TESTIMONY OF PAUL M. BERTSCH BEFORE

THE SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT

AND

THE SUBCOMMITTEE ON ENERGY AND THE ENVIRONMENT

OF

THE HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY

The Department of Energy's Support for the

Savannah River Ecology Laboratory (SREL), Part I

July 17, 2007

Room 2318

Rayburn House Office Building

10:00 a.m. - 12:00 p.m.

Chairman Miller, Chairman Lampson, Ranking Member Sensenbrenner, Ranking member Inglis, and subcomittee members: thank you for inviting me to testify on this important and most unfortunate situation. My name is Paul Bertsch and I am a Professor of Environmental and Soil Chemistry at the University of Georgia (UGA) and former Director of the Savannah River Ecology Laboratory (SREL), a research laboratory located on the Savannah River Site (SRS) near Aiken, SC and operated by UGA through a cooperative agreement with the U.S. Department of Energy (DOE). The SRS is a former nuclear materials production and processing facility that now has primary missions in environmental cleanup, including the processing and stabilization of high level radioactive waste, as well as in tritium processing and plutonium disposition.

SREL is the quintessential interdisciplinary research lab founded in 1951 by the late Dr. Eugene Odum, widely regarded as the father of modern ecology. The mission of SREL from the very beginning has been to provide an independent assessment of SRS operations on the environment and the mission is accomplished through a program of research, undergraduate and graduate student training, and environmental education and outreach to the general public. The diversity of scientific backgrounds represented by SREL's research staff is a manifestation of Dr. Odum's vision for the field of ecology, i.e., the discipline of ecology represents the intersection of the physical, biological, earth, and mathematical sciences. As such, SREL is recognized internationally by a range of scientific communities and, thus, looms much larger than its relatively small size in terms of notoriety and scientific impact.

The events leading up to the recent budget crisis represent, in my view, unusual and remarkable actions by the DOE managers that have had very unfortunate consequences for SREL and its dedicated employees. The outcome also has very unfortunate consequences for citizens of communities surrounding the SRS and the rapidly growing downriver communities in GA and SC that rely on the Savannah River and the Middendorf aquifer as critical natural resources. The tremendous community support for SREL that has been manifested in letters and editorials in local newspapers as well as in e-mails and phone calls to elected officials and DOE agency representatives has been both overwhelming and humbling.

I have been asked to provide you with the background and facts, supported by written documents, that led to the current funding crisis; facts that are seemingly in direct conflict with what has appeared in letters from DOE officials to both the I&O and E&E subcommittee chairs and in statements by DOE spokespersons to the media.

The events began in the spring of 2005 as the President's FY 06 budget request to Congress, eliminated all funding for SREL, which at the time was funded through DOE's Office of Science. This happened despite the fact that, in the same budget request, the performance-based budgeting documentation justifying the FY 06 request for the Environmental Remediation Sciences Division (ERSD) in the Office of Science listed SREL studies as two of the seven major accomplishments for FY 04. This represented almost 30% of the performance-based indicators generated by an organization that received less than 7% of ERSD's budget. The response from stakeholders representing a broad cross section of the general public, regulators, community leaders, and elected officials was prompt and forceful, resulting in many front page articles, editorials and letters in support of SREL.

In the ensuing months, I worked with UGA administrators and elected officials from GA and SC as well as DOE and NNSA officials to get funding restored for SREL in FY 06. Following numerous meetings and exchange of documents delineating the role and importance of SREL's work at the SRS that extended for more than two months, a meeting with Ms. Jill Sigal, then the DOE Assistant Secretary for Congressional and Intergovernmental Affairs was arranged. In addition to Ms. Sigal, the May 11, 2005 meeting included staff members from the offices of Senator Chambliss (R-GA), Isakson (R-GA), Graham (R-SC) and DeMint (R-SC); staff from Representatives Norwood (R-GA), Kingston (R-GA), Barrett (R-SC), and Wilson (R-SC); several UGA administrators; representatives from UGA's Government Relations Office, including advocates from the Washington D.C. based McKenna Long Aldridge; Dr. James Decker, Principal Deputy Director of the Office of Science; and me. The meeting began with Mr. Chambliss' chief of staff summarizing the issues relative to the zeroing out of SREL funding in the President's FY 06 budget request and the concern by the joint delegation relative to the negative impacts this action would have on their constituents.

Following this discussion, I spoke about the importance of SREL's work to the SRS cleanup mission, long-term stewardship, end state vision, and support of new missions as well as the impact of SREL's environmental education and outreach programs. I also discussed how the various SRS stakeholders including members of the general public and state and federal regulators relied on SREL for independent information concerning the impacts of SRS operations on the environment. I also spoke about the impact SREL's research had on a number of scientific fields. At the end of this discussion, Ms. Sigal asked me about SREL's contracts and grants from other agencies, private foundations, and industry. I spoke about the large increase in funding from outside sources SREL had experienced over the past several years and to our plans to increase this funding in the future. Ms. Sigal then asked me to describe a funding portfolio for SREL if it were to survive the budget crisis. I indicated that I believed that DOE-SR would fund \$2.0-3.5 M a year in projects, a point that Ms. Sigal challenged, suggesting that she did not think the SRS valued SREL's work. I respectfully disagreed with Ms. Sigal and spoke to my more than 20 years experience working on the SRS in partnership with DOE program and contractor personnel and to the unique capabilities SREL provided in support of SRS programs and activities as well as the role SREL had in the overall public support of the SRS. I was then asked if Ms. Sigal could speak with anyone in DOE familiar with the SRS that clarrify this issue. I suggested that Charles Anderson, formerly from the SRS and now at DOE-HQ would be a good individual to speak with regarding SREL and its role on the SRS. Ms. Sigal suggested that she would be meeting with Mr. Anderson that week and would discuss the issue with him. I then described SREL's ongoing successful efforts at expanding funding from other agencies, private foundations, and corporations and how, based on encouragement from DOE program managers at the SRS and in the Office of Science, this funding was leveraged with the DOE funds to maintain a viable and vibrant research lab despite many years of reduced and then flat funding from DOE. I also described the need for funding SREL infrastructure given that SREL was responsible for maintenance and upkeep of more than 100,000 square feet of office and sophisticated laboratory space in three different locations on the SRS. Ms. Sigal questioned DOE's responsibility for infrastructure support at which time I engaged Dr. Decker in the conversation, believing that, given his experience with facility support by the Office of Science, he would understand my position. Dr. Decker agreed that a responsible landlord and steward was a requirement for keeping sophisticated laboratories vibrant and at the cutting-edge of science.

Ms. Sigal then asked me to articulate this funding portfolio in a two page document and deliver it to her by COB the following day. I generated this document which specifically identified sources of funding for SREL, including $2.0 to $3.5 M in project funds from the SRS and $2 M in infrastructure support from EM and NNSA, in additional to $2-3 M in outside funding (attachment A). The document was generated and then reviewed by UGA administers and the final version was delivered to Ms. Sigal's office late afternoon on May 12th, 2005. The next information regarding the SREL budget that I received came two weeks later from UGA administrators who told me that the GA delegation received confirmation that SREL would receive $4.3 M in funding for FY 06, with $3M coming from DOE-SR, $1M from the Office of Science, and $300K from NNSA. While this level of funding enabled SREL to survive, it represented a 47% reduction in funding from FY 05 and led to a staff reduction of about 30%.

On June 27th, 2005, I received a FAX from Senator Chambliss' Office of a memorandum from Charles Anderson, Principal Deputy Secretary for Environmental Management, to Mr. Jeffrey Allison, the DOE SR-Site Manager (attachment B). The memorandum stated **"SREL is important to the Environmental Management (EM) Program and other Department of Energy (DOE) program offices. Research projects will be conducted to address DOE needs as related to cleanup, stewardship, SRS end state, and potential new SRS missions".** The memo went on to direct Mr. Allison to work with me and my staff to develop the scope of the new cooperative agreement to commence July 1, 2006; **"In addition, DOE-SRS is requested to prepare a new cooperative agreement that begins July, 2006 to establish a framework for future SREL activities."** On July 1, 2005, I received a letter from Mr. Allison which captured the major elements of Mr. Anderson's memo in addition to stating that he (Mr. Allison) had directed DOE-SR contracts personnel to begin work on the new five-year cooperative agreement **"I have directed the Office of Contracts and Management to begin the process to renew the cooperative agreement for an additional 5 years to establish a framework for future SREL activities"** (attachment C). At this point I would like to emphasize that at no time was it communicated to me that any element of the funding portfolio document previously submitted to Ms. Sigal needed to be modified in any way or that the document contained unrealistic expectations from DOE's perspective.

Following Mr. Anderson's directive, deliberations leading to the negotiation of the new cooperative agreement commenced in an August 2005 meeting with Mr. Allison and other members of his staff, including Mr. William Spader, Deputy Manager; Mr. Roger Butler, Assistant Manager for Business; and Dr. Karen Hooker, Director of the Environmental Health and Quality, who also served as SREL's Program Manager. We discussed SREL's reconfiguration plan to address the 47% reduction in funds and ~30% reduction in work force from FY 05 to 06. Mr. Allison was pleased with the plan and the smooth and safe transition, but stressed his interest in SREL maintaining a strong outreach program despite the reduction in funding and staff. We discussed what research areas SREL should focus on given the guidance we received from DOE-HQ. I spoke of SREL's expertise in providing site specific data that could be used in cost avoidance activities such as use of monitored natural attenuation and in developing long-term surveillance and monitoring activities, as well as the work focused on environmental stewardship. Mr. Spader told Mr. Allison the site specific work and long-term surveillance and monitoring activities were very important to the EM closure program. We also discussed a funding level needed to keep SREL viable. I was asked what my understanding was of the Offices of Science's funding for FY 07 would be, i.e., was the $1M recurring? I answered that I was sure it was not and while we would continue to pursue grants from the Office of Science we could not expect future funding for the SREL program. I also mentioned that UGA would be reducing its additional investment of state funding beginning July 1, 2007. Mr. Allison indicated that we should plan on a budget of $4M in EM funds in FY 07 and, while not making a firm commitment, we should also request additional funds to make up for the decrease in GA State funding for FY 08. Mr. Allison directed Dr. Hooker and me to work together to develop the work scope for the new cooperative agreement commensurate with a $4M funding level.

Dr. Carl Strojan, Associate Director of SREL and I met monthly with Dr. Hooker and Mr. Dennis Ryan to define the work scope and other details of the cooperative agreement beginning September, 2005. Early drafts of the CA were passed back and forth beginning in November, 2005. Mr. Donnie Campbell, Contracting Officer for DOE- SR sent a letter to Dr. David Lee, UGA's Vice President for Research requesting a follow-up cooperative agreement (CA) based on FY 06 funding base-line for a 12 month base budget year and four 12-month renewal Periods of Performance (attachment D). UGA submitted a final version of the proposed agreement to DOE in February, 2006.

In a March, 2006 budget meeting involving SREL's Administrative Financial Director Dr. Laura Janecek, and Ms. Sarah Blanding, the SRS-CFO, confusion arose relative to DOE-EM's funding level for support of SREL's work in FY 07. The CFO indicated that it was her understanding that DOE-SR would be providing SREL $3M for FY 07 as in FY 06. As this was inconsistent with previous discussions, I sent a letter dated March 26, 2006 to Mr. Allison requesting clarification. I received verbal assurance confirmed by a letter from Mr. Allison dated March 31, 2006 reiterating that DOE-SR would provide $4M in EM funds to support SREL research activities broadly defined in appendix A of the cooperative agreement and more specifically in the 2007 research plan (attachment E). During a visit to the SRS by Dr. David Lee (UGA VP-Research) Mr. Allison reiterated the importance of SREL to the SRS and the intention of DOE-SR to adequately fund SREL to carry out its work. Mr. Allison also acknowledged the difficult reconfiguration process that SREL was subjected to in FY 06, praised the reconfiguration plan developed by SREL, and stated "SREL will not close on my watch."

In June 2006, the DOE review of the CA submitted by UGA in February was still not complete and DOE extended the existing CA until September 30, 2006.

The DOE review and negotiations on suggested changes to the cooperative agreement were completed by the end of August 2006. In early September a signing ceremony for the CA was discussed with Mr. Allison and Dr. David Lee and a date in late September was planned. The completed CA was sent to Washington D.C. for 48 hr. notification of Congress and was returned for signing the week of September 4. DOE contracts personnel alerted SREL that they anticipated Mr. Allison's signature on Friday, September 8 and requested SREL to confirm David Lee's availability to sign the CA.

Just prior to Mr. Allison's planned signing the CA, he ordered all DOE-SR contracts be submitted for 72 hr not 48 hr notification, which follows a different procedure. Mr. Allison ordered the SREL cooperative agreement to go through the 72 hr. notification process.

During the process involved in 72 hr. notification to Congress many questions began to be raised and DOE-SR began requesting additional information from SREL. Eventually I was told that Ms. Jill Sigal had became involved and was questioning the terms of the CA that had been worked out over the previous year following the guidance provided by Mr. Anderson in June 2005 memo (*vide supra*). I was also told that Mr. Allison was directed not to sign the CA.

In an October 3, 2006 meeting involving Dr. Strojan, Mr. Campbell, Mr. Allison and me, Mr. Allison stated that he was being directed to commit only $1M in EM funds for FY 07 and nothing in the out years of the CA. I indicated that if we were to only receive only $1M in FY 07 that I would have to develop a closure plan. Mr. Allison stated that closure not an option; SREL's work was too important to the SRS and EM needed this work. I was directed by Mr. Allison to work with the three EM line organizations on the SRS to "projectize" SREL's work scope defined in appendix A of the CA and specifically in the research plan for FY 07. Mr. Allison also volunteered to call Dr. David Lee or Dr. Arnett Mace (UGA Provost) to describe the intention of DOE to fund SREL's work through this alternate funding paradigm and to provide assurance that there would be sufficient support of SREL programs via this alternate mechanism. An additional extension of the CA was required until the end of December 2006, even though SREL only had sufficient funding to operate through the end of November. The delay in signing of the CA attracted attention from the SRS Citizens Advisory Board, the press, and ultimately Congressmen and Senators from both GA and SC. There were several articles in the Augusta, Aiken, and Columbia newspapers.

A meeting was arranged with the assistant managers of the three EM line organizations (Waste Disposition Project (WDP), Soil and Groundwater Closure Project (SGCP), and Nuclear Waste Stabilization Project (NWSP)) Dr. Hooker, Mr. Ryan, other representatives of the three line organizations, Dr. Strojan and me. Mr. Spader opened the meeting stating that SREL needed to work with the three line organizations to "projectize" the work scope in the FY 07 research plans. He stated that SREL was important to the EM mission and indicated that the SRS needed to identify $800 M in cost avoidance in the upcoming years and that SREL, in addition to executing its role in long-term stewardship, would play a major role in this effort. Mr. Spader then left the meeting. The discussion then turned to focusing on the mechanics of "projectizing" the work scope.

In early November 2006, Mr. Allison told me that SREL should work with program personnel on "projectizing" the work scope demonstrating the mission related nature of the projects. He also indicated that he was no longer going to be involved directly in the process but that Mr. Ryan and Mr. Ben Gould were to be the points of contact.

The funding language inserted by DOE-HQ into the CA continued to evolve and become more complicated throughout October and November 2006. The last version committed $1M in funding from EM for infrastructure and up to $4M in task funding. In another conversation in November 2006, Mr. Allison once again suggested that he would be willing to describe the new procedures for funding SREL's work to Dr. David Lee to verify that sufficient funds to operate SREL would be available in FY 07. Given that SREL was going to run out of funds sometime in December, UGA and SREL felt that there was no alternative but to sign the CA with the new complicated funding language and to work in good faith to make the alternate funding model work. The new cooperative agreement was signed in December 2006.

We continued to work in good faith with representatives from DOE-SR to "projectize" the work scope. In late January, 2007 the process was completed and the funding was identified (~ $3 M including $391 K provided by the contractor in FY 06). The new funds could not be transferred until the continuing resolution for the FY 07 budget was resolved. SREL was told that while DOE-HQ would not be involved in these FY 07 funding decisions, they would likely commence a review of the FY 07 projects and guide decisions for FY 08. SREL and DOE-SR program staff were urged to begin work on the FY 08 projects. This process was begun in early February 2007. SREL was contacted the week of February 12, 2007 and told that project funding was to be transferred to SREL's CA.

In a February 20 meeting, Mr. Allison announced that, as part of the planned DOE-SR restructuring, SREL would now report to the Assistant Manager for Closure Projects, Ms. Yvette Collazo and that he would be handing off day to day responsibility of the SREL program to Ms. Collazo. I discussed my frustration with the inefficiency of the process for "projectizing" SREL's work scope and that having this completed 5 months into the FY made planning virtually impossible. Mr. Allison indicated that this was the first time through and he agreed that we needed to streamline the process. Mr. Allison then left the meeting turning it over to Ms. Collazo. Ms. Collazo then announced that she had just participated in a conference call with DOE-HQ and stated that they intended to "peer review" each project for ***FY 07*** to evaluate the "mission critical nature" linked to specific Project Basline Schedules (PBSs) in FY 07 prior to release of ***any*** project funding. I indicated that this was not our understanding and that we had begun work on the FY 2008 projects. Ms. Collazo indicated that she was new to the program and that these were her orders from DOE-HQ and that we needed to get to work on revising the project list for FY 07 and link projects to specific PBS elements and demonstrate the "mission critical" nature of the work in FY 07. I then asked for clarification on the definition of "mission critical" as well as the nature and the timetable of the "peer" review process. No specifics were available nor have ever been provided. The evolution of the presentation of the tasks beginning with the FY2007 research plan through the final "peer reviewed"task matrix table can be captured in attachment F, although there were several additional iterations not included in this attachment. In an April meeting with Ms. Collazo, Mr. Mark Gilbertson, Dr. Strojan and me, we were told that the outcome of the peer review of SREL projects would result in no additional funding for FY 07 as only those projects funded by the contractor with FY 06 funds were deemed mission critical for meeting FY 07 goals. This discussion was formalized in a letter from Jeff Allison to me dated May 7, 2007-more than seven months into the FY.

