

**ADDRESSING GLOBAL ENVIRONMENTAL CHALLENGES:
A WHITE PAPER ON THE PROMOTION OF INTERDISCIPLINARY RESEARCH
AND TEACHING AT THE COLLEGE OF WILLIAM & MARY**

May 11, 2010

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I. Introduction

The challenges of the 21st century appear at all scales of space and time, and are increasingly complex and interdisciplinary in their nature and profoundly environmental in their context. Rarely can these challenges be studied, researched or solved simply from a single disciplinary perspective. To maintain and enhance its status as a leader in higher education, William & Mary needs to encourage greater interdisciplinary approaches to solving environmental problems and to understanding their relationships with society. It needs to incorporate these approaches into the fabric of its strong liberal arts education – even to the point of making them second nature. Building more interdisciplinary perspectives into teaching and research will not only better prepare our students to meet the complex environmental challenges of the 21st century; it also will enable the College to leverage its strengths in departments, schools, and programs throughout the College to create economies of scale and attract resources that would not otherwise flow to the College under a traditional, discipline-specific approach.

A. Brief Background

The 1994 Strategic Plan “Into the Fourth Century” identified the university’s existing strengths in environmental science and policy as an area for integration and additional support. As a consequence, interdisciplinary collaborations in environmental science and policy flourished at W&M in the mid - 1990s with the formation of an Environmental Science & Policy Cluster whose Director reported to the Provost. Among the Cluster’s accomplishments were the active involvement of faculty from Arts & Sciences, Law, VIMS, Business and Education; the successful pursuit of a large grant from the W.M. Keck Foundation for the construction of a field laboratory to study environmental science and policy in a dedicated space; funding from Canon Virginia to support a speaker series; the creation and filling of two faculty positions to support the undergraduate Environmental Science & Policy program (one in Economics linking ecology and economics and a second in Biology solidifying the link between the Biology Department and the Keck Lab); the development of a new introductory environmental science and policy course for ENSP through the involvement of faculty throughout the university; and collaboration with the Arts & Sciences and Law School deans and with faculty from Arts & Sciences, VIMS, and Law on the successful submission of an initial grant from the Mellon Foundation to promote the further development of ENSP through additional faculty hires. The Cluster also spearheaded collaboration on interdisciplinary grant proposals to NSF for an LTER research site and the initial IGERT (both unsuccessful), as well as faculty workshops and meetings. Once the Cluster was dissolved (in large part because of its success in producing tangible benefits that could be attached to other units) and much of its coordinating function, authority and funding transferred

to Arts & Sciences, collaborative opportunities among schools and faculties declined significantly.

B. Charge to the Working Group

In the fall of 2009, President Reveley asked the Vice Provost for Research Dennis Manos and Professor Dennis Taylor (SMS/VIMS) to assemble an ad hoc group from across the university to explore ways to enhance and encourage the further development of interdisciplinary teaching and research related to the environment. The charge to the committee was to inventory and assess the strengths and weaknesses within A&S and the graduate and professional schools of Business, Education, Law and Marine Science (SMS/VIMS) related to environmental education and research; to survey faculty interest in interdisciplinary teaching, research and scholarship on environmental topics; and to recommend how best to bring these interests, expertise and creative strengths in environmental areas from across the university together in a fashion that would stimulate creative thinking and open new opportunities for supporting innovative teaching and research throughout W&M.

II. Findings

William & Mary already has considerable strengths and interests in environmental science and policy. The Working Group assessed those strengths and interests before preparing this white paper. The survey confirms the existence of a large number of interested faculty who are presently engaged, complemented by additional faculty who would also be eager to participate. The results are described briefly in the next section. A more comprehensive review of the survey is found in Appendix A.

A. Survey Results

The Working Group used the list of faculty maintained by the Provost's Office to conduct the 15-question survey. The first nine of the questions drafted by the committee were intended to assess the degree to which faculty were either currently participating in programs related to environmental issues, had participated in such programs in the recent past, or would be willing to participate in the immediate future. Questions were also designed to assess the degree to which such participation was interdisciplinary in nature. The 10th through the 13th questions invited responders to list their name and contact information as part of a college wide effort to enhance programs in this area. The 14th question asked responders to assess the importance of various items the Working Group had identified as impediments to interdisciplinary work, and the 15th question invited open-ended responses to a solicitation for suggestions to remove barriers or provide incentives for interdisciplinary work.

