify potential future research needs.

Below are brief descriptions that exemplify the types of involvement we have with USEPA, ATSDR and the states. Although many of our partnerships have been ongoing for many years, only the most recent activities are highlighted.

USEPA

Office of Solid Waste and Emergency Response (OSWER)

We have worked closely with Office of Solid Waste and Emergency Response (OSWER), the USEPA office that has responsibility for all USEPA hazardous waste-related programs, including Superfund. Specifically within OSWER, we have established ongoing ties with the Office of Emergency and Remedial Response (OERR) and the Technology Innovation Office (TIO).

On a regular basis we meet with the Deputy Director of OERR, the OSWER office that is directly responsible for implementing the USEPA Superfund program, to discuss ongoing and future coordination efforts. The current Deputy Director, Dr. Elizabeth Southerland, is actively engaged in maintaining strong ties with the SBRP, and is enthusiastic about utilizing the resources that lie within the SBRP, to the benefit of hazardous waste site cleanup. We were very pleased that Dr. Southerland accepted our invitation to speak at the SBRP national meeting in November 2002, and is willing to serve as an EAG member. Ms. Jayne Michaud, the senior OERR risk assessor, serves as the program liaison to SBRP, and has been a strong advocate of the SBRP within OSWER and OERR. Over the last four years, OERR has detailed two senior managers to work directly with the SBRP. These details have been timed to coincide with the preparation of new SBRP RFAs. The input from these senior managers has resulted in effective communication and coordination between NIEHS and USEPA in the development of the RFA. In addition, SBRP has coordinated closely with OERR's Community Involvement Center to share community outreach materials and tools, and more effectively assist local communities.

To further the transfer of our research results, we have networked with TIO to leverage their communication tools with the broader USEPA, state, federal, private contractor remediation community. The *RISKeLearning* web-based science seminar series initiated in the fall of 2002 is a prime example of leveraging of resources.

Regional Offices

Over the years, we have developed ties to some Regional Offices; however, with the recent detail of Mr. Larry Reed, OERR, to NIEHS, we have increased our efforts to reach out to these offices. Since August 2002, we have met on site with USEPA Superfund regional managers and technical staff in Regions 1, 4, 9 and 10. The purpose of these meetings was to evaluate how familiar the regions are with SBRP research; what their future research needs are; how interested they are in sustaining a close relationship with the SBRP; and what more the SBRP should do to encourage greater outreach and use of its research results. These sessions were productive "brainstorming" opportunities that resulted in recommendations for future collaboration. Discussion points from these meetings are summarized in Attachment A.

Office of Research and Development (ORD)

The USEPA's ORD has both an intramural and a university grant-based research program that supports several environmental laws under the USEPA's purview, including Superfund. We have established an ongoing collaboration with the ORD's Superfund-related research program to promote: 1) the mutual understanding of the research programs, 2) the sharing of research results, and 3) the identification of effective science communication tools. Significant collaborative efforts this last year were:

- ORD's and the Hazardous Substances Research Centers (HSRC) participation in the SBRP's national annual conference at the University of Arizona, November 3-6, 2002, entitled "Transitioning Basic Science into Practical Application to Meet Environmental and Public Health Challenges." Randy Wentsel of ORD, Lew Semprini of the Western Regional HSRC, University of Oregon, and Danny Reible of the Southwest HSRC, Louisiana State University were active participants on two separate panel discussions dealing with effective outreach and technology transfer.
- The SBRP staff participated in the December 2-3, 2002 Annual HSRC Directors' meeting in Washington, D.C. to discuss how the SBRP and HSRC's could work more effectively together and further assist the USEPA and community stakeholders.

- SBRP requested Dr. Katherine Banks of the Midwest HSRC, Purdue University, to participate as a member of the SBRP External Advisory Group, and she graciously accepted.
- SBRP continues to work with USEPA ORD through an ongoing series of coordination conference calls and meetings to "brainstorm" efficient ways of interagency collaboration that can further our public health goals and be accomplished within our given resources. Currently, a joint workshop is being planned to highlight the state-of-the-art of PCB research.
- SBRP, ORD and the HSRC's are using all the above approaches to identify additional opportunities to enhance our collaborations.

ATSDR

We have also sought to maintain productive relations with ATSDR. Dr. Robert Spengler, Associate Administrator for Science, has served as our primary liaison with ATSDR. Dr. Chris DeRosa has served on different SBRP committees and has graciously agreed to serve as a member of the EAG. Our collaborative efforts have resulted in the joint publication of a special issue of the International Journal of Hygiene and Environmental Health that highlights the Superfund-related research being conducted by USEPA, ATSDR, and SBRP. Most recently, the SBRP co-sponsored the International Conference on Chemical Mixtures, which was organized and hosted by ATSDR.