At the end of June ~40 SREL employees lost their jobs and more involuntary separations will occur over the next year as various non-DOE funded contracts and grants end.
In the absence of additional funding from DOE, it is likely that SREL will be closed as indicated in a recent letter from UGA President Michael Adams to Secretary Bodman. Thus, a unique 56-year old laboratory with a long institutional memory about the SRS and its operations and impacts that plays an important role in generating information needed for human and ecological

risk assessments, for the development and implementation of novel alternate remediation strategies, and for ensuring the long-term stewardship of the 310 square mile SRS reservation will be lost. While the human cost associated with involuntary separation of employees is always difficult, it is particularly tragic in this instance. SREL employees are extremely dedicated individuals who are committed to their important work. As an example, even with the budget uncertainty this spring, very few SREL employees left for other jobs as they all were dedicated to the institution and they worked hard to ensure SREL's continued success. Some SREL employees who were terminated June 30, 2007 continue to report to work feeling compelled to wrap up their research projects and organize their data so it will not be lost forever. The SREL support staff is equally dedicated, as they feel directly connected to the important research conducted by SREL researchers and are proud that they enable the internationally acclaimed research accomplishments of their colleagues. The closure of SREL will be felt by the SRS, as DOE program managers, contractors, and regulators have relied on the data and information provided by SREL researchers over the years. This unfortunate and totally preventable event is especially troublesome to the general public in the Central Savannah River Area and in the down river communities who have come to rely on the open and independent evaluation of the impacts of SRS operations on the overall environment. This looms especially large as the SRS enters a new phase of plutonium processing for disposition of excess stockpiles, while at the same time planning to emplace significant quantities of reclassified high-level radioactive waste tank residuals. Finally, as the status of Yucca Mountain continues to be uncertain, vitrified high-level waste being generated at the SRS appears to be destined to remain stored on the SRS well into the future.

In summary, the events discussed in my testimony above, backed by written and verbal documentation, reveal what appear to be unusual and extraordinary events along with contradictory direction on part of DOE-HQ personnel leading to the funding impasse of the SREL cooperative agreement. Mr. Jeffrey Allison was clearly charged in a June 2007 memo from Mr. Charles Anderson to work with me and my staff to define the scope for a new cooperative agreement. This process commenced in August 2005 and concluded in August 2006 with a cooperative agreement that was ready to be signed in September 2006, prior to interference from DOE-HQ. Mr. Anderson's June 27, 2005 memo to Mr. Allison directly lifted verbiage from the funding portfolio document that I submitted to Ms. Jill Sigal on May 12, 2005 as guidance for activities that SREL should include in the new cooperative agreement. In the absence of any other feedback concerning the funding portfolio document, it was clear to me that the $2 to $3.5 M target for DOE-SR task related work was accepted by DOE-HQ. While the funding language of the CA was changed via DOE-HQ insistence in the September-November 2006 time frame, we worked in good faith with DOE-SR personnel to projectize our work scope and I believe that DOE-SR personnel were also working in good faith. Until May 7, 2007, Dr. Strojan and I were consistently told by SRS management and program staff that SREL's work was important, that there was a need for the work, and that there was sufficient funding for the work. In my 23 years at SREL all CAs and M&O contracts have always been developed with the SRS Site Manager and program staff and there has never been involvement from DOE-HQ of this magnitude. In fact, Article XXIX of the cooperative agreement on Evaluation, Analysis, Assistance, and Approval states "evaluation, analysis, assistance, and approval required by this Agreement shall be accomplished at the DOE's Savannah Operations Office, Aiken, South Carolina, by the Contracting Officer or his duly authorized representatives." These facts along with my familiarity of Section 8.0 of the Savannah River Operations Office Human Capital

Management Systems Manual, Chapter 1, Section 1.1, Rev 2, which states that the Manager can authorize procurement contracts up to $5 million "without review", as well as the obvious fact that SRS program personnel are in the best position to understand site needs, led me to believe that SRS management and program personnel were responsible for deciding what should be funded and at what appropriate level. Furthermore, the notion that SREL submitted proposals that were "peer reviewed"and deemed not supportive of SRS or DOE missions is unsubstantiated by any facts surrounding the events that actually took place. As one can see from examining attachment F, we were asked to transform our research plans developed with SRS program staff to meet SRS needs and objectives and containing sufficient detail into a matrix table where specific tasks were represented by several line descriptors. These matrix tables simply could not undergo a peer review according to DOE's own requirements stipulated in 10 CFR 600.3 for management of cooperative agreements. Furthermore, we were never provided any detail about the peer review process nor did we receive written comments from the peer review. I submit that this is because there never was a peer review actually executed as required by 10 CFR 600.3.

I also want to address claims that we have not been aggressive in pursuing other funding opportunities as stated in letters from DOE to this committee and by DOE spokespersons in the press. SREL scientists currently have $5.25 in current contracts and grants and brought in close to $2.5 M in UGA FY 07. This is a very strong record of competitive funding for an environmentally focused organization of only 11 faculty members. This meets the target in the funding portfolio document that I submitted to Ms. Sigal in May 2005. Finally, even if one were to condone DOE-HQ's role in developing and controlling a task funding process and making decisions on tasks as small as $30,000, would any reasonable individual believe that a process whereby the outcome is revealed seven months into the FY is fair or makes good business sense?

Once again, I thank you for this opportunity to testify before this joint hearing and I look forward to your questions.

Attachment A

SAVANNAH RIVER ECOLOGY LABORATORY

Long-term Funding

The following activities assume SREL's cooperative agreement with DOE will be renewed as of July 1, 2006 and that the Laboratory will continue to provide certain core functions for DOE including an independent evaluation of the ecological effects of Savannah River Site operations. In addition SREL will broaden its funding sources and achieve a better balance between direct DOE funds, competitive grants, university and private support to sustain a program of ecological research, education, and outreach. This long-term approach also assumes that DOE provides an assurance of short-term funding to SREL to avoid the termination of a substantial number of SREL employees September 30, 2005 and maintain viable operations until the end of the existing cooperative agreement on June 30, 2006.

1. Task Funding (<u>$2.0-$3.5 million task specific projects from DOE</u>)
Specific tasks would be conducted as requested by DOE project managers to address research needs related to environmental management, potential new SRS missions, stewardship, and the end state vision for the SRS based on specific proposals. Following are examples of activities within three categories: environmental characterization, ecological risk and effects, and remediation and restoration.

- **Environmental Characterization**—Characterization is a necessary first step in determining environmental and health risks and devising remediation and restoration strategies. This information is also a critical component of NEPA reports, RODs, and other regulatory documents. Characterization is more than simply measuring contaminant concentrations in biota or other media, or reporting the presence of organisms at various locations. It includes developing an understanding of the processes that control distributions of contaminants, chemical forms, and their bioavailability with a long-term stewardship perspective. Task examples:
  - **a.** Continue development of long-term ecological databases to determine whether any changes being observed are the result of natural fluctuations or operational impacts.
  - **b.** Determine the biogeochemical processes that control chemical speciation and mobility of toxic metals, organic contaminants, and radionuclides.
  - **c.** Assess whether sentinel species or other biosensors can be used to characterize environmental health.
  - **d.** Determine the types of mathematical or statistical models that best describe contaminant distributions and the uptake and accumulation of contaminants in biota.
  - **e.** Develop novel biosensors and ecosensors for cost-effective long-term monitoring and surveillance of contaminated and remediated sites.

- **Ecological Risk and Effects**—Estimated risks and effects determine the need for remediation and restoration efforts, while perceived risks and effects determine the public's acceptance and support for DOE policies and actions. Estimating risks and effects on the basis of sound science helps to ensure that good decisions are made by reducing uncertainties associated with complex environmental processes. A recent National Academy of Sciences report (1999) stated that *"Ecological risks are better characterized at the Savannah River Site than at any other Doe installation, due in part to the designation of the site as a National Environmental Research Park and the presence of the Savannah River Ecology Laboratory."* Task examples:

a. Determine how changes in contaminant speciation influence dose-response and toxicity relationships.
b. Determine how much molecular or cellular damage from a contaminant is necessary before effects become significant to individuals, populations, and communities.
c. What are the potential effects and interactions from exposure to mixed contaminants?
d. Define better the risks from low dose-rate, chronic exposures to radiation.
e. Develop novel, cost-effective biomarkers for assessing ecological impacts on biota.

- **Remediation and Restoration**—The knowledge and expertise based at SREL are ideally suited to address the remediation and restoration of large land areas contaminated with relatively low levels of metals, organics, and radionuclides. Various types of bioremediation, natural attenuation, and *in situ* processes are applications based on scientific principles that already exist. Task examples:

a. Identify the traits of native plants and populations that best determine their suitability for use in remediation and restoration
b. Determine the sustainability of microbial transformations and other bioremediation processes over time.
c. Determine whether natural processes, such as plant succession, can be directed or accelerated to establish sustainable vegetation at lower costs on remediation sites, including waste closure caps.
d. Determine the primary mechanisms by which chemical amendments immobilize contaminants, and identify the appropriate geochemical and biological endpoints to assess sustainability.

2. External Grants and Contracts ($2-3 million estimated from various sources)
Currently SREL receives approximately $1.5 million annually in competitive external grants and contracts. An expansion in future grants and contracts in mission-related areas will be sought to enhance research, education, and outreach programs at SREL.

3. Infrastructure and Administrative Support <u>($2 million from EM/NNSA/DOE)</u>
Currently, approximately $3.5 million is required to maintain the Laboratory's infrastructure and to provide the administrative support needed to operate the facility. Categories include onsite management, safety services, facility maintenance, equipment, custodial services, personnel and procurement, financial accounting and reporting, property management, computer and GIS services, library support and SRS Set-Aside management. This proposal envisions a future annual commitment of $2 million from DOE with increased funding coming from UGA and other sources.

Attachment B

DOE F 1325.8
(08-93)

United States Government

Department of Energy

memorandum

DATE:

RECEIVED
JUN 27 2005

REPLY TO
ATTN OF: EM-21 (Sandra Waisley, 202-586-3087)

SUBJECT: Support for the Savannah River Ecology Laboratory (SREL)

TO: Jeffrey M. Allison, Manager, Savannah River Operations Office

The purpose of this memorandum is to provide direction for the support of SREL research activities in Fiscal Year (FY) 2006. The SREL is located within the Savannah River Site (SRS) and it is operated through a cooperative agreement with the University of Georgia Research Foundation; this agreement expires June 30, 2006. SREL is important to the Environmental Management (EM) Program and other Department of Energy (DOE) program offices. Research projects will be conducted to address DOE needs as related to cleanup, stewardship, SRS end state, and potential new SRS missions.

DOE-SRS is directed to allocate $3,000,000 in FY 2006 from available EM funds for applied research in three critical areas: Ecological Risks and Effects; Remediation and Restoration; and Environmental Characterization. In addition to EM funding, the National Nuclear Security Administration and the Office of Science will provide $300,000 and $1,000,000, respectively, for work in FY 2006. In addition, DOE-SRS is requested to prepare a new cooperative agreement that begins July 2006 to establish the framework for future SREL activities.

If you have any further questions, please contact me at (202) 586-7709 or Mr. Mark Gilbertson, Deputy Assistant Secretary for Environmental Cleanup and Acceleration, at (202) 586-0755.

Charles E. Anderson
Principal Deputy Assistant Secretary for
Environmental Management

cc:
Bruce B. Scott, NA-50
Jill L. Sigal, CI-1
James F. Decker, SC-2
Mark W. Frei, EM-30
Mark A. Gilbertson, EM-20

Attachment C

Department of Energy
Savannah River Operations Office
P.O. Box A
Aiken, South Carolina 29802

JUL 0 1 2005

Dr. Paul M. Bertsch, Professor and Director
University of Georgia
Savannah River Ecology Laboratory
Drawer E
Aiken, SC 29802

Dear Dr. Bertsch:

SUBJECT: Support for the Savannah River Ecology Laboratory (SREL)

By memorandum dated June 27, 2005, Mr. Charles E. Anderson, Principal Deputy Assistant Secretary for Environmental Management (EM), provided direction to my office of the planned Fiscal Year (FY) 2006 funding for SREL. Subsequent to receiving FY 2006 new budget authority, the Department of Energy, Savannah River Operations Office, will allocate $3,000,000.00 from available EM funds for applied research in three critical areas: Ecological Risks and Effects; Remediation and Restoration; and Environmental Characterization. In addition to EM funding, the National Nuclear Security Administration and the Office of Science will provide $300,000 and $1,000,000, respectively, for work in FY 2006.

As you know, the current cooperative agreement ends in June 2006. I have directed the Office of Contracts Management to begin the process to renew the cooperative agreement for an additional 5 years to establish the framework for future SREL activities.

If you have any questions, please contact me or have your staff contact Donnie Campbell at 952-7732 or Karen Hooker at 952-8379.

Sincerely,

Jeffrey M. Allison

Jeffrey M. Allison
Manager

OCM-05-084

cc: C. Anderson, EM-2, HQ

Attachment D

Department of Energy
Savannah River Operations Office
P.O. Box A
Aiken, South Carolina 29802

FEB 0 6 2006

Dr. David Lee
Executive Vice President
University of Georgia Research Foundation
622A Boyd Graduate Research Center
Athens, GA 30602-7411

Dear Dr. Lee:

SUBJECT: Follow-on Cooperative Agreement for Savannah River Ecology Laboratory Program (SREL)

REFERENCE: (a) Cooperative Agreement No. DE-FC09-96SR18546, Expiration Date, June 30, 2006
(b) Confirmation Request (C. Corbin, OCM/B. Nestor, SREL December 2005)

This letter references the follow-on Cooperative Agreement for the Savannah River Ecology Laboratory Program (SREL), it is confirmation of a verbal discussion between Chris Corbin, Office of Contracts Management, and Bob Nestor, SREL, the grant representatives for the project. In December 2005, Mr. Nestor stated that SREL would proceed with initiating the procurement package for February 2006 submission. The current Cooperative Agreement expires June 30, 2006.

The follow-on Cooperative Agreement should be based on the current level of funding provided by the Department of Energy (DOE): 12-month Base Budget Year, with four 12-month renewal Periods of Performance (POP). At this time DOE-Savannah River Operations Office (SR) management anticipates that funding will continue to be provided by the Office of Science and DOE-SR based on availability of funds and the existing budget constraint.

Request that the application for the follow-on Cooperative Agreement be mailed to the attention of Christine S. Corbin, or hand carried to Building 730B, Cube 2256, by close of business February 28, 2006.

Any questions you or your staff may have can be directed to Christine S. Corbin at (803) 952-9263 or the undersigned at (803) 952-7732.

Sincerely,

D. L. Campbell
Office of Contracts Management
Contracting Officer

OCM-06-027

cc: L. Janecek, SREL
Dennis Ryan, EQMD

Post-it® Fax Note 7671

Date	# of pages ▸
To L. Janecek	From C. Corbin
Co./Dept. SREL	Co. OCM
Phone # 5-8213	Phone # 2-9263
Fax # 53509	Fax #

Attachment E

Department of Energy
Savannah River Operations Office
P.O. Box A
Aiken, South Carolina 29802

MAR 3 1 2006

Dr. Paul M. Bertsch
Director and Professor
Savannah River Ecology Laboratory
Drawer E
Aiken, SC 29802

Dear Paul,

SUBJECT: Clarification Concerning the Savannah River Ecology Laboratory (SREL) Budget for Fiscal Year (FY) 2007 (Your Letter, 3/28/06)

Thank you for your letter of March 28, 2006, concerning the FY 2007 budget plans for SREL. This confirms Dr. Karen Hooker's March 29, 2006, telephone call to you reaffirming that the Savannah River Operations Office plans to fund $4 million dollars for SREL operations in FY 2007.

I regret that circumstances have required that our most recent quarterly meeting be rescheduled several times. I look forward to meeting with you on April 18th.

Sincerely,

Jeffrey M. Allison
Manager

OESH-06-0095

Attachment F

FY07 RESEARCH PLAN

Savannah River Ecology Laboratory
The University of Georgia

October 1, 2006 to September 30, 2007

Introduction

Through a Cooperative Agreement between the Department of Energy and the University of Georgia Research Foundation, Inc. (DE-FC09-07SR22506) SREL provides an independent evaluation of the ecological effects of SRS operations through a program of ecological research, education, and public outreach. This program involves basic and applied environmental research, with emphasis upon expanding the understanding of ecological processes and principles, and upon evaluating the impacts of industrial and land use activities on the environment. This is accomplished through a broad-based program of field and laboratory research conducted on the SRS and published in the peer-reviewed scientific literature; by providing education and research training for undergraduate and graduate students from colleges and universities throughout the United States and abroad; and by engaging in community outreach activities and service to professional organizations.