The survey generated a 58% response rate across the 538 invitees. Of the 314 responders, 249 (nearly half of all invitees) completed the entire survey. In response to question 10, 108 faculty members indicated that they would be willing to participate in College-wide work in this area. Among this group of responders 100 provided us with a name, phone, and email contact information. One hundred and fifty five faculty were unwilling, or unable, to participate, and

fifty-one did not answer that question, which likely means they also were unwilling or unable to participate. The names submitted will be kept confidential (as Provost operational or working documents and data). Of the responders more than 20 came from VIMS, between 5 and 10 each from the Law School and Business School, several from the School of Education, and the remainder was distributed broadly from Arts and Sciences, mainly from physical and social sciences, but also included a few faculty from Area I.

A brief summary of the short questions follows: 124 faculty self identified as having skills needed to teach or do research in environmental matters; 90 of these have published in relevant areas previously, with 65 identifying either a significant part or the majority of their research in this area within the last five years, joined by five others at that level more recently. Among responders, 81 would be moderately interested or very interested in writing proposals for outside funding in this area, 69 were slightly interested, and 112 were not interested in proposal writing. Furthermore 87 faculty would be moderately or very interested in participating in such funded work, 57 slightly interested, and 121 not interested; 89 would be moderately or very interested in participating in seminars, 96 would be slightly interested, and 79 were not interested; and 93 are moderately or very interested in team teaching in cross listed curricular offerings, 60 slightly interested, and 110 not interested in team teaching in this area.

Verbatim comments (see the appendix) were critical of question nine, which asked faculty for their opinion about the level of support for interdisciplinary research and teaching. Some called it a “loaded question” since the range of answers did not offer “too high” as a possibility. We constructed the question and choices this way because there has been a longstanding presumption that support for interdisciplinary work is too low and barriers too high. Accepting that presumption, we intended to interrogate the reasons; this can be taken as a design flaw in the survey. Notwithstanding this criticism, 158 faculty felt that there was much too little or somewhat too little support for interdisciplinary work, whereas 156 either felt support was about right (87), or did not answer this question (69). Note that those 69 who did not answer may also have felt support was either “about right”, or “too high”. In any event we can derive that many professors believe that support is too low. Among faculty marking various impediments in question 14 as either “very important” or “somewhat important”, 86 pointed to difficulty in including these experiences for consideration in tenure or promotion matters; 128 felt it was difficult to obtain funding for this research, 80 felt a lack of interest among their colleagues, and 109 felt their department culture did not encourage interdisciplinary activity.

B. Working Group Findings

After reviewing survey results, comparing the results of prior efforts to encourage interdisciplinary teaching and research, and talking to faculty involved in current efforts, the Ad Hoc Committee makes the following findings.

- The Working Group finds that the survey reveals a broad and fairly significant faculty interest in interdisciplinary environmental work across all of the schools and faculties. A large number of faculty are already engaged, largely through existing programs. Undergraduate teaching and research have increased in part as a reaction to the groundswell of student interest. In addition to its popular undergraduate program in

Environmental Science & Policy, the College also has strong environmental offerings and faculty expertise in the Virginia Institute of Marine Science/School of Marine Science, The Thomas Jefferson Program in Public Policy, the Law School, and the Business School.

- The Working Group finds that much more interdisciplinary environmental work might be done with improved incentives, reduced impediments, additional support, and realignments of procedures that encourage faculty to engage in interdisciplinary work.
- Based on an academic audit undertaken by the Committee on Sustainability in 2009, the Working Group finds that teaching and scholarship in a broad spectrum of areas and disciplines is now incorporating increased amounts of sustainability and environmental content. These results reveal growing interest and activity in interdisciplinary scholarship relating to environmental issues.¹
- Finally, the Working Group finds that the Environmental Science & Policy Cluster created as a university-wide project to foster better coordination and engagement in interdisciplinary environmental teaching and research by faculty throughout the university was a successful model that attracted extra-mural support and laid the foundations for a stronger undergraduate major and the minor in environmental science and policy.