The SBRP has also been involved in the NIEHS – ASTDR collaborative efforts to promote an integrated research agenda and the most effective use of research results in the field. On February 12, 2002, Drs. Olden and Falk convened a meeting of both agencies' senior scientists and managers to identify a few areas for the two agencies to focus particular efforts of coordination. The two agencies followed up on the SBRP – ATSDR specific collaboration efforts in a meeting in early January 2003. At this meeting SBRP staff with Dr. Henry Falk, Assistant Administrator ATSDR, and many ATSDR Division Directors. Details of the meeting are specified in the meeting report presented in Attachment B.

State Hazardous Waste / Superfund Agencies

We recognize that the states have very real and practical needs with regard to hazardous waste sites, and accordingly, the SBRP can be an important resource to the states. However, establishing partnerships with the states has been challenging because states rely heavily on methods used and approved by USEPA and ATSDR. They are cautious about engaging with programs that they

perceive do not directly meet their needs. Therefore, we have found that our partnerships with USEPA and ATSDR help serve as a transition or introductory point for NIEHS. We also encourage our grantees, through their outreach programs, to engage directly with their state departments of health and environment. In addition, we have been in contact with some state associations such as the Association for States and Territorial Health Officials (ASTHO) and the Association of State and Territorial Solid Waste Management Officials (ASTSWMO). Most recently, we met with ASTSWMO to discuss their unique needs and the appropriate vehicles for communicating our program results to them. The report from this meeting is included in Attachment C.

2g. Attachment A USEPA Regions – Major Discussion Points

The meetings with Regional staff (RS) were very productive. The RS were supportive and appreciative of our efforts to make SBRP research available and of our interest to engage them in the SBRP. There was strong recognition that the *Research Briefs* are valuable vehicles for transferring important research findings. There were several discussions that focused on fine-tuning communication tools already in place. Other suggestions were more broad in nature. The RS also identified areas of research need, which will be of use to us when we develop the RFA.

Refining Communication Tools

Research Briefs

- Expand the distribution list to include
  - States
  - Remediation contractors
  - Environmental Business Councils
- Provide links on the *Research Brief* web pages to more in-depth information on the research

Superfund Site Table

- Make the table searchable by state, region and type of research
- Add USEPA point of contact information for each site

Conferences and Workshops

- Continue USEPA involvement in the SBRP's Annual Meetings
- Notify regions of SBRP supported conferences

General Comments/Suggestions

- USEPA and SBRP investigators and staff should coordinate on "sediments"
- SBRP and USEPA should purse internships for SBRP students within USEPA
- USEPA regions and SBRP grantees should continue to expand joint seminar series
- USEPA regions expressed keen interest in our currently under-development directory of expertise

2g. Attachment B ATSDR Meeting Report

The NIEHS SBRP staff met with senior ATSDR management on January 7th to discuss how the SBRP program presently supports the ATSDR mission, how it may be able to do more in the future, and what research needs are most critical to ATSDR.

Bill Suk, Beth Anderson, Claudia Thompson, and Larry Reed from SBRP and Jayne Michaud from USEPA Superfund met with Henry Falk and Peter McCumiskey, ATSDR Division Directors and other senior managers (including Juan Reyes, Chris DeRosa, Libby Howze, and David Williamson).

The major observations made by Dr. Falk were:

- Since both ATSDR and NIEHS report sequentially to the same VA-HUD appropriation committee, it is important to continue to emphasize the dialogue and collaboration between the two agencies.
- ATSDR needs to be using the NIEHS science in discharging its mission.
- ATSDR is a service agency, basically, but it is a difficult task since the science is so imperfect. Therefore, sound science can only support their efforts.
- The response to the WTC disaster has shown that both agencies must be positioned to integrate their disaster response capabilities to be prepared for any future major disasters.
- Informatics is an area of continued interest; opportunities for coordination should be pursued.
- NIEHS' toxicogenomics program has important implications to ATSDR's health assessments and continued dialogue between the two agencies is important.
- CDC's emphasis is presently on assessing potential biological agents, but they are also working from a master list of 501 possible chemicals of concern for a terrorist action. Many of those chemicals have incomplete toxicity data. This is of potential interest to ATSDR and NIEHS, and efforts need to be coordinated.