This FY07 research plan is based on a July 1, 2005 letter from the DOE Site Manager (Jeffrey M. Allison) to the SREL Director (Paul M. Bertsch) identifying DOE support for research in three critical areas: (1) *environmental characterization*, (2) *ecological risks and effects*, and (3) *remediation and restoration*. Research at SREL addresses knowledge gaps in these areas by taking advantage of unique expertise in the environmental sciences and ecology, the unparalleled field research opportunities at the SRS, and the long-term data sets, research tools and capabilities that SREL has developed over the last half-century.

Since many of SREL's studies involve multi-year efforts, the FY07 research plan includes a number of ongoing projects.

Research Programs

SREL's research programs are dynamic and have been developed either in response to requests from DOE, through SREL's own initiative, or some combination of these approaches. FY07 research activities are associated primarily with the characterization, effects, and remediation of near-surface contamination on the SRS, as well as long-term stewardship of SRS lands.

Major research efforts in the DOE complex have focused mainly on the fate and transport of subsurface contamination to address issues at the Hanford and INEL sites. At the SRS, Oak Ridge, and many smaller closure sites in the DOE complex, near-surface contamination or the outcropping of subsurface contamination to surface streams has more immediate implications in terms of risk to humans and the environment. For example, about 44 tons of uranium and a similar amount of nickel were released to the Tims Branch-Steed Pond corridor from 1956 to 1984, representing about 97% of the gross alpha activity released by the SRS. Other stream corridors, reservoirs, and waste sites on the SRS include large areas contaminated with levels of cesium and other radionuclides, metals, and organics that sometimes exceed regulatory limits and raise concerns among regulators and the general public. Traditional engineering approaches are inappropriate and too costly to address these concerns and remediate large areas. Alternate approaches, such as monitored natural attenuation and various types of bioremediation may provide less costly, less invasive, and more desirable solutions. Crucial to making these alternate approaches successful are the acquisition of site-specific data, an understanding of when and why alternate approaches may be appropriate, and then gaining support for their use.

SREL is a unique organization that is well positioned to investigate issues associated with near surface contamination and then to communicate research findings to DOE, Site contractors and various stakeholders. Near-surface contaminants are subjected to complex biogeochemical cycling and may be transferred to higher trophic levels, potentially posing unacceptable ecological and human health risks. SREL's proposed research addresses these topics, as well as others related to long-term stewardship and the recently-completed End State Vision for the SRS.

Environmental Characterization

Characterization is a necessary first step in determining environmental and health risks and in devising appropriate remediation and restoration strategies. Environmental information is also needed to make informed decisions about long-term stewardship and land management, and it is also a critical component of NEPA reports, Records of Decision (ROD), and other regulatory documents. Environmental characterization is more than simply measuring contaminant concentrations in biota or other media, or reporting the presence of organisms at various locations. It includes developing an understanding of the processes that control distributions of contaminants, chemical forms, and their bioavailability. Characterization is also necessary to construct models of how natural and engineered systems function, both in the presence and absence of environmental contamination.

Ecological Risks and Effects

Estimated risks and effects determine the need for remediation and restoration efforts, while perceived risks and effects determine the public's acceptance and support of DOE policies and actions. Providing a scientific basis for estimating ecological risks and effects helps to ensure that good decisions are made by reducing uncertainties associated with complex environmental processes. A 1999 report from the National Academy of Sciences stated that *"Ecological risks are better characterized at the Savannah River Site than at any other DOE installation, due in part to the designation of the site as a National Environmental Research Park and the presence of the Savannah River Ecology Laboratory."*

Remediation and Restoration

The knowledge and expertise based at SREL are ideally suited to address the remediation and restoration of large land areas contaminated with relatively low levels of metals, organics, and radionuclides. SREL conducts multidisciplinary research designed to assist in the development, evaluation and stakeholder acceptance of remediation and restoration efforts that protect human and ecosystem health. Fundamental to the success of various bioremediation, natural attenuation, and *in situ* remediation applications is an understanding of the underlying scientific principles on which they are based.

FY07 Goals and Milestones

Following are FY07 goals and milestones for SREL and the research programs described above. These are described at a level of detail that is appropriate for a cooperative agreement.

FY07 SREL Institutional Goals and Milestones

- Ensure that safety remains the top priority in all activities.
- Continue to focus DOE-funded research programs on SRS issues and communicate results to DOE, Site contractors and the general public.
- Continue to provide support to site contractors where appropriate (e.g., wildlife GIS database, MWMF research and regulatory support, and peer review of SRS annual environmental report).
- Complete an institutional strategic plan that ensures the longer-term viability of SREL on the SRS.
- Increase the amount of funding to SREL from external contracts and grants for work that complements DOE-funded programs.
- Publish at least 50 peer-reviewed papers in scientific journals and books.

FY07 Research Program Descriptions and Milestones

Eight longer-term scientific goals have been identified as priorities for the three programmatic research areas. These are listed below, along with brief descriptions of the research planned for FY07. Field studies on environmental characterization will take place throughout the general Site, whereas field and laboratory research on contaminants will focus on the Steed Pond-Tims Branch corridor, Pen Branch, 400-D Area basins, and the Mixed Waste Management Facility.

Environmental Characterization

TASK 1.0: Develop long-term ecological databases for use in Site documents and to determine whether any changes being observed are the result of natural fluctuations or operational impacts.

1.1 Wildlife studies on the SRS – Long-term studies that are needed to explain changes in site amphibian, reptile, and other wildlife populations to distinguish construction and operational impacts from long-term, natural fluctuations.

These ongoing studies have been supported at SREL by NNSA/DOE-DP. The studies build upon a large existing database and experience to support environmental policies and commitments from NNSA and other SRS organizations. Efforts include documenting responses of organisms to local contamination and land use changes, determining distribution and abundance of protected species that could restrict construction projects and other site activities, and establishing the extent of dispersal of organisms from contaminated and uncontaminated sites.

The value of using herpetofauna (amphibians and reptiles) as study species hinges on the high species richness of the Southeast in general and of the SRS in particular. The SRS is the largest tract of land in North America for which herpetofaunal species abundance, distribution, and diversity have been measured on a long-term basis, resulting in the documentation of high numbers of individuals from dozens of sites and more species of herpetofauna than reported from any other public land area in the United States. Amphibians and reptiles are excellent bioindicators of environmental health because certain aspects of their physiology, morphology, behavior, life history, and ecology may increase their susceptibility to environmental stress.

Studies will continue to document patterns of distribution and abundance of herpetofauna on the SRS, as well as the movement of reptiles and amphibians among wetlands and other SRS habitats. The juxtaposition of numerous uncontaminated sites on the SRS with operational facilities and contaminated sites creates an excellent research opportunity for comparative studies.

Traditional approaches, such as radiotelemetry, drift fences, and coverboard arrays will be employed to assess habitat use. GIS methods and stable isotope techniques will also be used to quantify spatial relationships and physiological processes, respectively. Efficient, cost-effective techniques for sampling and studying herpetofauna are needed as various agencies adopt reptiles and amphibians as bioindicators in monitoring programs. SREL continues to be a major contributor to the development, testing and advancement of techniques for animal monitoring, inventory, stable isotopes technology, DNA analyses and GIS habitat mapping.

- Continue sampling and monitoring of all amphibian and reptile species at Rainbow Bay, site of the longest continuous herpetological monitoring study in the world, and other long-term study sites on the SRS (*Gibbons*).
- Begin cataloguing data from earlier DOE-funded projects (*Gibbons*).
- Submit a renewal proposal to NSF for a complementary project to assess impacts of forest land-management practices on amphibian populations using the SRS as one of the study sites (*Gibbons*).

1.2 <u>Studies of the microbial communities of contaminated and uncontaminated streams</u> – Research to determine if bacterial exposure to metals will result in bacteria with increased resistance to both metals and antibiotics.

There is growing concern that metal contamination acts as a selective agent in the attenuation and proliferation of antibiotic resistance. It has been hypothesized that metal and antibiotic resistance traits may be co-selected for in bacteria; thus we would predict that bacterial exposure to metals would result in increased resistance to both metals and antibiotics. To test this hypothesis, a genotypic study was undertaken to ascertain whether specific resistance determinants are co-selected for in environmental bacteria. The relative abundances of a metal resistance gene (arsC) and an antibiotic resistance gene (tetAC) from contaminated and reference sites were assessed using quantitative PCRT (qPCR). Results suggest that these metal and antibiotic resistance gene abundances are variable in the environment, but that these genes are generally more abundant in metal-contaminated sites. Other studies examined the antibiotic resistance profiles of 437 environmentally-isolated *Escherichia coli* strains, representing two metal-contaminated coastal sites and an uncontaminated reference site. Isolates from the metal-contaminated sites exhibited resistances to three or more structurally diverse antibiotics in 53% and 40% of screened isolates, respectively, compared to just 29% from the uncontaminated reference site. Furthermore, a small number of isolates from the metal contaminated sites exhibited extreme multi-antibiotic resistance (to 9 or more antibiotics) that exceeds all previously reported levels of antibiotic resistance currently published in the scientific literature. Significantly, this small subset of multi-resistant strains was also extremely resistant to a number of front-line antimicrobials, which include moxifloxacin and ciprofloxacin. The detection of extreme multi-antibiotic resistance in pathogenic bacteria isolated from environments devoid of significant sources of antibiotic contamination is of considerable concern. Metal contaminated environments may subsequently contain a sizeable pool of antibiotic resistance determinants capable of horizontal transfer via commensals into clinical settings.

- Characterize microbial communities associated with sediment, water, and biofilms in contaminated and uncontaminated streams on the SRS using culture-independent and molecular methods (*McArthur*).
- Using field and laboratory approaches, determine the impacts of ash basin runoff on microbial communities associated with sediments, open water, and biofilms in D-Area (*McArthur*).

1.5 Carolina bay restoration studies – Research to characterize baseline hydrologic conditions in these wetlands and assess vegetation changes as a baseline for evaluating wetland restoration success.

More than 300 isolated depression wetlands (Carolina bays) occur on the SRS. Once very common throughout the southeastern Coastal Plain province, most Carolina bay wetlands in the region have been drained, cleared, or totally destroyed as a result of land management practices including forestry and agriculture, and by urban and industrial development. The importance of these wetlands as habitat for many regional wetland animal and plant species has been well-documented through long-term SREL studies. It is also recognized that climate-induced fluctuating water levels (including periods of dry as well as inundated conditions) are a critical characteristic of the environment for these unique species. What is not well known is the natural variability in hydrologic conditions among Carolina bay depression wetlands of different size and location, and whether restoration of such conditions in drained or disturbed depression wetlands will enable re-establishment of the characteristic flora and fauna.

- Continue long-term study of hydrologic conditions and vegetation responses in reference Carolina bay wetlands as a baseline for assessing wetland restoration success (*Sharitz*).

1.4 Sandhills threatened, endangered, or sensitive (TES) species population studies – Help determine if the management of red-cockaded woodpecker habitat at SRS adversely impacts (or benefits) other threatened, endangered and sensitive sand hills plant species.

Along the southeastern Fall Line region, there are extensive areas of sandhills and related xeric forests that support a unique flora and fauna, including a suite of threatened, endangered and sensitive (TES) plant and animal species. Federal lands along the Fall Line, including the SRS and military installations, are managed to promote open pine woodlands as habitat for the federally endangered red-cockaded woodpecker (RCW). It is not known if management directed towards RCW populations (single-species management) is beneficial, or possibly harmful, for other sandhills TES species. The goals of this research, which is leveraged by funds from the Strategic Environmental Research and Development Program (SERDP), are to evaluate the effects of land management activities on sandhills communities, to assess whether there is a combination of management activities that is suitable for all or most of the sandhills TES species, and to make recommendations for multiple-species management.

- Resample marked populations of sandhills threatened, endangered, and sensitive (TES) plant species to determine effects of land management activities, (*Sharitz*).
- Complete assessment of survival and reproductive success of sandhills TES plant species in experimental restoration gardens under different land management practices (*Sharitz*).

1.5 SRS GIS wildlife survey data base – Review SREL and USFS-SR publications, reports, theses, and dissertations generated and assemble records for vertebrate species and site locations for 77 receptor species. This information is used for SRS risk assessments and in communicating with regulators.

SREL will review SRS publications, reports, theses and dissertations, and assemble records for 77 vertebrate receptor species and their SRS locations for use in an existing GIS database. The information collected will include: species scientific name, reference citation, geographic location(s) of studies, habitats and keywords from the citation(s). Site locations for the 77 receptor species will be determined and then shape files and accompanying metadata will be created. Updates to the database tables will continue in Microsoft Access 2000 format. Abstracts will be generated for all new publications and provided in html format. All information to include database, html documents, metadata, and any new geo-spatial data will be provided in hardcopy, PDF, or CD formats to WSRC-SGCP.

- Submit semi-annual updates to the GIS database on SRS vertebrate receptor species in January and July (*Davis*).

1.6 SRS GIS historic research sites – Create a new GIS coverage of historic research sites to be used when conducting ecological and health risk assessments as well as evaluating site remediation efforts, siting new facilities, or locating clean reference sites.

SRS organizations have done well in publishing their research findings, but have done little to capture the locations of these studies in a comprehensive GIS database. SREL will review the scientific literature and appropriate documents to identify both long-term and short-term research sites on the SRS. This will include those areas where ecological research has been conducted by Site researchers as well as research sponsored by a Site organization. In addition, SREL will survey WSRC-SRNL and USFS-SR to identify their long-term study sites. The Site Use Permit digital database will be available from WSRC's Site Services and from this recently updated database SREL will identify historic/long-term research sites and their geographic locations. SREL will explore the feasibility of identifying those areas thought to be historical/long-term study sites that were used prior to the Site Use permit system (1951 to 1974). In addition, all relevant existing GIS layers (e g., Waste Sites) will be evaluated for GIS overlay purposes.

Once historic/long-term/short-term research sites on the SRS have been identified, SREL will create a comprehensive GIS layer for these areas. This coverage will produce ArcView/ArcGIS shapefiles delineating either study area points or polygon locations. The associated tabular data will include originating/responsible organization(s) for the research area and will include the following attributes: study description, research citations, organizational and PI contacts, Site Use Permit number (if applicable), and SRS grid location. Additional attributes will be identified as needed, such as possible contaminants used in the study. FGDC compliant metadata will accompany the coverage.

- Complete a listing of long-term and short-term research sites along with their SRS grid locations by April 2007 (*Davis*).
- Complete a GIS coverage for historic research sites by October 2007 (*Davis*)

1.7 Fish studies in Tims Branch – Research to determine metal concentrations in selected fish species along the stream gradient from upper Tims Branch to its confluence with Upper Three Runs. These results will be combined with results from two existing preliminary studies to examine accumulation over time, use stable isotope analyses to assess trophic position of biota within different stream habitats relative to accumulation, and determine if the impoundments influence the concentration of metals in aquatic biota.

We propose to (1) determine metal concentrations in selected fish species along the stream gradient from upper Tim's Branch to its confluence with Upper Three Runs, (2) compare metal concentrations in fish in this study to two preliminary studies (including analysis of the 2005 fish for Ni, U and other metals) to examine accumulation over time, (3) utilize stable isotope analyses to assess trophic position of biota within different stream habitats relative to accumulation, and (4) determine if the presence of impoundments (beaver ponds) influences the concentration of metals in aquatic biota (streams vs. ponds). Such studies will determine the impacts of historical contamination on accumulation of metals by fish, document possible changes in accumulation over time for some locations, and allow better determination of whether or not Tim's Branch system poses risks to piscivorous wildlife. Additionally, if impoundments are found to affect contaminant concentration levels, it may influence management/remediation of this aquatic system (e.g. through addition or removal of impoundments). These data (metals concentrations and stable isotope values for aquatic biota) will be a contribution to a planned future large-scale trophic level assessment of this ecosystem.

Selected species of fish will be collected (of varying trophic level) from beaver impounded waters along the drainage, including one pond above the M-Area input, as well as the flowing stream reaches between these impoundments. This sampling design will include all areas sampled in both preliminary studies. Fish samples will be analyzed for stable isotopes and metals at SREL using standard methods.

- Complete field sampling at all locations by January (*Bryan*)
- Complete all analyses by August (*Bryan*)
- Submit final report to WSRC-SGCP by November 2007 (*Bryan*)

1.8 Fourmile Branch aquatic biota study – This research will document contaminant levels and determine potential risks to piscivorous wildlife and possibly humans. Biota will include an invertebrate and three fish species of different trophic levels to examine effects of trophic position. The project will focus on mercury, radiocesium, other metals, and tritium.