III. Recommendations

Inherently interdisciplinary in nature, environmental issues pose some of the greatest local and global challenges of all time. With a greater interdisciplinary focus, William & Mary would be well positioned to assume the mantle of educating future generations of environmentally literate leaders, scholars, and citizens: graduates who could understand the science, the policy and the socio-cultural dimensions of complex environmental issues.

In order to achieve this greater interdisciplinary focus, overcome impediments to faculty engagement, and provide a creative locus for generating new interdisciplinary collaboration and extramural funding relating to environmental issues, the committee envisions the creation of a formal structure, with a Director, whose purpose is to encourage interdisciplinary research and teaching and facilitate the growth of this enterprise. We believe that the former Environmental Science and Policy Cluster provides a useful starting model that is sufficiently adaptive and flexible to achieve this purpose. It can be easily modified to encourage greater faculty participation and to grow over time as the interdisciplinary effort grows, expands and succeeds. We further believe that this new formal structure should begin modestly with a relatively small investment in a program that encourages interdisciplinary groups of faculty to self-organize around a shared scholarship based on environmental interests. Over time, as these emergent groups of faculty increase in number and gain success, the College can position itself to capture new funding resources not normally considered as options by our faculty and thereby enhance its position as a leading university of the 21st C. We describe how this would develop below.

¹ See the results of that survey at the College's sustainability website:
<http://www.wm.edu/sites/sustainability/documents/academicauditreport.pdf>.

A. Cluster to Institute: Strengthening and Growing Interdisciplinary Work

An important initial action is to seek ways to strengthen the College's core environmental programs in ENSP and VIMS. Both programs will require greater financial investment to increase capacity as interdisciplinary research and teaching develops across the university.

Relative to its number of majors and minors (56 in 2010), ENSP has one of the lowest M&O budgets of any Arts & Sciences department or program and has experienced difficulty maintaining the effectiveness of original MOUs and receiving credit for ENSP related teaching at the departmental level. Since the Cluster disbanded in 2003, no person or group reporting to the Provost has had responsibility for promoting interdisciplinary work on the environment.

For some time now, the School of Marine Science/Virginia Institute of Marine Science (SMS/VIMS) has been under-supported with respect to its mission in teaching, research and advisory service. One of the nation's leading institutions specializing in coastal and estuarine marine science, SMS/VIMS has a separate state-supported budget that is distinct from that of the university. The current recession has had a large affect on the extent of state support, impacting SMS/VIMS' ability to fully fund support functions and to provide additional support for research and teaching. This will likely persist for the foreseeable future. However, the strengths of SMS/VIMS provide W&M with considerable depth and expertise in environmental studies at all scales from local to global. SMS/VIMS has contributed substantially to teaching and mentoring in ENSP, and growing numbers of SMS/VIMS faculty are engaged in collaborative efforts on the Williamsburg and Gloucester Point campuses. These contributions and strengths are a critical asset for any initiative seeking to expand interdisciplinary environmental work throughout the university and to create new, mutually beneficial partnerships and collaborations.

In parallel with action to strengthen ENSP and SMS/VIMS, W&M would create a formal structure *under the Provost* for promoting interdisciplinary research and teaching on the environment throughout the university. In its initial form this structure should resemble that of the Environmental Science and Policy Cluster. However, over time, its understood trajectory would include growth based on proven successes to achieve the condition of a much larger entity. We propose to call this structure the Institute for Society and the Environment (see below). The essential idea is to create an open, stimulating and welcoming structure capable of engaging faculty and students from across all the disciplines, programs, departments, and schools of the College. This more formal structure involving both responsibility and accountability would be better positioned to promote the unique intellectual chemistry needed to support the development of a strong interdisciplinary framework linking the faculty and students willing to meet the challenges of the work itself. There are a variety of tools and methods for implementing and growing this formal structure. The discussion that follows in the section on "Basic Organization and Structure" describes just a few of those tools.

From the onset the Institute for Society and the Environment would provide the direction and the impetus now missing and much needed for the development of interdisciplinary and

collaborative approaches to environmental issues. Though the Institute could focus on one or more particular environmental topics or problems,² this proposal advocates instead for a more flexible, adaptive and broad-based approach. Instead of permanently targeting particular problems, the Institute would encourage research, teaching and community-based activities at the cutting edge of a variety of environmental issues and involving a variety of disciplines, including science, policy, law, the arts and humanities. Instead of operating like a traditional department, school, program or center, the Institute would function as a loose federation of interested scholars and academic units.