The larger meeting with ATSDR division directors was chaired by Peter McCumiskey. Some of the major observations included:

- Both Agencies recognize the need to demonstrate not only the collaboration being undertaken, but also the real world benefits of that collaboration.
- Community outreach is a very good area to focus on collaboration.
- In the area of children's health, the ATSDR Pediatric Environmental Health Services Units (PEHSUs) and NIEHS' Children's Health Centers have been collaborating very well. This demonstrates an area where non-Superfund NIEHS resources are being leveraged to further help the USEPA Superfund field program.
- Informatics was cited as a field still early in the developmental stages. A joint committee was looking to ensure that there was coordination between the agencies, especially in the development of new databases.

- NIEHS' microarray data may be a very appropriate early application of a coordinated informatics approach.
- SBRP noted that NIH has a GPRA goal of an integrated database system by 2012, so we should make sure our collaboration is integrated with those broader efforts.
- The Gene SNP's data base may be another good pilot informatics collaboration effort.
- The importance of the human genome research results need to be translated to the general public and to the field of risk assessment.
- The SBRP GIS research programs at University of California – San Diego and Boston University could serve as useful tools in the development of the informatics collaboration between the agencies.
- ATSDR would like to learn more about the University of California – San Diego GIS effort.
- Coordinated research efforts that the two agencies have initiated (e.g., thyroid hormone research, portable analytical devices, and biomarkers) are continuing.
- The importance of developing real time field analytical equipment was emphasized. Communities want such real time data if new technologies are going to be used to remediate a site. Such research also has counter-terrorism applications. Local communities are very interested in monitoring technologies that they can use (e.g., radon testing kits).

2g. Attachment C Meeting Report: Association of State and Territorial Solid Waste Management Officials (ASTSWMO) CERCLA Research Center Subcommittee Charleston, SC (1/15/03)

SBRP (Claudia Thompson and Larry Reed) met with the ASTSWMO CERCLA Research Center Subcommittee to discuss the States' effective use of the SBRP resources, identify additional steps the SBRP could take to help them with their site assessment and cleanup responsibilities, and to elicit any additional research needs for future SBRP consideration.

ASTSWMO was represented by Gary King (Illinois), Mark Giesfeldt (Wisconsin), Bary Behrns (Missouri), Jay Naparstek and Dale Young (Massachusetts), Barbara Coler (California), Mike Rosen (Oregon), Ken Kloo (New Jersey), John Regan (New Hampshire), Tom Kennedy (Executive Director of ASTSWMO), Kris Swanson (ASTSWMO staff associate), and Randy Hippen (USEPA ASTSWMO liaison).

After the presentation by SBRP staff, the following points / issues were raised:

- SBRP should work with Kris Swanson of ASTSWMO as a central contact point to ensure that SBRP communications (e.g., *Research Briefs*, lists of upcoming conferences, *RiskeLearning* web-based seminars, etc.) are networked through ASTSWMO and interested states so that they can also take advantage of these research opportunities.
- The California representative noted that SBRP was linked almost exclusively with state toxicologists. Although it is good to have that link, SBRP needs to expand its state collaboration to include the site managers who are responsible for the overall conduct of technical activities at the state and state led Superfund sites.
- California has some large Superfund sites that are contaminated with PAH's and that are using *in situ* treatment. SBRP related activities should be incorporated into plans to ensure that the science is being appropriately leveraged.
- Perchlorates research is important to the State of California and several groups, including the SBRP, are conducting these studies. These research efforts should be coordinated to ensure appropriate collaboration can be pursued.
- The Missouri representative noted that the state has done research with USEPA Region 7 on the bioavailability of site-specific soil lead using pig feeding studies, and had also initiated studies of the bioavailability of lead after treatment of the soil with phosphates.
- Missouri has only assessed eight of their 33 lead mining counties. They have had to pay universities to do this research at these 8 sites. Missouri would like to explore working cooperatively with the SBRP to see if they could propose their sites for SBRP research that would also be of use to them in assessing the public health risk.

- The Illinois representative noted that SBRP programs had done site-specific data gathering at several Illinois sites, but he was not aware of the results. It was agreed that we would follow up with the SBRP programs to ensure that the results of the site-specific data gathering were forwarded to him.
- There was discussion regarding the need to identify state hazardous waste sites that could serve as demonstrations for the new science and technologies coming out of the SBRP. This could be another follow up activity with ASTSWMO. Kris Swanson referred to a Training and Technology Transfer Group that would be a good focus for this effort to match up new science with applicable state Superfund sites.