The Fourmile Creek drainage near H and F areas has a history of contamination by radiocesium (^{137}Cs), tritium, mercury and other contaminants through direct release into this stream and migration via groundwater from area seepage basins down gradient to the drainage. Contaminated groundwater reaches the surface before entering the creek at the seepline located at the transition of upland and wetland vegetation associated with the creek. Earlier monitoring studies have documented the movement of these contaminants to Fourmile Creek water and sediments and, to a lesser extent, into biota, but potential risks to piscivorous wildlife have not been assessed. We propose a one-year study of aquatic biota within the Fourmile Creek area impacted by H and F areas to document contaminant levels and determine potential risks to piscivorous wildlife and possibly humans. We will sample biota along the Fourmile Creek gradient to include locations above, adjacent to, and below the impacted areas. Beaver impoundments will be targeted as sampling locations, allowing comparison with existing data (fish mercury concentrations) from impoundments on other drainages on the SRS. Biota will include an invertebrate (crayfish) and three fish species of different trophic levels to examine effects of trophic position. Pending funding availability, the project will focus on mercury and other metals, cesium and tritium. Data collected here provide contaminant information for risk assessments incorporating trophic transfers and can be used in existing receptor species models of piscivorous wildlife (wading birds/wood storks, river otters, etc.). Concentrations from larger fish can be used to assess human health risks.

- Complete field sampling at all locations by April (*Bryan*)
- Complete all analyses by August (*Bryan*)
- Submit final report to WSRC-SGCP by November 2007 (*Bryan*)

1.9 D-Area Ash Basin herpetofauna study – Field assessment will be conducted to quantify the herpetofauna community in the D-Area Ash Basin wetlands in comparison to similar uncontaminated sites. Part of this effort will be to develop general models that can be used to identify SRS areas that are healthy (or unhealthy) in terms of predicted diversity of herpetofauna.

We propose to develop a model to determine the ecological health of an area on the SRS based on herpetofaunal distribution and abundance. The ultimate goal is to develop indices of ecosystem health for well-studied locations based on the ratio of observed to predicted species occurrences. By accounting for known effects of habitat structure on herpetofaunal biodiversity, the indices will be useful indicators of other types of impacts, such as contaminants. Estimates of herpetofaunal diversity would be applied to other areas of SRS to help support remedial decisions for small scale operable units (OUs) or large scale investigations such as the Integrator Operable Units. Predicted biodiversity could be used to determine areas of the SRS that are healthy in terms of herpetofauna, those areas that may indicate impairment or are marginal in terms of ecosystem health, and those areas where further investigation is required. This effort will be coordinated with and contribute toward the Integrator Operable Unit (IOU) program.

Two measures of ecosystem health will be developed based on well-studied locations and then applied to an area of SRS where contaminants are present or where remedial actions may be considered to support remedial decisions based on ecological concerns, such as the D-Area Ash Basin wetlands. The first will be a simple "species richness index," that is, the ratio of the number of species present in the impacted area to the number expected based on our data from an ecologically similar but relatively unimpacted area. Information on species accumulation curves, which have been developed for extensively studied systems on the SRS, will allow us to account for those rare species that are difficult to detect. The second will be a "species composition index" based only on the subset of species for which meaningful habitat models can be developed (i.e., not all species are expected to show a high degree of predictability based on readily available habitat data). As above, this index will be the ratio of the number of species present to the number expected, with consideration for *sensitivity to contaminants and regional rarity*. Together, these indices will provide an integrative, comprehensive descriptor of the ecological status of the system.

Existing information on the herpetofaunal distribution of the relevant IOU will be compiled and the data formatted for comparison with the unimpacted area. Additional field work will be conducted as needed to quantify the actual biodiversity and, subsequently, derive the index of ecological health for D-Area Ash Basin wetlands. In the future, this application can be used to identify areas of the SRS that are healthy in terms of predicted diversity of herpetofauna, those areas that may indicate impairment or are marginal in terms of predicted herpetofaunal diversity, and those areas where further investigation is required based on using models to predict herpetofaunal biodiversity in habitats across the SRS. Statistical models developed for well-studied locations could be extended across the habitats of the SRS to generate a map of predicted herpetofaunal biodiversity creating a baseline of biodiversity predicted to occur at any given location, as determined from structural characteristics of the habitat.

- Provide update on site selection and initial sampling efforts for D-Area IOU (*Gibbons and others)*
- Develop GIS model that describes the effects of terrestrial land use/habitat type on select target species (*Gibbons and others)*
- Use the models and field data collected from D-Area and control sites to determine the species richness and species composition indices for the D-Area IOU (*Gibbons and others*)

1.10 H-02 outfall studies – Water samples will be collected and analyzed from seven SRS reference streams and the A-01 constructed wetland outfall for baseline information to compare to H-02 constructed wetland. The H-02 wetland is being constructed for wastewater compliance at the tritium facilities.

In constructed wetlands, fluctuations in their ability to efficiently remove contaminants from the water column occur due to seasonal and hydrologic effects, very similar to the fluctuations observed in natural systems. While the fluctuations occurring in constructed wetlands may be a cause of some regulatory concern, they may reflect patterns observed in natural wetlands. For example, variation in temperature and hydrology can affect the substrate redox potential, altering the forms and subsequent release of various nutrients and potential contaminants. It is well understood that as oxygen concentration of the substrate decreases, the redox potential decreases with conversion of nitrate to ammonia, sulfate to hydrogen sulfide, and conversion of iron and manganese to more mobile forms which are released from the sediments. Under oxidizing conditions, iron and manganese form oxides which reduce the dissolved concentrations of these metals. So the observation that concentrations of iron and manganese vary in the effluent from the A-01 constructed wetlands is consistent with our knowledge of natural wetland systems.

To avoid regulatory concerns regarding future effluent limits and operation of constructed wetlands, we will determine the iron and manganese concentrations of stream water from several natural streams on the SRS at locations that are similar in vegetation type, topography, hydrology, and soils to the constructed wetlands (e.g. emergent marshes, organic soil sites, and bayheads). We will choose 6-8 sites for monthly water sampling, with weekly sampling occurring during a 4-week period in each season. Thus, the annual cycle will be described by approximately 24 samples from each site. In addition to determining total iron and manganese concentrations of these unfiltered water samples, numerous supporting measurements will be necessary to put these values in context of the hydrology, season, and physical environment. These include stream gauge height, air temperature, water temperature, dissolved oxygen, pH, and Eh. Other chemical parameters which would be influenced by redox conditions and would interact with the iron and manganese concentrations will also be measured and include forms nitrogen. This sampling should continue for at least a two-year period to examine annual patterns and variability between years.

With these data, we will be able to determine if the A-01 outfall data collected in the regulatory/monitoring program follow similar seasonal patterns as natural systems and if important chemical constituents are of similar concentrations as natural water chemistry on the SRS. Thus, the operation of A-01 and subsequent operation of H-02 constructed wetlands will not be limited by seasonal variability in release of iron and manganese from highly reduced sediments.

In a second component of this task, a series of toxicity experiments will test the hypothesis that organic contributions from the wetland will negate the effects of increased iron or manganese by making them less bioavailable and, therefore, less toxic to typical aquatic indicator species. A Water-Effect Ratio (WER) determination will be conducted according to methods outlined by US EPA (1994). Individual experiments will be done for each metal of concern (Fe, Mn, and Cu) in each of three seasons to examine the seasonality effect that may be occurring in the treatment system. In each season, water will be collected: 1) upstream and 2) immediately downstream of the A-01 wetlands. In addition, a third water type will be used (a reconstituted laboratory control water typically used for SC regulatory purposes). For each type of water, a 48-hour acute toxicity test will be conducted with *Ceriodaphnia dubia* to determine the LC50 for each metal being tested. The LC50 calculations will be based on both total recoverable metal and dissolved metal concentrations.

- Select sampling sites and begin studies by November (*McLeod*)
- Coordinate activities with SRNL and NNSA in quarterly meetings (*McLeod, Mills and Unrine*)
- Submit findings to NNSA in October 2007 (*McLeod*)

1.11 <u>K-Area ecological studies</u> – Ecological baseline studies will be conducted in K-Area and adjacent watersheds to help assess the impacts of existing and future operational activities.

A series of baseline studies will be designed and implemented in FY07 to assess the ecological impacts, if any, of operational activities related to K-Area Material Storage.

- In collaboration with K-Area personnel, design and implement an ecological baseline study that will enable regulators and the general public to understand the nature of any impacts, if any, from existing and future operations (*Hinton and others*).

Task 2.0: Determine the biogeochemical processes that control chemical speciation and mobility of toxic metals, organic contaminants, and radionuclides.

2.1 <u>Uranium and nickel speciation in the Steed Pond-Tims Branch system</u> – Research to understand the biogeochemical processes that control the mobility of heavy metals to help make realistic estimates of human health and ecological risks and prudent remediation and management decisions for contaminated lands.

On the SRS, a mixture of heavy metals has accumulated in wetland and riparian sediments rich in natural organic matter and iron oxide minerals. The sediments lie along a several kilometer stretch of Tims Branch, which received direct discharges of wastewater from metallurgical facilities involved in the manufacture of reactor targets used in plutonium production. Substantial quantities of U, Ni, and Al were released to the environment, along with lesser quantities of Zn, Cu, Pb, and Cr. The nature and extent of this contamination poses a number of challenges for DOE in terms of remediation and long-term stewardship. The presence of U, Ni, and the other metals is a concern as remobilization and transport offsite via erosion may occur. Traditional remediation approaches will destroy a functioning and valuable ecosystem and exact a high cost, both monetarily and in terms of risk, due to their labor intensive and invasive nature. Such approaches are also contrary to DOE guidelines (10 CFR, Part 1022) for compliance with Executive Orders 11988 and 11990 established for the protection and management of wetlands and floodplains.

In this research, we apply the capabilities provided by the microprobe facilities at DOE's National Synchrotron Light Source and the Advanced Photon Source to characterize elemental distributions and chemical forms of U and Ni in contaminated riparian sediments on the SRS. These methods, when combined with information obtained from traditional bulk chemical characterization techniques and from electron microprobe analysis, allow for a much greater understanding of the biogeochemical control and cycling of heavy metals in a dynamic and complex environment than previously possible. With such knowledge, more realistic assessments of ecological risk can be made and more appropriate solutions devised. To date, experimental results support observations of U affinity for organic matter and Ni affinity for inorganic sorption reactions. Moreover, these data support the contention that decaying organic matter is a sink for U in this riparian system.

- Continue ongoing studies examining solid and aqueous phase uranium and nickel speciation in the Steed Pond-Tims Branch system (*Bertsch*).

2.2 <u>Natural attenuation of PCE/TCE in Pen Branch hyporheic sediments</u> – Research to study the role of monitored natural attenuation (MNA) processes within the hyporheic zone in mitigating the flux of PCE, TCE, and CT from the Chemicals, Metals, and Pesticide (CMP) groundwater plume into Pen Branch Creek.

The CMP groundwater plume originates below the Chemical, Metals, and Pesticide (CMP) pits waste site on the SRS. Between 1971 and 1979, chlorinated solvents, metals, pesticides, and electrical parts containing PCBs were dumped into unlined pits at the site. In 1984, the waste materials were excavated and the site was back-filled with soil, including the installation of a shallow (3 ft.) plastic liner to minimize surface water infiltration. However, the dense chlorinated solvents have penetrated the 90 ft. vadose zone beneath the pits and remain a source of contamination to the underlying Upper Three Runs Aquifer groundwater. The contaminated groundwater plume is moving north and intersects a section of Pen Branch Creek between Road C and Youman's Road. The contaminants of concern in the CMP groundwater plume are tetrachloroethylene (PCE), trichloroethylene (TCE) and, to lesser extent, carbon tetrachloride (CT).

Saturated floodplain soils and sediments adjoining streams generally provide conditions favoring reductive dechlorination and have been the focus of several MNA studies at the SRS, including PCE/TCE plumes migrating toward Four Mile Branch Creek and Castor Creek. However, no studies have explicitly examined natural attenuation processes within the subsurface stream sediments where they are directly linked to stream surface water. This region is called the hyporheic zone and has been shown to play a critical role in controlling the flux of groundwater solutes to surface waters. This zone is the final interface before contaminants outcrop into regulated receiving waters.

The goal of this research is to examine the role of MNA processes within the hyporhic zone in mitigating the flux of PCE, TCE, and CT from the CMP groundwater plume into Pen Branch Creek. Specific tasks are to determine the distribution of source contaminants and their degradation products in the hyporheic zone within the expected region of plume outcropping in Pen Branch Creek. Relevant geochemical and microbial MNA parameters are also measured to provide the necessary environmental context to draw inferences regarding the predominant processes controlling the contaminant distribution.

- Continue studies to determine natural attenuation processes involved in the degradation of PCE/TCE in Pen Branch hyporheic sediments impacted by the CMP groundwater plume (*Mills, Zhang, and Romanek*).

2.3 Development of compound-specific isotope ratio analysis – Research to identify the primary carbon processing pathways used by microorganisms in Pen Branch sediments to provide insights into the biogeochemical parameters controlling the degradation rates of PCE and TCE in this system. Examine nitrogen sources and protein turnover in natural and impacted environments.

The stable isotope composition of natural and anthropogenic materials provides insights into the origin and modification of carbon- and nitrogen-bearing compounds in terrestrial and aquatic ecosystems over time. The knowledge gained is amplified when bulk materials are separated into their component compounds prior to isotopic analysis. Toward this end, the stable isotope laboratory at SREL has been developing protocols for the pre-purification and carbon isotope analysis of microbial lipids from soils and sediment samples by gas chromatography-C-isotope ratio mass spectrometry (GC-C-IRMS). The first carbon isotope measurements of phospholipid fatty acid methyl esters are complete and protocols are being developed to analyze the neutral lipid and glycolipid fractions. Standard reference materials of known carbon isotope content are being developed for all three lipid fractions to facilitate the collection of calibrated analyses. This methodology will be used to obtain carbon isotopic data on the microbial lipids isolated from the hyporheic sediment in Pen Branch Creek. These results will help elucidate the primary carbon processing pathways used by microorganisms in these sediments and provide further insight into the biogeochemical parameters controlling the degradation rates of PCE and TCE in this system.

In another aspect of this work, because nitrogen isotopes are fractionated as they are passed up a food chain, natural abundance distribution patterns may be used to estimate the trophic position of consumers in an ecosystem. In addition, deviations from the expected relationships can be used to determine if stressors (e.g. environmental or natural) are affecting physiological processes such as protein turnover.

- Develop compound-specific isotope ratio analysis as a tool to evaluate the roles indigenous microbial populations play in the cycling of carbon and nitrogen in terrestrial and aquatic environments impacted by SRS activities (*Romanek, Zhang, and Mills*).
- Analyze the nitrogen stable isotope composition of amino acids to determine the source and fate of nitrogenous compounds and how contaminants affect protein metabolism in microorganisms and higher level organisms (*Romanek*).

2.4 Application of surface complexation models to descriptions of contaminant migration in the vadose zone – To support *in situ* remediation approaches, a series of batch and column studies is evaluating the ability to enhance contaminant metal reduction within highly weathered soils and aquifer sediments with special emphasis on nutrient amendments.

The effectiveness of enhanced *in situ* remediation approaches depends largely on the ability to deliver and stimulate the growth of dissimilatory metal-reducing bacteria within the zone of interest while maintaining formation integrity, especially in close proximity to recharge wells. A series of batch and column studies will be conducted to evaluate the ability to enhance contaminant metal reduction within the highly weathered soils and aquifer sediments of the southeastern U.S., with special attention placed on the impact of nutrient amendments on the mobility of Cr(VI) and other redox sensitive contaminants. Previous batch and column studies indicated that *in situ* reduction may be an effective means of remediating groundwater systems contaminated with redox sensitive contaminants such as U and Cr; however, effectiveness may be greatly influenced by the composition and mineralogy of the soil in question. Preliminary column experiments also indicated that buffered nutrient solutions often required to stimulate the microbial reduction may enhance the migration of contaminants by altering surface chemical processes and inducing clay dispersion that could adversely impact formation integrity and hydraulic conductivity.

- Complete laboratory studies and publish results from evaluating the impact of variably saturated conditions on contaminant (uranium, chromium, cesium) partitioning in the subsurface environment, specifically the application of Surface Complexation Models (SCM) to the description of contaminant migration in the vadose zone (*Seaman*).

Task 3.0: Assess whether sentinel species or other sensors can be used to characterize environmental health.

3.1 Alligator population and genetic studies – Data from earlier and ongoing studies are being used to generate a population database as well as mutation rates in American alligators with the goal of using the alligator as a sentinel species for metal and radionuclide contamination on the SRS.

Blood samples from alligators captured will be added the SREL DNA lab collection. Phenotypic measures (length, weight, etc.) as well as date and location of capture will be added to a long-term database of alligators captured on the SRS. Collaborative studies will be leveraged to understand the mutation rates of alligators and other crocodilians. Work will involve collaborators from the State of Louisiana (Rockefeller Refuge), the Universities of Southern California, South Carolina, and Sydney. These observations and experiments will contribute to a broader understanding of alligator reproductive strategies and how they can be used as environmental sentinels.

- Continue collaborative research studies to characterize genetics of American alligators on the SRS and in reference populations off-site (*Glenn*).
- Submit a manuscript for publication describing new microsatellite DNA loci (*Glenn*).
- Co-organize an International Workshop on Crocodilian Genetics and Genomics with researchers at Texas Tech University and the Smithsonian Tropical Research Institute in Panama (*Glenn*).

3.2 Using ecological indicators to determine disturbance associated with regional land use – Environmental indicators developed at Fort Benning are being applied to disturbed areas at the SRS to determine if these indicators have long- term application for on-site land use decisions.

Complete a comparison of ecological indicators developed at Fort Benning with an SRS forest stand within the Advanced Tactical Training Area (ATTA). The ATTA site has been prescribe-burned and was thinned recently, but has had no military or heavy vehicle use. The SRS site is being compared to 40 sites at Ft. Benning that spanned disturbance classes from low (class 1) to high (class 10).