The benefits of a more formal structure that takes this broad-based perspective are numerous and include:

- A more inclusive framework and avoidance of a monopoly-like arrangement for a particular school, department, program or center;
- Avoidance of conflicts with the jurisdiction of existing programs or centers that may have a related focus;
- Avoidance of a perception of preferential treatment;
- A more fluid and flexible approach to structuring that would allow the budget to vary more from year to year;
- A lower maintenance, more fluid approach to defining the work of the Institute and thus fewer reliance interests being formed in particular areas of expertise;
- A clear and primary focus on encouraging interdisciplinary work on environmental matters broadly defined;
- A commitment to work with existing faculty, programs and schools interested in environmental teaching and research, thus strengthening their interests while increasing the pool of available faculty and broadening the necessary interdisciplinary foundations for expanded teaching and mentoring within ENSP;
- An affiliation with the Center for Geospatial Analysis that better reflects its campus-wide potential and enables it to serve broader university interests;
- Development of a market (of sorts) for environmental learning at William & Mary, with the focus shifting as cutting edge issues emerge and student demand and faculty expertise changes and evolves; and
- Direct incentives to raise the level of faculty interest in seeking external funding through sponsored programs, building on the successful trend in the last five years for small teams of individuals to partner in grants that garner more support than would have resulted from the sum of individual grants.

B. Recommendations

² For an example of such a more focused approach, see Appendix B. The proposal calls for the creation of a Center for the Study of Energy and the Environment. This activity follows the philosophical approach outlined on the College's website at <http://www.wm.edu/energyenvironment>. The economic model to sustain the Center's activity is predicated on raising a large endowment from which annual operating money will flow through annual interest.

Based on what we have learned from past experience with the support and coordination of interdisciplinary programs, our recent surveys of faculty interest including recognized impediments to the faculty's effective participation, and our evaluation of ways to improve on those experiences and address those concerns, the Committee makes the following recommendations.

- We recommend the creation of a named entity, described below. We are suggesting a suitable name would be “the Institute for Society and the Environment”. This recommendation builds on the successful model of the Cluster, and expands opportunities for the broader support and engagement of faculty from all Departments, Programs and Schools through the implementation of a more formal structure offering new avenues for faculty innovation and creativity in interdisciplinary teaching and research.
- We very strongly recommend that the Institute's Director *report directly to the Provost* in order to retain a definitive university-wide character. An essential feature of the Cluster's success was that its Director reported directly to the Provost, sending a clear signal about its university-wide character and purpose.
- We recommend that particular attention should be given to the relationship between the Institute and the home Departments or Schools for faculty who are selected to direct the Institute or have Institute affiliations. Interdisciplinary work at universities often poses unique challenges and risks for the faculty member's professional advancement – risks that often arise from incomplete understandings of how the divided commitment will be reflected in the annual review and the tenure and promotion processes. This is particularly true of junior and tenure track faculty who lack the protections of tenure or seniority. Interdisciplinary work requiring release time also poses challenges for departments and schools that must still meet curricular requirements and accreditation standards.
 - Each faculty member who receives release time to be engaged in the Institute should work within the framework of a formal memorandum of understanding (MOU) that follows an agreed upon model, and fully addresses the standards to be used for annual merit evaluations and evaluations for promotion and tenure, as well as the teaching obligations of the faculty member. Standards should be consistent across schools, departments and programs.
 - The Provost's Office should explore whether this model for interdisciplinary MOUs is consistent with or otherwise needs to be incorporated into the language of the College Faculty Handbook.
 - A faculty member's MOU should remain in effect for the duration of the faculty member's engagement with the Institute.
 - In choosing interdisciplinary environmental courses to be taught by faculty on release time because of their engagement with the Institute, the curricular needs of the department or school should be given serious weight.