- Complete all aspects of the study.

Ecological Risks and Effects

Task 4.0: Determine how the form of a contaminant influences dose-response and toxicity relationships.

4.1 Dose-response relationships in receptor species – ongoing studies using various receptor species, including earthworms, to assess dose-response relationships for metals and radionuclides.

The Tims Branch/Steed Pond system is heavily contaminated with U, Ni, and other metals that were released during operation of the M-Area nuclear materials metallurgical facility used to fabricate U targets for the production of Pu. Ongoing studies are examining the ecological risk associated with the contamination dispersed in riparian sediments along several km of the Tims Branch corridor. The EPA's Earthworm Subchronic Toxicity test (EST) forms part of the Ecological Effects Test Guidelines, allowing the characterization of potential ecological risk from soil contamination by exposing earthworms to various incremental mixtures of the test soil over and measuring mortality or bioaccumulation. Such toxicity tests play an increasingly important role in how regulatory agencies estimate ecological risk by attempting to measure bioavailability rather then relying on total metal concentrations in soils or sediments. Preliminary studies have demonstrated that U and Ni accumulation from contaminated Tims Branch sediments by the model earthworm *Eisenia foetida* are significantly greater than those from control soils. In upcoming studies we will be evaluating the potential ecological significance of this observation.

- Complete experiments using receptor species, such as earthworms and nematodes, to determine dose-response relationships to metal contaminants (*Bertsch, Glenn, Neal*).

4.2 Dose response relationships of Medaka fish to gamma irradiation – Current experiments focus on characterizing additional families of the model fish, Medaka, to better understand variance in response among individuals, response at different stages during spermatogenesis, response of chronic versus acute exposure, and transgenerational effects.

Determining dose-response relationships for various levels of exposure to ionizing radiation is important for understanding biological effects and for determining the lowest dose at which effects can be measured. Dose response relationships may vary with different doses (being linear among some doses and non-linear among others), dose rates, radiation type and energy, and among individuals (because of differing genetic susceptibility and environmental factors). SREL is conducting experiments using acute irradiation of Medaka to determine the dose response relationships between mutation rates of microsatellite DNA loci and the radiation doses applied. Preliminary results suggest that mutations are significantly elevated in hatchlings of Medaka after their parents were exposed to any of the four radiation doses used, when compared to the mutation frequencies of the offspring of the same parents before exposure. FY07 studies will build upon these preliminary results.

- Determine the dose-response relationships of: (1) DNA changes in Medaka fish red blood cells and (2) germ-line mutations at microsatellite DNA in Medaka fish exposed to acute and chronic sublethal doses of radiation (*Glenn and Hinton*).

Task 5.0: Determine the potential effects and interactions from exposure to mixed contaminants.

5.1 Studies of the interaction of nickel and TCE in plants in the Steed Pond-Tims Branch ecosystem – Research will focus on the effects of less toxic doses of nickel to hybrid poplar plants to determine effects on the formation of metabolites in the leaves and roots of the plants.

In Tims Branch, there is long-standing contamination from nickel, and migration of a chlorinated solvent plume will be moving trichloroethylene into the area. There are three possible outcomes for the interactions between the contaminants and the plants: (1) the presence of the nickel will interfere with the metabolism of trichloroethylene (TCE) in the plants, (2) the presence of TCE will affect the plant root cell membranes, altering nickel uptake, and (3) the movement of TCE into the area will affect soil chemistry and make the nickel more bioavailable. We have been exposing hybrid poplar plants to varying concentrations of trichloroethylene and nickel in hydroponic conditions to determine if outcomes 1 or 2 are likely to occur. Preliminary data indicate that the presence of nickel affects the formation of metabolites in the leaves and roots of the plant. Preliminary data regarding changes in nickel uptake with exposure to TCE are less conclusive. We are expanding this work to include nickel doses that better mimic the Tims Branch system and are also increasing the number of plants per condition to obtain better statistical reliability.

- Examine the interactions between nickel and trichloroethylene (TCE) in the Tims Branch-Steed Pond system, including how nickel might affect plant enzymes involved in the metabolism of TCE, how TCE might affect the uptake of nickel in plants by changing cell membrane structure, and how the presence of TCE may affect soil chemistry and thus nickel bioavailability to plants (*Newman*).
- Publish results demonstrating the potential for using tree species (poplar, sweet gum, sycamore, loblolly pine, Leyland cypress) for remediation and restoration purposes (*Newman*).
- Continue evaluating different types of grasses for their ability to assimilate and degrade TCE (*Newman*).
- Publish results from studies on the ability of native plants along Pen Branch to assimilate and degrade both TCE and PCE (*Newman*).

Task 6.0: Define more clearly the risks from low dose-rate, chronic exposures to radiation.

6.1 <u>Effects of low-dose rate ionizing radiation</u> – Radiation effect studies using site amphibian species as model organisms to determine their radiosensitivity during egg development, larval period, and metamorphic period will continue as part of an effort to establish data for potential radiation protection guidelines for natural populations.

Recently, international radiation protection guidelines changed from emphasis on protection of humans, with an implied protection of biota, to explicit guidance for plants and animals. However, debate exists concerning appropriate endpoints to measure when ensuring protection of biota. Amphibians are an interesting model for examining radiation exposure to biota because many species spend a large part of their life in wetlands where radioactive ^{137}Cs can accumulate, and thus they have potential to be chronically exposed. Currently, there is a lack of knowledge on the level of protection needed for amphibians, especially regarding chronic low-dose radiation exposure. We are particularly interested in the combined effect of multiple stressors and have designed experiments to test whether the stress associated with a greater density of organisms impacts effects from irradiation.

- In collaboration with Colorado State University, complete experiments on the transgenerational effects of low dose rate irradiation using medaka fish as a model to determine the genetic response and frequency of mutations in exposed and unexposed progeny from irradiated parents (*Glenn and Hinton*).

Remediation and Restoration

Task 7.0: Identify the traits of native species and populations that best determine their suitability for use in remediation and restoration.

7.1 Evaluation of native plants most successful in the restoration of Carolina bays – To complete research analyses on the final two years of this five-year study that suggests that passive revegetation can be a successful strategy for these wetlands.

In 1998, the SRS Carolina Bay Restoration Project was initiated by SREL, the U.S. Forest Service, the U.S. Fish and Wildlife Service, and several universities. Sixteen severely degraded Carolina bays were chosen for experimental restoration, and DOE-SR will receive credits to its wetland mitigation bank for this project. After pre-treatment studies in 1998-2000, the hydrology of these bays was restored in 2000-2001 by plugging drainage ditches. Vegetation treatments included clear-cut removal of invasive woody species and planting of wetland herbaceous or forest species into the basins. It was anticipated that wetland species present as seeds in the soil (seed bank) would germinate and become established once soil, light, and moisture conditions were appropriate (passive revegetation). Results to date have provided some evidence that passive revegetation can be a successful restoration strategy for these wetlands. After removal of forest dominated by woody species, the restored wetlands quickly developed a dense cover of herbaceous species, roughly half of which were wetlands species. In addition, seed banks contributed many wetland species to the restored vegetation. However, hydrologic recovery was slowed by unpredictable drought conditions that allowed non-wetland species to become established and to persist. Deep and long ponding in later years reduced vegetative cover and suppressed herbaceous species. Thus, the potential exists for a self-designed vegetative cover dominated by wetland plants, depending upon the final hydrologic regimes that become established in individual wetlands.

- In collaboration with the U.S. Forest Service-SR, complete an evaluation of life-history traits of native plant species most successful in restoration of drained Carolina bay wetlands (*Sharitz*).

7.2 Mixed Waste Management Facility (MWMF) remediation – A cooperative effort with USFS-SR and WSRC-SGCP to assist with site waste management and provide the evapo-transportation efficiency estimates required for the Corrective Action Report (CAR).

SREL is supporting several activities aimed at optimizing ongoing remediation efforts at the Mixed Waste Management Facility. Specifically, SREL will work collaboratively with the US Forest Service-SR and WSRC-SGCP to draft the biannual evapotranspiration report, maintain automated environmental monitoring equipment, and report activities associated with managing the tritium irrigation site.

- Complete the 2006 MWMF Efficiency Report for 2006 (*Seaman*)
- Integrate automated flow meter data into the MWMF database (*Seaman*)

Task 8.0: Determine the primary mechanisms by which natural attenuation and engineered remediation processes immobilize contaminants, and identify the appropriate geochemical and biological endpoints to assess sustainability.

8.1 Evaluations of the effectiveness of hydroxyl apatite amendments on TCE degradation by microbes – Complete research demonstrating that hydroxyl apatite amendments may offer a feasible approach to reducing metal toxicity to microorganisms at mixed waste sites, thereby enhancing the degradation of co-contaminants.

Binary and ternary mixtures of contaminant classes (e.g., metals, radionuclides, chlorinated hydrocarbons) have been identified at 64% and 49% of U.S. Department of Energy (DOE) facility waste sites, respectively. Although microorganisms can degrade many organic contaminants, co-contaminant metals inhibit processes required for attenuation and bio-remediation, although few studies have addressed their impacts. Thus, a major challenge in developing remediation strategies for mixed waste sites includes understanding how the presence of metals can affect microbial processes involved in contaminant degradation or sequestration. For over three decades the Tims Branch watershed, located on the SRS, received metal-contaminated wastewater resulting from production of U-Al alloy fuel and depleted U targets. This waste was comprised primarily of U and Ni with lesser amounts of other metals. Additionally, an ~8 km^2 subsurface plume of chlorinated organic solvents, primarily trichloroethylene (TCE) and tetrachloroethylene, originating from this processing facility, has begun to outcrop within riparian sediments along the Tims Branch corridor. Previous studies have examined the chemical and biological availability of Ni and U at this site and shown that Ni appears to be more available to a number of bioreceptors than U. Considering the known toxic effect of these metals, they could potentially hinder intrinsic degradation of TCE at this site. Hydroxylapatite (HA) is recognized for its ability to sequester lead (Pb) and other metals, including U and Ni, to reduce metal toxicity. Studies are being conducted to determine whether metal sequestration via HA amendments may offer a feasible approach to reducing metal toxicity to microorganisms at mixed waste sites, thereby enhancing the degradation of co-contaminant organics.

- Complete studies and publish results that evaluate the effectiveness of hydroxyl apatite amendments in reducing metal toxicity to microorganisms and thus promoting TCE degradation (*Bertsch*).

8.2 Analyses of field-scale tracer data from H-Area subsurface injections experiments – Complete analyses of data obtained from a series of field-scale experiments using tritiated water, bromide, and two fluorobenzoates as tracers in the water table at SRS to study contaminant migration in the subsurface environment.

Hydrodynamic dispersion (the combined effects of chemical diffusion and differences in solute path length and flow velocity) is an important factor controlling contaminant migration in the subsurface environment. However, few comprehensive three-dimensional data sets exist for critically evaluating the impact of travel distance and site heterogeneity on solute dispersion. A series of field-scale experiments using tritiated water (^3H_2O), bromide (Br-), and two fluorobenzoates (2,4 and 2,6 Di-FBA) as tracers was conducted in the water-table aquifer on the SRS. Dispersivity varied greatly between wells located at similar transport distances and even between zones within a given well. Complex multiple-peak breakthrough patterns observed within certain sampling zones were replicated in subsequent tracer experiments, and a strong correlation was observed between dispersivity and arrival times observed from one experiment to the next, indicative of the general reproducibility of the tracer results. Analyses will be completed and results published.

- Publish results from H-Area subsurface injection experiments to determine the impact of travel distance and geologic formation heterogeneity on longitudinal dispersivity of tracers under non-uniform flow conditions (*Seaman*).

9-20-06

Savannah River Ecology Laboratory

Scope of Work for FY2007-FY2011

The Savannah River Ecology Laboratory (SREL) provides an independent evaluation of the ecological effects of Savannah River Site (SRS) operations through a program of ecological research, education and outreach. This involves both basic and applied research, with emphasis on areas of critical concern for the Office of Environmental Management (EM), including environmental characterization, ecological risks and effects, and remediation and restoration. The SREL also supports ongoing planning and regulatory efforts for SRS projects through the continued development and maintenance of extensive ecological data bases and the management of the SRS National Environmental Research Park. Finally, SREL also helps DOE to effectively discuss environmental issues and information with other SRS organizations, regulators, DOE decision-makers, and stakeholders.

SREL's annual $4 million budget from EM, with projected annual adjustments for inflation, will be used for salaries, fringe benefits, supplies, travel and indirect costs as estimated below.

Category	Amount ($K)
Salaries	$2,385
Fringe Benefits	555
Expenses and Travel	500
Equipment	100
Indirect Costs (@11.5%)	460
TOTAL	$4,000

When summarized by tasks, the annual budget will be allocated as estimated below.

Task	Amount ($K)
Operational Support*	$1,500
Research Programs	2,185
Education	140
Outreach	175
TOTAL	$4,000

*Includes management and administrative support, infrastructure and facility maintenance, custodial services, safety services, and computer services.

Additional annual funding is received from NNSA ($500K), The University of Georgia (about $1 million), and external grants (about $2 million). DOE-SR provides utilities at no cost and services valued annually at about $150K for telephones, fire protection and radiological support.

Following is a summary of projected tasks under the new cooperative agreement. SREL's research programs are dynamic and have been developed either in response to requests from DOE, through SREL's own initiative, or some combination of these approaches. Current and proposed activities deal with problems associated with the characterization, risks and effects, and remediation of groundwater and soil contamination on the SRS, as well as others related to long-term stewardship and the recently-completed End State Vision for the SRS. The identified tasks are multi-year efforts (FY2007-FY2011), but individual subtasks will be revised annually based on results from the previous year and projected future requirements. Estimated costs for each task are provided; they are expected to be reasonably similar from year to year.

Environmental Characterization

Characterization is a necessary first step in determining environmental and health risks and in devising appropriate remediation and restoration strategies. Environmental characterization information is also needed to make informed decisions about remediation approaches, long-term stewardship and land management, and it is also a critical component of NEPA reports, Records of Decision (ROD), and other regulatory documents. Environmental characterization is more than simply measuring contaminant concentrations in groundwater, soil, biota or other media, or reporting the presence of organisms at various locations. It includes developing an understanding of the processes that control distributions of contaminants, chemical forms, and their bioavailability. Characterization is also necessary to construct models of how natural and engineered systems function, both in the presence and absence of environmental contamination.

Task 1. Develop long-term ecological databases for use in Site documents and to determine whether any changes being observed are the result of natural fluctuations or operational impacts. ($315K/year)

Field studies will take place throughout the general Site and mostly involve continuation of ongoing work. For example, sampling and monitoring of all amphibian and reptile species will continue at Rainbow Bay, site of the world's longest continuous herpetological study, which was begun during construction of the Defense Waste Processing Facility. Data collection on hydrologic conditions and vegetation responses in more than 20 reference Carolina bays will continue as a baseline for assessing wetland restoration success. Two other ongoing efforts will involve extending a database on alligator genetics and population dynamics, and re-sampling threatened, endangered, and sensitive plant species to determine effects of land management activities. A newer effort will characterize microbial communities associated with sediment, water, and biofilms in contaminated and uncontaminated streams on the SRS as a component of SREL's bioremediation research and research related to developing novel long-term surveillance monitoring activities. Finally, a WSRC-funded subtask will continue to update a GIS database on SRS animal species used by SRS in ecological risk assessments.

Task 2. Determine the biogeochemical processes that control chemical speciation and mobility of toxic metals, organic contaminants, and radionuclides. ($400K/year)

Laboratory studies will be conducted along with field-based research at several locations on the SRS. Continuing research will characterize solid- and aqueous-phase uranium and nickel speciation in the Steed Pond-Tims Branch system, generating information that will be essential to developing potential *in situ* remediation solutions or information relative to natural attenuation through sequestration. In another study, the role of dissimilatory iron-reducing bacteria in determining the fate of chromium and uranium in SRS surface and vadose zone soils will be examined. Laboratory studies will continue to evaluate the impact of variably-saturated conditions on contaminant (uranium, chromium, and cesium) partitioning in the subsurface through application of Surface Complexation Models to describe contaminant migration in the vadose zone. Degradation of organic contaminants will be studied in the field to determine rates of natural attenuation of TCE and PCE at the interface of Pen Branch and the CMP groundwater plume, i.e., the hyporheic zone. Compound-specific isotope ratio analysis will be developed as a tool to evaluate the roles that indigenous microbial populations play in the cycling of carbon and nitrogen in terrestrial and aquatic environments affected by SRS activities.

Task 3. Assess whether sentinel species or other sensors can be used to characterize environmental health. ($275K/year)

A number of novel approaches are being examined to supplement or replace traditional methods of data collection. For example, in cooperation with WSRC and USFS-SR, an automated weather station and a remote wireless monitoring system are being installed for estimating evapo-transpiration potential at the Mixed Waste Management Facility (MWMF). The information will then be used to help determine application rates for the tritium irrigation system. Similarly, testing will continue of an automated vadose-zone monitoring and pore-water sampling system, also at MWMF, including comparing a remote wireless system in side-by-side trials with conventional field-based methods. Another novel approach includes evaluating the potential for using stable isotope signatures in freshwater mollusk shells as reliable monitors of water chemistry in surface waters of the SRS. On a larger scale, interactions among microbial diversity, ecosystem processes, and abiotic factors will be examined for their ability to predict effects of physical and chemical changes in the environment. In conjunction with a DoD-DOE-EPA-funded SERDP grant, a series of ecological indicators to be identified by DoD will be used to place SRS upland pine-hardwood forests on an index of regional land-use disturbance. Finally, with partial funding from the National Science Foundation, field research will continue on a study to characterize impacts of forest land-management practices on amphibian populations using the SRS as one of the study sites.