C. Basic Institute Organization and Structure

If the College decides to proceed with an Institute for Society and the Environment, full engagement of faculty representing the schools, departments and programs will be necessary in planning and determining the organizational details and timeline for the full development of the Institute. Such a group would devise the exact structure and the operational details that will emerge in this process. Here, we provide suggestions that we hope will be useful to guide that work. Our premise is to begin with the basic structural framework used previously in the Cluster to initiate the process of interdisciplinary faculty development. As the work of the Institute progresses, its future development and growth will be determined on the basis of its performance, its success in creating a climate of interdisciplinarity at W&M, and the quality of its output. In the following section, we show one way that this might proceed.

In the initiating stage, the main structural components of the Institute³ would include a Director chosen in a competitive process from the full-time faculty; several Institute Affiliated Faculty drawn from across the university (also selected competitively, see below); an Advisory Panel with representation from key academic units; and a close affiliation with the Center for Geospatial Analysis. There would also be budget support for the Institute Director, funds for faculty stipends and buyouts, and M&O to support operation of the Institute.

Institute Director: Selected competitively from the full-time, tenured faculty and appointed by the Provost, the Director would serve for three years with an additional three years following a successful performance review. In the initial phase the appointment would be part time (25% of a 12-month appointment as Director) with a salary supplement equal to three-months of the 12-month salary. As the Institute develops the Director's work may increase and could become a full-time appointment supported by Institute funds. The Director would report directly to the Provost on the operations of the Institute. Key criteria for selecting the Director would include a strong record of scholarship and teaching in an environmental area and experience in leading a complex operation or organization as an administrator, a project manager, or in some other comparable capacity. Administrative duties would include leading the Institute in proposal development and fundraising efforts, cultivating new research initiatives and collaborations, developing areas of concentration for the Institute in consultation with the Advisory Panel; curricular integration and innovation, personnel management, and budgetary oversight. In addition to administrative responsibilities, the Director would teach at least one environmental course a semester (which may be structured to satisfy curricular needs in the home unit), and satisfy governance responsibilities in his or her department or school.

Faculty Affiliations: William & Mary has impressive research interests and expertise in a number of environmentally relevant areas. Examples of where those established research interests correspond to leading edge environmental concerns are given in Appendix C. They are numerous. Appendix D contains a sampling of recent interdisciplinary requests for proposals (RFPs) issued by the NSF and NOAA, which have relevance to existing W&M capabilities as well. To paraphrase John Donne, W&M has "the anagram of a good face." The key lies in our ability to solve the puzzle by creating a means of gathering faculty expertise and competence and matching that to opportunity.

³ This report assumes that as a distinct A&S program, the current ENSP governance structure remains in effect and that any alteration to that structure or change in the ENSP status is a matter for Arts & Sciences to determine.

The mechanism for encouraging faculty to self-organize around focused areas of interdisciplinary environmental scholarship is central to how the Institute will successfully identify competitive excellence and engage faculty in cutting edge research on some of the leading questions of our time. The Institute would provide a new program for faculty to promote interdisciplinary environmental research and teaching, building on the interests and strengths of existing faculty. The program has two components discussed in more detail below: 1) short-term Environmental Enquiry Groups (EEGs) and 2) Long-term Environmental Quest groups (LTEQs). Together, these provide a mechanism for collaborative exploration of specific environmental issues; such exploration would promote collaborative research, course development, and/or proposal development for external funding. The structure of the proposed program is modeled after the Global Inquiry Groups (GIGs), a joint venture of the Reves Center for International Studies and the Charles Center that encourages scholarly investigation transcending disciplinary, departmental, and school lines. In contrast to the GIGs, the program we propose would focus on environmental issues and questions. Examples of areas that might be proposed by faculty include carbon sequestration, energy and the environment, environmental justice, water sustainability, and land use and water quality in the Chesapeake Bay watershed (see Appendix C). Faculty groups wishing to work within an EEG or LTEQ would be selected through a competitive proposal process. Each participating member of a group would receive a stipend, and each group would receive a budget appropriate to the proposed area of focus.

During its initiating phase, the Institute would begin with the implementation of EEGs to encourage new faculty collaborations. As success of the EEGs grows, LTEQs would be phased in to cultivate deeper research interactions.