Ecological Risks and Effects

Estimated risks and effects determine the need for remediation and restoration efforts, while perceived risks and effects determine the public's acceptance and support of DOE policies and actions. Estimating ecological risks and effects on the basis of sound science helps to ensure that good management decisions are made by reducing uncertainties associated with complex environmental processes. A 1999 report from the National Academy of Sciences stated that *"Ecological risks are better characterized at the Savannah River Site than at any other DOE installation, due in part to the designation of the site as a National Environmental Research Park and the presence of the Savannah River Ecology Laboratory."*

Task 4. Determine how the form of a contaminant influences dose-response and toxicity relationships. ($300K/year)

Radionuclides and metals will be the focus of most of the research on this topic. Experiments will determine the dose-response relationships from acute and chronic sublethal doses of radiation on DNA mutations in red blood cells and reproductive cells in the model fish, medaka. In other studies, metal concentrations, metal distributions within organisms, and potential molecular damage resulting from exposure to nickel will be examined in earthworms, nematodes, and turtles—all organisms with the potential to bioaccumulate metals and transfer them to higher trophic levels. Portions of this work will be conducted at the National Synchrotron Light Source at Brookhaven National Laboratory. Finally, the stable isotope composition of nitrogen in amino acids of microorganisms and higher-level organisms will be analyzed to determine the source and fate of nitrogenous compounds, and how contaminants affect protein metabolism in these organisms.

Task 5. Determine the potential effects and interactions from exposure to mixed contaminants. ($300K/year)

Estimating ecological risks and effects from mixed contaminants (e.g., radionuclides and metals) is difficult and not generally attempted, even though mixed contaminants are commonly found in DOE waste sites. Several field and laboratory studies are underway to develop new methods and generate new knowledge in this area. Interactions between nickel and trichloroethylene (TCE) are being studied in the Tims Branch-Steed Pond system, including how nickel might affect plant enzymes involved in the metabolism of TCE, how TCE might affect the uptake of nickel in plants by changing cell membrane structure, and how the presence of TCE may affect soil chemistry and thus nickel bioavailability to plants. In a related study, assays will be completed to determine the influence of nickel and uranium on TCE degradation by TCE-degrading bacteria. A study involving radiation and metals will be done in collaboration with scientists at the Medical College of Georgia to examine radiation-induced molecular responses in fish embryos with and without exposure to cadmium. Finally, field and laboratory approaches will be used to determine the impacts of ash basin runoff on microbial communities associated with sediments, open water and biofilms in 400-D Area.

Task 6. Define more clearly the risks from low dose-rate, chronic exposures to radiation. ($170K/year)

With partial funding from DOE's Office of Science and in collaboration with scientists from Colorado State University, experiments will be conducted on the transgenerational effects of low-dose rate irradiation using medaka fish as a model to determine the genetic response and frequency of mutations in exposed and unexposed progeny of irradiated parents. Irradiation experiments will be done at SREL's Low Dose Irradiation Facility located at PAR Pond.

Remediation and Restoration

The knowledge and expertise based at SREL are ideally suited to address the remediation and restoration of large land areas contaminated with relatively low levels of metals, organics, and radionuclides. SREL conducts multidisciplinary research designed to assist in the development, evaluation and stakeholder acceptance of remediation and restoration efforts that protect human and ecosystem health. Fundamental to the success of various bioremediation, natural attenuation, and *in situ* remediation applications is an understanding of the underlying scientific principles on which they are based.

Task 7. Identify the traits of native species and populations that best determine their suitability for use in remediation and restoration. ($175K/year)

Two areas of emphasis for this research are phytoremediation of contaminated sites on the SRS, and the use of native vegetation in restoration of degraded habitats. Studies will evaluate the potential for using tree species, such as poplar, sweet gum and sycamore, for remediation and restoration. We will also conduct studies on the ability of native plants along Pen Branch to assimilate and degrade both TCE and PCE. New phytoremediation research will begin to evaluate different grasses for their ability to assimilate and degrade TCE.

In collaboration with the U.S. Forest Service-SR, life-history traits of native plant species most successful in restoration of drained Carolina bays will be evaluated. Finally, the survival and reproductive success of threatened, endangered, and sensitive plant species will be assessed in experimental restoration gardens under different land management practices with partial support from a DoD-DOE-EPA SERDP grant.

Task 8. Determine the primary mechanisms by which natural attenuation and engineered remediation processes immobilize contaminants, and identify the appropriate geochemical and biological endpoints to assess sustainability. ($250K/year)

Laboratory studies involving co-contaminants will be completed to evaluate the effectiveness of hydroxyl apatite amendments in reducing metal toxicity to microorganisms, which should then enhance TCE degradation by the microorganisms. This is part of an effort to understand the biogeochemical processes leading to natural attenuation of uranium, nickel and other co-contaminant metals in Steed Pond-Tims Branch, and cesium in contaminated SRS stream corridors. In an ongoing study being conducted in collaboration with WSRC, existing field-scale solute tracer data from H-Area subsurface injection experiments will be analyzed to determine relationships between travel distance and geologic formation heterogeneity on longitudinal dispersion of the tracer, which acts as a surrogate for contaminants.

Education

Task 9. Support the education of college undergraduates and graduate students as one of SREL's core activities. ($140K/year)

Since SREL's founding, education and training of students have been important components of SREL's program. Undergraduate and graduate students from around the world are provided an opportunity to conduct research on the SRS under the supervision of SREL scientists. Students are integrated into SREL's research programs and supported with funding from DOE and external grants. SREL's summer undergraduate program is largely supported by the National Science Foundation. SREL seeks to graduate at least five students each year with M.S. or Ph.D. degrees based on research conducted at SREL.

Outreach

Task 10. Maintain outreach and communication programs to enhance the public's understanding of environmental issues affecting the SRS. ($175K/year)

Outreach to the general public is an important component of SREL's cooperative agreement and complements the Lab's research efforts. Environmental outreach programs target a range of audiences and age groups in an effort to increase the general public's awareness and understanding of environmental issues affecting the SRS and surrounding region. SREL personnel conduct over 200 presentations per year and provide associated educational materials to K-12 students, teachers and the general public.

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(Rev. 2)

Savannah River Ecology Laboratory (SREL) Scope of Work Office of Environmental Management

- In FY 2006, EM funded SREL research through an Assistant Manager for Waste Disposition Project account (EY8748140, Project 0001764 / ADSSR0014C / 41000).

- In FY 2007, SREL research will rely on two sources of EM funding. The first is $1,000,000 from SR Program Support. SREL will also conduct research for EM line organizations using individual task funding.

- For FY 2008, all EM funding for SREL will come from "tasks" funded by the line organizations.

The following summary identifies specific research subtasks for each of the eight SREL research task areas as well as the education and outreach components of the SREL project. It includes an estimate of the subtask cost for FY 2007 of $4,000,000. It also identifies which SR line organization(s) might benefit most from the identified research. Although it is recognized that all SR organizations could benefit from SREL activities, the following breakdown focuses on the Assistant Manager for Closure Project (AMCP), Assistant Manager for Nuclear Material Stabilization Project (AMNMSP), and the Assistant Manager for Waste Disposition Project (AMWDP).

Environmental Characterization

Characterization is a necessary first step in determining environmental and health risks and in devising appropriate remediation and restoration strategies. Environmental characterization information is also needed to make informed decisions about remediation approaches, long-term stewardship and land management, and it is also a critical component of NEPA reports, Records of Decision (ROD), and other regulatory documents. Environmental characterization is more than simply measuring contaminant concentrations in groundwater, soil, biota or other media, or reporting the presence of organisms at various locations. It includes developing an understanding of the processes that control distributions of contaminants, chemical forms, and their bioavailability. Characterization is also necessary to construct models of how natural and engineered systems function, both in the presence and absence of environmental contamination.

Task 1. Develop long-term ecological databases for use in Site documents and to determine whether any changes being observed are the result of natural fluctuations or operational impacts. ($504,000)

- Amphibian studies on the SRS ($104,000) - - Long-term studies that are needed to explain changes in site amphibian populations to distinguish construction and operational impacts from long-term, natural fluctuations. Driver: Regulatory documents for NEPA, RCRA, CERCLA, etc.; Value: Provides credible site-specific information for regulatory documents and environmental stewardship.
- Studies of the microbial communities of contaminated and uncontaminated streams ($150,000) - - Research to determine if bacterial exposure to metals will result in bacteria with increased resistance to both metals and antibiotics. Driver: Regulatory documents for NEPA, RCRA, CERCLA, etc.; Value: Provides credible site-specific information for regulatory documents and environmental stewardship.
- Carolina bay restoration studies ($75,000) - - Research to characterize baseline hydrologic conditions in these wetlands and assess vegetation changes as a baseline for evaluating wetland restoration success. Driver: Environmental restoration and SRS stewardship; Value: Supports wetland restoration, wetland mitigation banking, and U.S. policy of no net loss of wetlands.
- Sand Hills threatened, endangered, or sensitive (TES) species population studies ($75,000) - - Help determine if the management of red-cockaded woodpecker habitat at SRS adversely impacts (or benefits) other threatened, endangered and sensitive sand hills species. Driver: Compliance with the Endangered Species Act; Value: Provides site-specific data for assessing compliance.
- Alligator population dynamics ($100,000) - - Continue efforts to add blood samples from additional alligators into the SREL DNA laboratory collection as part of a long-term site data base project. Driver: Environmental restoration and SRS stewardship; Value: Provides site-specific data for developing and assessing a long-term environmental monitoring program on ecosystem health.

Task 2. Determine the biogeochemical processes that control chemical speciation and mobility of toxic metals, organic contaminants, and radionuclides. ($640,000)

- Uranium and nickel speciation in the Steed Pond – Tims Branch system ($200,000) - - Research to understand the biogeochemical processes that control the mobility of heavy metals to help make realistic estimates of human health and ecological risks and prudent remediation and management decisions for contaminated lands. Driver: Environmental remediation; Value: Provides site-specific data for reducing uncertainties and costs of remediation.
- Natural attenuation of PCE/TCE in Pen Branch hyporheic sediments ($165,000) - - Research to study the role of monitored natural attenuation (MNA) processes within the hyporhic zone in mitigating the flux of PCE, TCE, and CT from the

Chemicals, Metals, and Pesticide (CMP) groundwater plume into Penn Branch Creek. Driver: Environmental remediation; Value: Provides site-specific data for reducing uncertainties and costs of remediation.

- Development of compound-specific isotope ratio analysis ($200,000) - - Research to identify the primary carbon processing pathways used by microorganisms in Pen Branch sediments and provide insights into the biogeochemical parameters controlling the degradation rates of PCE and TCE in this system. Driver: Environmental remediation; Value: Provides site-specific data for reducing uncertainties and costs of remediation.
- Application of surface complexation models to descriptions of contaminant migration in the vadose zone ($75,000) - - To support in situ remediation approaches, a series of batch and column studies are evaluating the ability to enhance contaminant metal reduction within highly weathered soils and aquifer sediments with special emphasis on nutrient amendments. Driver: Environmental remediation; Value: Provides site-specific data for reducing uncertainties and costs of remediation.

Task 3. Assess whether sentinel species or other sensors can be used to characterize environmental health. ($440,000)

- Studies the effects of nickel exposures in turtles ($100,000) - - Through a controlled dosing experiment, research results demonstrate the potential utility of turtles as a sentinel species for a range of ecological risk applications and for long-term surveillance and monitoring activities. Driver: Environmental remediation; Value: Provides site-specific data for developing and assessing a long-term environmental monitoring program on ecosystem health.
- Studies of the relationship between microbial antibiotic resistance and environmental contamination ($110,000) - - *Escherichia coli* are being screened for levels of antibiotic resistance and known contamination as indicators of water-borne pathogens. Driver: Environmental remediation; Value: Provides site-specific data for developing and assessing a long-term environmental monitoring program on ecosystem health.
- Alligator population and genetic studies ($80,000) - - Data from earlier population studies are being used to develop new models of reproduction strategies as well as mutation rates in American alligators with the goal of using the alligator as a sentinel species for SRS. Driver: Environmental remediation; Value: Provides site-specific data for developing and assessing a new long-term environmental monitoring approach on ecosystem health.
- Using ecological indicators to determine disturbance associated with regional land use ($80,000) - - Environmental indicators developed at Fort Benning are being applied to disturbed areas on the SRS to determine if these indicators have long-term application for on-site land use decisions. Driver: Environmental stewardship; Value: Tests newly developed methods for assessing ecosystem health on the SRS.
- Using freshwater mollusks to monitor water chemistry ($70,000) - - Research using shells of freshwater bivalves from six SRS sites suggests that these bivalves may be reliable monitors of environmental conditions, but require additional research involving organism health. Driver: Environmental stewardship; Value:

Provides site-specific data for developing and assessing a long-term environmental monitoring program on ecosystem health.

Ecological Risks and Effects

Estimated risks and effects determine the need for remediation and restoration efforts, while perceived risks and effects determine the public's acceptance and support of DOE policies and actions. Estimating ecological risks and effects on the basis of sound science helps to ensure that good management decisions are made by reducing uncertainties associated with complex environmental processes. A 1999 report from the National Academy of Sciences stated that *"Ecological risks are better characterized at the Savannah River Site than at any other DOE installation, due in part to the designation of the site as a National Environmental Research Park and the presence of the Savannah River Ecology Laboratory."*

Task 4. Determine how the form of a contaminant influences dose-response and toxicity relationships. ($480,000)

- Exposure of earthworms to sediments from the Steed Pond – Tims Branch ecosystem ($75,000) - - Ongoing studies demonstrate that uranium and nickel accumulation from contaminated Tims Branch sediments using the model earthworm *Eisenia foetida* are significantly greater than those from control soils. Driver: Environmental remediation, Value:
- Exposure of transgenic nematodes to bioavailable metals ($85,000) - - Ongoing research demonstrates that transgenic nematodes can be used for fast and inexpensive detection of heavy metals in aquatic environments. Environmental remediation; Value: Provides site-specific data for developing and assessing a new long-term environmental monitoring approach on ecosystem health.
- Dose response relationships of Medaka to gamma irradiation ($90,000) - - Current experiments focus on characterizing additional families (of Medaka) to better understand variance in response among individuals, response at different stages during spermatogenesis, response of chronic versus acute exposure, and transgenerational effects. Driver: Environmental remediation; Value: Provides site-specific data on radiation effects for reducing uncertainties and costs of remediation.
- Rates of DNA repair in red blood cells from bluegills exposed to gamma radiation ($90,000) - - Continuing research will involve the repair dynamics and cellular responses to radiation-induced DNA damage, standardizing sampling protocols to maximize the detection of responses, and explaining variation in responses among individuals. Driver: Environmental remediation; Value: Provides site-specific data on radiation effects for reducing uncertainties and costs of remediation.
- Responses of native plants to elevated soil nickel concentrations ($70,000) - - Continuing research using loblolly pine seedlings suggests that elevated nickel concentrations (particularly when combined with flooding) contribute to stress

and reduced performance of loblolly pine seedlings. Driver: Environmental remediation and environmental stewardship; Value: Provides site-specific data for assessing impacts and reducing uncertainties and costs of remediation.

- Using nitrogen stable isotopes to study how contaminants affect protein metabolism ($70,000) - - A compound-specific isotope ratio analysis to determine the nitrogen and carbon isotope composition of individual amino acids that comprise protein is being developed to examine nitrogen sources and protein turnover in natural and impacted ecosystems. Driver: Environmental remediation; Value: Provides a tool for assessing site-specific impacts and reducing uncertainties and costs of remediation.

Task 5. Determine the potential effects and interactions from exposure to mixed contaminants. ($480,000)

- Determine the impacts of metal contamination on microbial communities ($100,000) - - Continuing research involving the growing concern that metal contamination acts as a selective agent in the attenuation and proliferation of antibiotic resistance. Driver: Environmental remediation and environmental stewardship; Value: Provides site-specific data on impacts of environmental contamination.
- Studies of the interaction of nickel and TCE in plants in the Steed Pond – Tims Branch ecosystem ($115,000) - - Research will focus on the effects of less toxic doses of nickel to hybrid poplar plants to determine effects on the formation of metabolites in the leaves and roots of the plants. Driver: Environmental remediation and environmental stewardship; Value: Provides site-specific data on impacts of environmental contamination and environmental health.
- Effects of low-dose rate ionizing radiation on frogs and toads ($75,000) - - Analysis of radiation effect studies on several site amphibian species to determine their radiosensitivity during egg development, larval period, and metamorphic period will continue as part of an effort to establish radiation protection guidelines for amphibians. Driver: Environmental remediation; Value: Provides site-specific data on radiation effects for reducing uncertainties and costs of remediation.
- Imaging of labeled non-target quantum dots within Medaka embryos ($75,000) - - Research is continuing, but initial findings indicate that the Medaka embryo may be a viable model for determining developmental problems from nanoparticle exposures. Driver: Environmental remediation and environmental stewardship; Value: Provides site-specific data for determining ecosystem health.
- Assess the influence of nickel and uranium on TCE degradation by bacteria ($115,000) - - Research is continuing to explore the how binary and ternary mixtures of contaminant classes negatively affect the use of microorganisms to degrade organic contaminants in the contaminated areas of the Tims Branch watershed. Driver: Environmental remediation and environmental stewardship; Value: Provides site-specific data on impacts of environmental contamination and environmental health.