Environmental Enquiry Groups (EEGs): The Institute would issue an annual call for proposals. Faculty interested in exploring an environmental topic in more depth using interdisciplinary approaches would submit a proposal to form an EEG (e.g., water resources, sustainable land use, climate change, endangered species, renewable energy, rising sea levels, environmental justice, etc.). We anticipate that many of these proposals would provide opportunities for integrating natural sciences, law and policy, social sciences, and/or the humanities. EEGs would consist of collaborative groups of five to eight faculty who would explore common interests and opportunities in terms of interdisciplinary and multi-disciplinary research and/or teaching related to a particular environmental issue or question. The Institute would begin with three, but could select up to five EEGs each year depending on the budget and the quality of the proposals. The designated EEGs would then be publicized university-wide, providing broad opportunity for all faculty to apply to participate in any of the funded EEGs. Each EEG would work on their project either during the summer or during the academic year; this work would include regular meetings and might involve discussions of readings, invited speakers, and proposal writing. Each EEG would submit a report the semester following their completion that would include a list of participants, their goals, outcomes, references, proposed activities, potential funding sources, and, depending on the project, an external proposal. If desired, EEG groups might seek additional funding to continue their work, either by submitting a proposal for internal funding to the Institute to become a Long-Term Environmental Quest (LTEQ) group, or by submitting a proposal for external funding through public or private grants. Several examples of the latter may be found in these NSF programs: *Ocean Acidification*; *Research Experience for*

Undergraduates; Transforming Undergraduate Education in STEM. The reports of successive EEGs would provide background and create foundations for new additions to the curriculum, resources for larger projects seeking extramural funding, or new research initiatives within the university and the Institute itself.

Long-Term Environmental Quest Groups (LTEQs): LTEQs require greater commitment, depth and disciplinary diversity, and a strong focus on securing long-term sponsored program support for the work. Proposals may emerge from the EEG process or they may arise *de novo*. LTEQs would be added as the Institute demonstrates success that would justify the additional funding to support the more substantial LTEQ. Initially there would be only one LTEQ group, with up to four in total added as the Institute develops and proves itself. The first instance would occur in year two with a call for faculty proposals to form an LTEQ. LTEQ groups would involve faculty from two or more schools/faculties, and would consist of between five and eight faculty participants and up to three graduate and/or undergraduate students. Proposals would describe how the group would address a particular environmental issue using an interdisciplinary/multidisciplinary approach that would provide opportunities for integrating natural sciences, law and policy, social sciences, and/or the humanities. Proposals would identify a set of deliverable products that would include research objectives, areas for extramural proposals for continued funding (e.g. the following NSF programs: *Coupled Human and Natural Systems; Environment, Society, and the Economy; Water Sustainability and Climate*), new courses (individual or team-taught), new modules that would be incorporated into existing courses, and possible public outreach efforts (e.g., the Mercury Expo produced by the Mercury sGIG). Project examples might include studies in areas such as carbon sequestration, renewable energy and biofuels, science and the human dimensions of urban development (other examples and more information about each is given in Appendix C). The LTEQ group would work for one to two years and would be expected to submit one or more proposals for external funding to support continued work. Proposal budgets would reflect the actual costs of the LTEQ including appropriate stipends and M&O for supplies, conferences, travel, visiting speakers, etc. necessary to the level of the project proposed. Each LTEQ would submit an annual report that would include a list of participants, their goals, outcomes, completed and proposed activities, potential funding sources, and one or more extramural proposals.

Over time, as the success of particular EEGs and LTEQs becomes apparent and faculty interest in particular areas solidifies, we expect the EEG and LTEQ process to identify university-wide areas of interdisciplinary competence and capacity where the university will be highly competitive. The benefit of identifying these areas through a process that develops emergent strengths often will reveal where and in what disciplines W&M may wish to add new faculty appointments that will strengthen the interdisciplinary effort by expanding capacity while serving to move W&M towards excellence. We believe this to be an important attribute of the Institute process that will benefit the university as a whole.

Center for Geospatial Analysis: Because of the importance of geospatial analysis to the study and resolution of environmental problems and because of the need for broader campus involvement, the Center for Geospatial Analysis would become affiliated with the Institute. An affiliation agreement would set forth the terms of the arrangement. Part of the Institute's obligation would be to raise funds to support two additional positions within the current CGA

structure: 1) an assistant director of the CGA to be responsible for increasing teaching and research use of GIS at W&M in environmental areas within the Schools of Business, Education and Law, as well as within the Institute; and 2) a technical GIS position to support environmental teaching and research within all sections of the College, including VIMS. Both positions would report to the CGA Director. The Director of the CGA, in turn, would be actively involved in the promotion of interdisciplinary research and study in the Institute.