Task 6. Define more clearly the risks from low dose-rate, chronic exposures to radiation. ($272,000)

- Radiation-induced untargeted germline mutations in Medaka fish ($272,000) - - Initial research indicates that the Medaka can serve as a model for studying contaminant-induced mutations, but additional research is needed to determine the consistency of response, identify which genomic context determines response, and determine whether or not results can be generalized across the genome. Driver: Environmental remediation; Value: Provides site-specific data on radiation effects for reducing uncertainties and costs of remediation.

Remediation and Restoration

The knowledge and expertise based at SREL are ideally suited to address the remediation and restoration of large land areas contaminated with relatively low levels of metals, organics, and radionuclides. SREL conducts multidisciplinary research designed to assist in the development, evaluation and stakeholder acceptance of remediation and restoration efforts that protect human and ecosystem health. Fundamental to the success of various bioremediation, natural attenuation, and *in situ* remediation applications is an understanding of the underlying scientific principles on which they are based.

Task 7. Identify the traits of native species and populations that best determine their suitability for use in remediation and restoration. ($280,000)

In FY 2007, Task 7 will include the following subtasks.

- Evaluation of native plants most successful in the restoration of Carolina bays ($50,000) - - To complete research analyses on the final two years of this five-year study that suggests that passive revegetation can be a successful strategy for these wetlands. Driver: Environmental restoration and SRS stewardship; Value: Supports wetland restoration, wetland mitigation banking, and U.S. policy of no net loss of wetlands.
- Assess survival of sandhills TES plant species under different land management regimes ($40,000) - - Continue sampling of research plots containing four sensitive, perennial sand hills plant species to assess their differing survival and reproductive responses to different disturbance treatments. Driver: Compliance with the Endangered Species Act; Value: Provides site-specific data for assessing compliance.
- Studies of plant species most useful for phytoremediation ($50,000) - - Prepare research findings on research projects that favorably compared native deciduous and coniferous trees to a remediation standard (hybrid poplar) with respect to uptake and degradation of TCE. Driver: Environmental remediation; Value: Provides site-specific data for reducing uncertainties and costs of remediation.

- Studies of plant species useful for biodiesel production in the Southeast ($40,000) - - Selected plant species (incorporating three fertilization regimes) will be assessed to determine the best plant/fertilizer combination to produce biodiesel as well as direct power generation through burning or ethanol production. Driver: None; Value: Provides data on potential alternative energy sources.
- Studies of carbon sequestration in nutrient-poor soils ($40,000) - - Complete research analysis on how growing conditions affect carbon sequestration in soils as a means of improving soils remediation. Driver: Environmental remediation; Value: Provides site-specific data for reducing uncertainties and costs of remediation.
- Investigation of the effects of flooding on MNA of a metal-contaminated site ($60,000) - - Completion of research involving mycorrhizal colonization on roots along the slope at the A-01 wetland along Tims Branch involving loblolly pine and broomsedge grass. Driver: Environmental remediation; Value: Provides site-specific data for reducing uncertainties and costs of remediation.

Task 8. Determine the primary mechanisms by which natural attenuation and engineered remediation processes immobilize contaminants, and identify the appropriate geochemical and biological endpoints to assess sustainability. ($400,000)

In FY 2007, Task 8 will include the following subtasks.

- Evaluations of the effectiveness of hydroxyl apatite amendments on TCE degradation by microbes ($200,000) - - Continuation of research demonstrating that hydroxyl apatite amendments may offer a feasible approach to reducing metal toxicity to microorganisms at mixed waste sites, thereby enhancing the degradation of co-contaminants. Driver: Environmental remediation; Value: Provides site-specific data for reducing uncertainties and costs of remediation.
- Analyses of field-scale tracer data from H-Area subsurface injections experiments ($200,000) - - Continuation of the analyses of data obtained from a series of field-scale experiments using tritiated water, bromide, and two fluorobenzoates as tracers in the water table at SRS to study contaminant migration in the subsurface environment. Driver: Environmental remediation; Value: Provides site-specific data for reducing uncertainties and costs of remediation.

Education

Since SREL's founding, education and training of students have been important components of SREL's program. Undergraduate and graduate students from around the world are provided an opportunity to conduct research on the SRS under the supervision of SREL scientists. Students are integrated into SREL's research programs and supported with funding from DOE and external grants. SREL's summer undergraduate program is largely supported by the National Science Foundation. SREL seeks to graduate at least five students each year with M.S. or Ph.D. degrees based on research conducted at SREL.

Task 9. Support the education of college undergraduates and graduate students as one of SREL's core activities. ($224,000)

Outreach

Outreach to the general public is an important component of SREL's cooperative agreement and complements the Lab's research efforts. Environmental outreach programs target a range of audiences and age groups in an effort to increase the general public's awareness and understanding of environmental issues affecting the SRS and surrounding region. SREL personnel conduct over 200 presentations per year and provide associated educational materials to K-12 students, teachers and the general public.

Task 10. Maintain outreach and communication programs to enhance the public's understanding of environmental issues affecting the SRS. ($280,000)

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TASKS	SUBTASKS	COST	DRIVERS	BEGAN	END
Environmental Characterization Characterization is a necessary first step in determining environmental and health risks and in devising appropriate remediation and restoration strategies. Environmental characterization information is also needed to make informed decisions about remediation approaches, long-term stewardship and land management, and it is also a critical component of NEPA reports, Records of Decision (ROD), and other regulatory documents. Environmental characterization is more than simply measuring contaminant concentrations in groundwater, soil, biota or other media, or reporting the presence of organisms at various locations. It includes developing an understanding of the processes that control distributions of contaminants, chemical forms, and their bioavailability. Characterization is also necessary to construct models of how natural and engineered systems function, both in the presence and absence of environmental contamination.					
1.0 Develop long-term ecological databases for use in Site documents and to determine whether any changes being observed are the result of natural fluctuations or operational impacts.	1.1 Amphibian studies on the SRS - - Long-term studies that are needed to explain changes in site amphibian populations to distinguish construction and operational impacts from long-term, natural fluctuations.	$82,000	?	FY2007	?
	1.2 Studies of the microbial communities of contaminated and uncontaminated streams - - Research to determine if bacterial exposure to metals will result in bacteria with increased resistance to both metals and antibiotics.	$116,500	?	FY2007	?
	1.3 Carolina bay restoration studies - - Research to characterize baseline hydrologic conditions in these wetlands and assess vegetation changes as a baseline for evaluating wetland restoration success.	$60,250	?	FY2007	?
	1.4 Sand Hills threatened, endangered, or sensitive (TES) species population studies- - Help determine if the management of red-cockaded woodpecker habitat at SRS adversely impact (or benefit) other threatened, endangered and sensitive sand hills species.	$60,250	?	FY2007	?
	1.5 Alligator population dynamics - - Continue efforts to add blood samples from additional alligators into the SREL DNA laboratory collection as part of a long-term site data base project.	$79,000	?	FY2007	?
Task 2.0 Determine the biogeochemical processes that control chemical speciation and mobility of toxic metals, organic contaminants, and radionuclides.	2.1 Uranium and nickel speciation in the Steed Pond — Tims Branch system - - Research to understand the biogeochemical processes that control the mobility of heavy metals to help make realistic estimates of human health and ecological risks and prudent remediation and management decisions for contaminated lands.	$154,000	?	FY2007	?
	2.2 Natural attenuation of PCE/TCE in Pen Branch hyporheic sediments - Research to study the role of monitored natural attenuation (MNA) processes within the hyporhic zone in mitigating the flux of PCE, TCE, and CT from the Chemicals, Metals, and Pesticide (CMP) groundwater plume into Penn Branch Creek.	$127,750	?	FY2007	?
	2.3 Development of compound-specific isotope ratio analysis - - Research to identify the primary carbon processing pathways used by microorganisms in Pen Branch sediments and provide insights into the biogeochemical parameters controlling the degradation rates of PCE and TCE in this system.	$154,000	?	FY2007	?
	2.4Application of surface complexation models to descriptions of contaminant migration in the vadose zone - - To support in situ remediation approaches, a series of batch and column studies are evaluating the ability to enhance contaminant metal reduction within highly weathered soils and aquifer sediments with special emphasis on nutrient amendments.	$60,250	?	FY2007	?
Task 3.0 Assess whether sentinel species or other sensors can be used to characterize environmental health.	3.1 Studies the effects of nickel exposures in turtles - - Through a controlled dosing experiment, research results demonstrate the potential utility of turtles as a sentinel species for a range of ecological risk applications and for long-term surveillance and monitoring activities.	$79,000	?	FY2007	?
	3.2 Studies of the relationship between microbial antibiotic resistance and environmental contamination - - Escherichia coli are being screened for levels of antibiotic resistance and known contamination as indicators of water- borne pathogens.	$86,500	?	FY2007	?
	3.3 Alligator population and genetic studies - - Data from earlier population studies are being used to develop new models of reproduction strategies as well as mutation rates in American alligators with the goal of using the alligator as a sentinel species for SRS.	$64,000	?	FY2007	?
	3.4 Using ecological indicators to determine disturbance associated with regional land use - - Environmental indicators developed at Fort Benning are being applied to disturbed areas at the SRS to determine if these indicators have long- term application for on-site land use decisions.	$64,000	?	FY2007	?

TASKS	SUBTASKS	COST	DRIVERS	BEGAN	END
	3.5 Using freshwater mollusks to monitor water chemistry Research using shells of freshwater bivalves from six SRS sites suggests that these bivalves may be reliable monitors of environmental conditions, but require additional research involving organism health.	$56,500	?	FY2007	?
Ecological Risks and Effects Estimated risks and effects determine the need for remediation and restoration efforts, while perceived risks and effects determine the public's acceptance and support of DOE policies and actions. Estimating ecological risks and effects on the basis of sound science helps to ensure that good management decisions are made by reducing uncertainties associated with complex environmental processes. A 1999 report from the National Academy of Sciences stated that "Ecological risks are better characterized at the Savannah River Site than at any other DOE installation, due in part to the designation of the site as a National Environmental Research Park and the presence of the Savannah River Ecology Laboratory."					
Task 4.0 Determine how the form of a contaminant influences dose-response and toxicity relationships.	4.1 Exposure of earthworms to sediments from the Steed Pond — Tims Branch ecosystem - - Ongoing studies demonstrate that uranium and nickel accumulation from contaminated Tims Branch sediments using the model earthworm *Eiseniafoetida* are significantly greater than those from control soils.	$60,520	?	FY2007	?
	4.2 Exposure of transgenic nematodes to bioavailable metals Ongoing research demonstrates that transgenic nematodes can be used for fast and inexpensive detection of heavy metals in aquatic environments.	$67,750	?	FY2007	?
	4.3 Dose response relationships of Medaka to gamma irradiation - - Current experiments focus on characterizing additional families (of Medaka) to better understand variance in response among individuals, response at different stages during spermatogenesis, response of chronic versus acute exposure, and transgenerational effects.	$71,500	?	FY2007	?
	4.4 Rates of DNA repair in red blood cells from bluegills exposed to gamma radiation - - Continuing research will involve the repair dynamics and cellular responses to radiation-induced DNA damage, standardizing sampling protocols to maximize the detection of responses, and explaining variation in responses among individuals.	$71,500	?	FY2007	?
	4.5 Responses of native plants to elevated soil nickel concentrations - - Continuing research using loblolly pine seedlings suggests that elevated nickel concentrations (particularly when combined with flooding) contributes to stress and reduced performance of loblolly pine seedlings.	$56,500	?	FY2007	?
	4.6 Using nitrogen stable isotopes to study how contaminants affect protein metabolism - - A compound-specific isotope ratio analysis to determine the nitrogen and carbon isotope composition of individual amino acids that comprise protein is being developed to examine nitrogen sources and protein turnover in natural and impacted ecosystems.	$56,500	?	FY2007	?
Task 5.0 Determine the potential effects and interactions from exposure to mixed contaminants.	5.1 Determine the impacts of metal contamination on microbial communities - - Continuing research involving the growing concern that metal contamination acts as a selective agent in the attenuation and proliferation of antibiotic resistance.	$79,000	?	FY2007	?
	5.2 Studies of the interaction of nickel and TCE in plants in the Steed Pond — Tims Branch ecosystem ($115,000) - Research will focus on the effects of less toxic doses of nickel to hybrid poplar plants to determine effects on the formation of metabolites in the leaves and roots of the plants.	$90,250	?	FY2007	?
	5.3 Effects of low-dose rate ionizing radiation on frogs and toads ($75,000) - - Analysis of radiation effect studies on several site amphibian species to determine their radiosensitivity during egg development, larval period, and metamorphic period will continue as part of an effort to establish radiation protection guidelines for amphibians.	$60,250	?	FY2007	?
	5.4 Imaging of labeled non-target quantum dots within Medaka embryos ($75,000) - - Research is continuing, but initial findings indicate that the Medaka embryo may be a viable model for determining developmental problems from nanoparticle exposures.	$60,250	?	FY2007	?
	5.5 Assess the influence of nickel and uranium on TCE degradation by bacteria ($115,000) - - Research is continuing to explore the how binary and ternary mixtures of contaminant classes negatively affect the use of microorganisms to degrade organic contaminants in the contaminated areas of the Tims Branch watershed.	$90,250	?	FY2007	?
Task 6.0 Define more clearly the risks from low dose-rate, chronic exposures to radiation.	6.1 Radiation-induced untargeted germline mutations in Medaka fish ($272,000) - - Initial research indicates that the Medaka can serve as a model for studying contaminant-induced mutations, but additional research is needed to determine the consistency of response, identify which genomic context determines response, and determine whether or not results can be generalized across the genome.	$208,000	?	FY2007	?

TASKS	SUBTASKS	COST	DRIVERS	BEGAN	END
Remediation and Restoration The knowledge and expertise based at SREL are ideally suited to address the remediation and restoration of large land areas contaminated with relatively low levels of metals, organics, and radionuclides. SREL conducts multidisciplinary research designed to assist in the development, evaluation and stakeholder acceptance of remediation and restoration efforts that protect human and ecosystem health. Fundamental to the success of various bioremediation, natural attenuation, and in situ remediation applications is an understanding of the underlying scientific principles on which they are based.					
Task 7.0 Identify the traits of native species and populations that best determine their suitability for use in remediation and restoration.	7.1 Evaluation of native plants most successful in the restoration of Carolina bays ($50,000) - - To complete research analyses on the final two years of this five- year study that suggests that passive revegetation can be a successful strategy for these wetlands.	$41,500	?	FY2007	?
	7.2 Assess survival of sandhills TES plant species under different land management regimes ($40,000) - - Continue sampling of research plots containing four sensitive, perennial sand hills plant species to assess their differing survival and reproductive responses to different disturbance treatments.	$34,000	?	FY2007	?
	7.3 Studies of plant species most useful for phytoremediation ($50,000) - - Prepare research findings on research projects that favorably compared native deciduous and coniferous trees to a remediation standard (hybrid poplar) with respect to uptake and degradation of TCE.	$41,500	?	FY2007	?
	7.4 Studies of plant species useful for biodiesel production in the Southeast ($40,000) Selected plant species (incorporating three fertilization regimes) will be assessed to determine the best plant fertilizer combination to produce biodiesel as well as direct power generation through burning or ethanol production.	$34,000	?	FY2007	?
	7.5 Studies of carbon sequestration in nutrient-poor soils ($40,000) Complete research analysis on how growing conditions affect carbon sequestration in soils as a means of improving soils remediation.	$34,000	?	FY2007	?
	7.6 Investigation of the effects of flooding on MNA of a metal-contaminated site ($60,000) - - Completion of research involving mycorrhizal colonization on roots along the slope at the A-0 1 wetland along Tims Branch involving loblolly pine and broomsedge grass.	$49,000	?	FY2007	?
Task 8.0 Determine the primary mechanisms by which natural attenuation and engineered remediation processes immobilize contaminants, and identify the appropriate geochemical and biological endpoints to assess sustainability.	8.1 Evaluations of the effectiveness of hydroxyl apatite amendments on TCE degradation by microbes - - Continuation of research demonstrating that hydroxyl apatie amendments may offer a feasible approach to reducing metal toxicity to microorganisms at mixed waste sites, thereby enhancing the degradation of co-contaminants.	$154,000	?	FY2007	?
	8.2 Analyses of field-scale tracer data from H-Area subsurface injections experiments- - Continuation of the analyses of data obtained from a series of field- scale experiments using tritiated water, bromide, and two fluorobenzoates as tracers in the water table at SRS to study contaminant migration in the subsurface environment.	$154,000	?	FY2007	?
Outreach Outreach to the general public is an important component of SREL's cooperative agreement and complements the Lab's research efforts. Environmental outreach programs target a range of audiences and age groups in an effort to increase the general public's awareness and understanding of environmental issues affecting the SRS and surrounding region. SREL personnel conduct over 200 presentations per year and provide associated educational materials to K- 12 students, teachers and the general public. Task 10. Maintain outreach and communication programs to enhance the public's understanding of environmental issues affecting the SRS.		$242,000	?	FY2007	?
		$3,000,270			

TASKS / SUBTASKS	FY 2007 COST	SR	PBS	DOE PROJECT SUPPORT	DOE CRITICAL NEED	SREL PRODUCT / DATE	END
Task 1.0 - Develop long-term ecological databases for use in Site documents and to determine whether any changes being observed are the result of natural fluctuations or operational impacts							
1.1 Studies of the microbial communities of contaminated and uncontaminated streams - - Research to determine if bacterial exposure to metals will result in bacteria with increased resistance to both metals and antibiotics.	$270,000	AMNMSP	SR-0011	1) Maintains ecological data bases through continuing research to support NEPA documents, RODs, and other regulatory documents. 2) Supplemental Analysis, Highly Enriched Uranium and Spent Fuel Management. 3) Supplemental EIS, Plutonium Disposition at SRS. 4) Programmatic EIS for the Global Nuclear Energy Partnership (GNEP).	None	1) Annual summary of results / 10-01-07 2) Journal publication / 06-30-07 3) Monthly highlights report	FY2008
1.2 Carolina bay restoration studies - - Research to characterize baseline hydrologic conditions in these wetlands and assess vegetation changes as a baseline for evaluating wetland restoration success.	$99,000	AMCP	SR-0030	1) Maintains ecological data bases through continuing research to support NEPA documents, RODs, and other regulatory documents. 2) Supports SRS Wetlands Mitigation Bank that would support cost avoidance for selected cleanup projects.	None	1) Annual summary of results / 10-01-07 2) Journal publication / 09-30-07 3) Monthly highlights report	FY2008
1.3 Sand Hills threatened, endangered, or sensitive (TES) species population studies- - Help determine if the management of red-cockaded woodpecker habitat at SRS adversely impacts (or benefits) other threatened, endangered and sensitive Sand Hills plant species.	$90,000	AMWDP	SR-0014	1) Maintains ecological data bases through continuing research to support NEPA documents, RODs, and other regulatory documents. 2) EA for the Tank Closure at SRS. 3) EA for Closure Alternatives for Stormwater Outfalls at SRS.	None	1) Annual summary of results / 10-01-07 2) Journal publication / 10-01-07 3) Monthly highlights report	FY2008
1.4 SRS GIS wildlife survey data base - - Review SREL and USFS-SR publications, reports, theses, and dissertations generated and assemble records for vertebrate species and site locations for 77 receptor species. This information is used for SRS risk assessments and in communicating with regulators.	$30,000	AMCP	SR-0030	Maintains ecological data bases through continuing research to support NEPA documents, RODs, and other regulatory documents.	Supports preparation of all CERCLA OU and IOU risk assessments and RODs.	1) Semi-annual update of data / 01-15-07 2) Semi-annual update of data / 07-15-07 3) Monthly highlights report	FY2011
1.5 SRS GIS historic research sites - - Create a new GIS coverage of historic research sites to be used when conducting ecological and health risk assessments as well as evaluating site remediation efforts, siting new facilities, or locating clean reference sites.	$35,000	AMCP	SR-0030	Maintains ecological data bases through continuing research to support NEPA documents, RODs, and other regulatory documents.	Supports preparation of all CERCLA OU and IOU risk assessments and RODs.	1) Monthly status reports 2) New GIS data layer / 10/30/07 3) Monthly highlights report	FY2011

TASKS / SUBTASKS	FY 2007 COST	SR	PBS	DOE PROJECT SUPPORT	DOE CRITICAL NEED	SREL PRODUCT / DATE	END
1.6 Fish studies in Tim's Branch - - Research to determine metal concentrations in selected fish species along the stream gradient from upper Tim's Branch to its confluence with Upper Three Runs. These results will be combined with results from two existing preliminary studies to examine accumulation over time, use stable isotope analyses to assess trophic position of biota within different stream habitats relative to accumulation, and determine if the impoundments influence the concentration of metals in aquatic biota.	$83,000	AMCP	SR-0030	Maintains ecological data bases through continuing research to support NEPA documents, RODs, and other regulatory documents.	Supports the Upper Three Runs CERCLA IOU ROD.	1) Monthly status reports 2) Final data and results / 10-15-07 3) Monthly highlights report	FY2008
1.7 Fourmile Branch aquatic biota study - - This research will document contaminant levels and determine potential risks to piscivorous wildlife and possibly humans. Biota include an invertebrate and three fish species of different trophic levels to examine effects of trophic position. The project will focus on mercury, radiocesium, other metals, and tritium.	$79,000	AMCP	SR-0030	Maintains ecological data bases through continuing research to support NEPA documents, RODs, and other regulatory documents.	Supports the Fourmile Branch CERCLA IOU ROD.	1) Monthly status reports 2) Final data and reports / 10-15-07 3) Monthly highlights report	FY2008
1.8 D-Area Ash Basin herpetofauna study - - Field assessment will be conducted to quantify the herpetofauna community in the D-Area Ash Basin wetlands in comparison to similar uncontaminated sites. Part of this effort will be to develop general models that can be used to identify SRS areas that are healthy (or unhealthy) in terms of predicted diversity of herpetofauna.	$65,000	AMCP	SR-0030	Maintains ecological data bases through continuing research to support NEPA documents, RODs, and other regulatory documents.	Supports the Savannah River / Floodplain Swamp CERCLA IOU ROD.	1) Monthly status reports 2) Task report / 10-15-07 3) Monthly highlights report	FY2009
1.9 K-Area ecological studies - - Ecological baseline studies will be conducted in K-Area and adjacent watersheds to help assess the impacts of existing and future operational activities.	$285,000	AMNMSP	SR-0011	1) Maintains ecological data bases through continuing research to support NEPA documents, RODs, and other regulatory documents. 2) Supplemental EIS, Storage of Surplus Plutonium Materials at SRS. 3) Establish an ecological baseline to enable future environmental assessment of impacts from plutonium processing (surveillance and disposition) facilities in K-Area.	None	1) Annual summary of results / 10-01-07 2) Monthly highlights report	FY2011
Task 2.0 - Determine the biogeochemical processes that control chemical speciation and mobility of toxic metals, organic contaminants, and radionuclides.							

TASKS / SUBTASKS	FY 2007 COST	SR	PBS	DOE PROJECT SUPPORT	DOE CRITICAL NEED	SREL PRODUCT / DATE	END
2.1 Uranium and nickel speciation in the Steed Pond — Tims Branch system - - Research to understand the biogeochemical processes that control the mobility of heavy metals to help make realistic estimates of human health and ecological risks and prudent remediation and management decisions for contaminated lands.	$75,000 $205,000	AMNMSP AMWDP	SR-0011 SR-0014	1) Operations at SRS have resulted in the release of heavy metal ions, including transition metals, metalloids, and actinides into the site environment. Research is needed to determine the biochemical processes that control chemical form and mobility. This information should provide a basis for more accurate risk assessments and improved remediation methods and should reduce regulatory and local stakeholder concerns about continuing site operations. 2) Supports the Upper Three Runs CERCLA IOU ROD.	None	1) Annual summary of results / 10-01-07 2) Journal publication / 07-01-07 3) Monthly highlights report	FY2008
2.2 Natural attenuation of PCE/TCE in Pen Branch hyporheic sediments - Research to study the role of monitored natural attenuation (MNA) processes within the hyporhic zone in mitigating the flux of PCE, TCE, and CT from the Chemicals, Metals, and Pesticide (CMP) groundwater plume into Pen Branch Creek.	$85,000	AMCP	SR-0030	1) Refinement of current natural remedial process remedies and the development of those remedies for non-organic (metals, radionuclides) contaminants is needed to enable timely regulatory approvals and the earlier shutdown of major groundwater cleanup facilities. 2) CMP Pits Post-ROD operation and maintenance and CERCLA IOU ROD.	None	1) Annual summary of results / 10-01-07 2) Journal publication / 10-01-07 3) Monthly highlights reports	FY2009
2.3 Development of compound-specific isotope ratio analysis - - Research to identify the primary carbon processing pathways used by microorganisms in Pen Branch sediments to provide insights into the biogeochemical parameters controlling the degradation rates of PCE and TCE in this system. Examine nitrogen sources and protein turnover in natural and impacted environments.	$85,000	AMCP	SR-0030	1) Scientific and policy support is needed to facilitate implementation of passive cleanup and cost-effective monitoring strategies leading to responsible completion of active remediation activities at SRS. 2) CMP Pits Post-ROD operation and maintenance and CERCLA IOU ROD.	None	1) Annual summary of results / 10-01-07 2) Journal publication / 09-01-07 3) Monthly highlights report	FY2008
2.4 Application of surface complexation models to descriptions of contaminant migration in the vadose zone - - To support in situ remediation approaches, a series of batch and column studies are evaluating the ability to enhance contaminant metal reduction within highly weathered soils and aquifer sediments with special emphasis on nutrient amendments.	$155,000	AMWDP	SR-0014	In situ reduction may be an effective means of remediating groundwater systems contaminated with redox sensitive contaminants such as U and Cr. However, before this approach (nutrient amendments) can be employed, additional data are needed to address uncertainties about varying mineralogy and the possibility of enhanced contaminant migration. The refinement of contaminant migration models and less expensive and less impactive remediation methods should reduce regulatory and stakeholder concerns about continuing site operations and cleanup strategies.	None	1) Annual summary of results / 10-01-07 2) Journal publication / 05-01-07 3) Monthly highlights report	FY2009
Task 3.0 - Assess whether sentinel species or other sensors can be used to characterize environmental health.							

TASKS / SUBTASKS	FY 2007 COST	SR	PBS	DOE PROJECT SUPPORT	DOE CRITICAL NEED	SREL PRODUCT / DATE	END
3.1 Alligator population and genetic studies - - Data from earlier and ongoing studies are being used to generate a population database as well as mutation rates in American alligators with the goal of using the alligator as a sentinel species for metal and radionuclide contamination on the SRS.	$165,000 $85,000	AMWDP AMNMSP	SR-0014 SR-0011	SRS has and will continue to treat store and dispose of radioactive liquid waste. SRS will also continue to store various forms of nuclear material. One method to characterize environmental is the development of sentinel species. The alligator is a candidate species for SRS. The development and use of sentinel species should reduce regulatory and local stakeholder concerns about continuing site operations.	None	1) Annual summary of results / 10-01-07 2) Journal publication / 07-15-07 3) Monthly highlights report	FY2011
3.2 Using ecological indicators to determine disturbance associated with regional land use - - Environmental indicators developed at Fort Benning are being applied to disturbed areas at the SRS to determine if these indicators have long- term application for on-site land use decisions.	$80,000	AMWDP	SR-0014	Site operations can impact large areas of SRS. Ecological indicators can be used o determine what, if any, long-term impacts are associated with particular site uses. The development and appropriate use of such indicators should reduce regulatory and stakeholder concerns about ongoing site operations.	None	1) Modeling results and analysis / 07-01-07 2) Journal publication / 08-01-07 3) Monthly highlights report	FY2007
Task 4.0 - Determine how the form of a contaminant influences dose-response and toxicity relationships.							
4.1 Dose-response relationships in receptor species--ongoing studies using various receptor species, including earthworms, to assess dose-response relationships for metals and radionuclides.	$105,000	AMWDP	SR-0014	SRS has and will continue to treat store and dispose of radioactive liquid waste. SRS will also continue to store various forms of nuclear material. One method to characterize environmental is the development of sentinel species. The alligator is a candidate species for SRS. The development and use of sentinel species should reduce regulatory and local stakeholder concerns about continuing site operations.	None	1) Annual summary of results / 10-01-07 2) Journal publication / 03-30-07 3) Monthly highlights report	FY2008
4.2 Dose response relationships of Medaka fish to gamma irradiation - - Current experiments focus on characterizing additional families of the model fish, Medaka, to better understand variance in response among individuals, response at different stages during spermatogenesis, response of chronic versus acute exposure, and transgenerational effects.	$80,000	AMWDP	SR-0014	SRS has and will continue to treat store and dispose of radioactive liquid waste. SRS will also continue to store various forms of nuclear material. Dose-response research Medaka research should help the site quantify radiological impacts to animal populations and could also reduce regulatory and local stakeholder concerns about continuing site operations.	None	1) Annual summary of results / 10-01-07 2) Journal publication / 02-15-07 3) Monthly highlight report	FY2011
Task 5.0 - Determine the potential effects and interactions from exposure to mixed contaminants.							

TASKS / SUBTASKS	FY 2007 COST	SR	PBS	DOE PROJECT SUPPORT	DOE CRITICAL NEED	SREL PRODUCT / DATE	END
5.1 Studies of the interaction of nickel and TCE in plants in the Steed Pond — Tims Branch ecosystem - - Research will focus on the effects of less toxic doses of nickel to hybrid poplar plants to determine effects on the formation of metabolites in the leaves and roots of the plants.	$90,000	AMCP	SR-0030	1) Data on natural remediation processes and the application of those processes for non-organic (metals, radionuclides) contaminants are needed to enable public acceptance, timely regulatory approvals, and an earlier shutdown of major groundwater cleanup facilities. 2) Supports the Upper Three Runs CERCLA IOU ROD.	None	1) Annual summary of results / 10-01-07 2) Journal publication / 02-01-07 3) Monthly highlights report	FY2009
Task 6.0 - Define more clearly the risks from low dose rate, chronic exposures to radiation.							
6.1 Effects of low-dose rate ionizing radiation-- Radiation effect studies using site amphibian species as model organisms to determine their radiosensitivity during egg development, larval period, and metamorphic period will continue as part of an effort to establish data for potential radiation protection guidelines for natural populations.	$295,000 $35,000	AMWDP AMNMSP	SR-0014 SR-0011	SRS has and will continue to treat store and dispose of radioactive liquid waste. SRS will also continue to store various forms of nuclear material. The study of low-dose rate radiation effects on wildlife populations should reduce regulatory and local stakeholder concerns about continuing site operations including the Saltstone Facility, K-Area plutonium storage and disposition, and the proposed GNEP.	None	1) Annual summary of results / 10-01-07 2) Journal publication / 03-01-07 3) Monthly highlights report	FY2011
Task 7.0 Identify the traits of native species and populations that best determine their suitability for use in remediation and restoration.							
7.1 Evaluation of native plants most successful in the restoration of Carolina bays - - To complete research analyses on the final two years of this five- year study that suggests that passive revegetation can be a successful strategy for these wetlands.	$91,000	AMWDP	SR-0014	Site operations can affect wetland areas of the site. The research and development of cost effective wetland restoration techniques can be used to repair wetland damage caused by past and existing site operations. Proven restoration techniques could also have application in future clean up efforts.	None	1) Final data and analysis / 09-01-07 2) Journal publication / 10-01-07 3) Monthly highlights report	FY2007
7.2 Mixed Waste Management Facility (MWMF) remediation - - A cooperative effort with USFS-SR and SGCP to assist with site waste management and provide the evapo-transportation efficiency estimates required for the Corrective Action Report (CAR).	$99,000	AMCP	SR-0030	1) Maintains ecological data bases through continuing research to support NEPA documents, RODs, and other regulatory documents.	Supports the Mixed Waste Management Facility CAR.	1) Annual summary of results / 10-01-07 2) Evapo-transpiration efficiency estimates / 02-15-07 3) Monthly highlights report	FY2011
Task 8.0 Determine the primary mechanisms by which natural attenuation and engineered remediation processes immobilize contaminants, and identify the appropriate geochemical and biological endpoints to assess sustainability.							

TASKS / SUBTASKS	FY 2007 COST	SR	PBS	DOE PROJECT SUPPORT	DOE CRITICAL NEED	SREL PRODUCT / DATE	END
8.1 Evaluations of the effectiveness of hydroxyl apatite amendments on TCE degradation by microbes - - Complete research demonstrating that hydroxyl apatie amendments may offer a feasible approach to reducing metal toxicity to microorganisms at mixed waste sites, thereby enhancing the degradation of co-contaminants.	$136,000	AMWDP	SR-0014	Co-contaminant metals can inhibit the microbial degradation processes responsible for attenuation and bioremediation of organic contaminants. Information is needed to understand these processes and interactions. Research results will be used for developing alternative in situ remediation methods for mixed contaminants. Results will also be used to evaluate co-contaminant metal toxicity against existing regulatory metals requirements (NPDES).	None	1) Annual summary of results / 10-01-07 2) Journal publication / 03-30-07 3) Monthly highlights report	FY2008
8.2 Analyses of field-scale tracer data from H-Area subsurface injections experiments- - Complete analyses of data obtained from a series of field-scale experiments using tritiated water, bromide, and two fluorobenzoates as tracers in the water table at SRS to study contaminant migration in the subsurface environment.	$98,000	AMWDP	SR-0014	Hydrodynamic dispersion is an important factor controlling contaminant migration in the subsurface environment. However, few comprehensive three-dimensional data sets exist for critically evaluating solute dispersion. Results from this field-scale study in H-Area will provide important site-specific information for evaluating solute dispersion in H-Area and other site facilities.	None	1) Annual summary of results / 10-01-07 2) Journal publication / 02-15-07 3) Monthly highlights report	FY2008
EM Total	$3,000,000						