C. Budgeting

The central budgetary premise for establishing an Institute for Society and the Environment is that it should begin small, in order to begin soon. It should then grow and develop only as it proves itself by generating competitive interdisciplinary teams of faculty that expand the university's diversity and competitiveness in sponsored programs, thus increasing the amount of funding coming to the College and SMS/VIMS. As the Institute grows and develops, budgets would be comprised of mixed funding resources, i.e. sponsored programs, private and foundation, institutional.

Appendix A

Application of the EEG and LTEQ Concept: Examples of Interdisciplinary Research Potential at W&M

The following is a sample of emerging prospects and relevant faculty, program or unit interest. Many of these examples address questions that fall within the consensus view of ten areas of global environmental concern or have a prominent place within the national security agenda. Further, as the United States moves to enact climate legislation many additional areas of interdisciplinary opportunities will open as well. Several are included here.

Carbon sequestration: A key strategy to control CO₂ emissions from coal energy resources. Carbon sequestration outcomes have great economic importance in our region. Expertise: VIMS, Law, Policy, ENSP, A&S, and CGA

Water sustainability/Water Cycles: One of the most critical issues facing society. It involves elements of Land Use Science Law and Policy, Distribution Systems, Sea Level Rise, Pollution. Most significantly, climate change can alter patterns of rainfall and disrupt the water cycle. W&M has expertise in all these areas.

Nitrogen/Phosphorus Cycles: Synthetic fertilizer production and automobile emissions now contribute the major portion of the planetary cycles involving these nutrients, posing severe impacts on water and soils, and creating dead zones in the coastal oceans. Expertise: VIMS, Law, Policy, ENSP, A&S, and CGA.

Land Use/Ecosystem Services: We rely extensively on the extensive but often unrecognized contributions that ecosystems provide to society's well being. Basic questions arise concerning

their protection and preservation. W&M has broad expertise here. An important area for the CGA.

Extinctions: The Earth is currently experiencing accelerating rates of extinction of species, making this one of the greatest periods of extinction known. We do not appreciate fully the implications of biodiversity loss or its remedy. Expertise in the Center for Conservation Biology, A&S, VIMS, Law, Policy, Education.

Chemical/Pharmaceutical Pollution: Currently, there are more than 80,000 synthetic chemicals on the global market, and we know that many of them can harm human health or disturb the reproductive cycles of certain species (in much the same way DDT caused eggshell thinning among birds of prey). Expertise in Law, Policy, VIMS, A&S.

Aerosol Pollution: There is mounting evidence that aerosol pollution—such as sulfates—can alter local rainfall patterns, changing the conditions for maintaining ecosystem services, affecting agriculture, etc. W&M has some capacity here. The CGA would be important to early analysis of change.

Mitigation Impacts: We know little about the environmental impacts of our attempts to mitigate and restore environments and resources. This is an open area where W&M has the capabilities to begin a comprehensive look at the issue, particularly as it applies to Chesapeake Bay.

Sea Level: An issue within climate change itself that presents a broad spectrum of environmental and legal policy questions. W&M is strong here.

Renewable Energy and Biofuels: What are the negative dimensions of the various alternative energy solutions? We know little of the legal and policy dimensions as they relate to the environment. Expertise in Law, Policy, A&S, VIMS.

Adaptation: For the past 10,000 years, humans have lived in a climate-stable world. Many believe that this has allowed agriculture and civilization itself possible. Now, human actions have introduced us to the possibilities of a climate-unstable world. How will we adapt in order to survive? This is a large crosscutting question that could engage faculty at W&M broadly.

Watershed analysis of land use and water quality in the Chesapeake Bay drainage basin: There is a current disconnect in the Chesapeake Bay model at the downstream end and the nutrient management strategies upstream. VIMS, CCRM, ENSP, CGA, Geology, Physics, and Mathematics would all be involved.

Science and the Human Dimensions of Urban Sprawl: A large area of NSF interest. Locally, James City County is an ideal study site for a major proposal. Would involve aspects of land use, community planning, stormwater management, water conservation, private property rights, etc. W&M is strongly positioned for a study such as this.