LA Board of Regents
NOTES for PROGRAM PROPOSALS (AA Policy 2.05)
(Please do not include this page with proposal submission.)

Neither a new program nor elimination/major revision of an existing program can be publicized or implemented prior to approval by the Board of Regents. A new program is a new Major which leads to a certificate or degree at a level or in a field not heretofore offered by the institution. It may involve the addition of courses to an existing degree program (e.g., expansion of a concentration or minor), or it may consist entirely of existing courses packaged in a manner which constitutes a new major. Upon approval, it will be added to the Curriculum Inventory (CRIN)

To expedite review, institutions are urged to discuss planned curricular additions with Academic Affairs staff *prior* to completion of a Letter of Intent or program proposal.

PROPOSAL CONTENT

DESCRIPTION should include the purpose of the program as well as the curriculum plus any prerequisite courses. Identify any incremental credentials that might be incorporated within the curriculum, concentrations, and/or approved electives. A reader should be able to describe what the program will accomplish for the completer and how it will do it.

NEED/RELEVANCE is the argument for program approval. Address duplication or similarities with existing programs elsewhere, and explain why the proposed program is different and/or necessary.

STUDENTS should include a justification for projected enrollments and completers. If the new program is the expansion of an existing, successful concentration or minor, provide the existing curriculum and recent enrollment/completer data.

FACULTY should demonstrate preparation or a plan to offer the program, explaining how the program would be offered, whether/how existing faculty can absorb the new courses and students, and expected sources of additional faculty that would be needed.

LIBRARY, SPECIAL RESOURCES, FACILITIES & EQUIPMENT describe what will be needed and how & when the institution will acquire it. Costs for additional resources should be reflected in the budget.

ADMINISTRATION includes new directors and anticipated timing of the administrative additions or changes.

ACCREDITATION should address any impact on and plans to protect the institutions status with SACSCOC as well as any relevant program requirements or recommendations in AcAf 2.13. If the institution will seek new or expanded accreditation, include an anticipated schedule of actions to be taken.

RELATED FIELDS summarizes how the proposed program 'fits into' the institution's existing offerings and strengths.

COSTS & REVENUE (BUDGET) should include new/additional costs referenced in the preceding text to show what new commitments the program would bring to the institution and how they would be covered.

Factors that will be considered in assessing a proposed program include, but are not limited to the following:

a. Relevance to the existing role, scope and mission of the institution;
b. Contribution to the wellbeing of the state, region, or academy;
c. Program duplication (existing/related programs at other institutions);
d. Institutional commitment to appropriately fund proposed program.

Louisiana Board of Regents

AA 2.05: REQUEST FOR AUTHORITY TO OFFER A NEW DEGREE PROGRAM*

-- Including incremental credentials building up to the Degree --

** Prior to final action by the Board of Regents, no institution may initiate or publicize a new program.**

Date: September 28, 2017

Institution: University of Louisiana at Lafayette	Requested CIP, Designation, Subject/Title: CIP 40.0699, Interdisciplinary Geosciences; Ph.D. in Earth and Energy Sciences
Contact Person & Contact Info: Dr. Azmy S. Ackleh Dean, Ray P. Authement College of Sciences University of Louisiana at Lafayette (337)-482-6986 ackleh@louisiana.edu	
Date Letter of Intent was approved by Board of Regents: August 23, 2017	
Date this Proposal was approved by Governing Board:	
Planned Semester/Term & Year to Begin Offering Program: Fall semester, 2018	

1. Program Description

Describe the program concept: (a) purpose and objectives; (b) mode of delivery (on-site/hybrid/on-line). Describe plan for developing and rolling out new courses.

(a) Purpose and Objectives

Our purpose is to offer a cutting-edge, interdisciplinary Geosciences doctoral degree program that integrates the expertise of the School of Geosciences (Programs of Geology and Environmental Science) with that of the Departments of Chemistry and Physics at UL Lafayette to provide new education and research opportunities focused on energy and the environment. Students in our program will develop an inter- and multi-disciplinary understanding of issues central to meeting the Energy and Environmental challenges of today and the future. The objectives of our program will be to:

- Provide educational and research opportunities in the area of "energy" acquisition that go well beyond fossil fuels and will include developing opportunities in biofuels, geothermal energy, solar-, wave-, and wind-energy.

- Provide educational and research opportunities in the area of the "environment" that will include understanding the chemistry of soils and waters; studying the anthropogenic impacts of energy acquisition on soils and waters, specifically on ocean and land ecosystems; understanding climate change and pollution; and developing the skills to perform research aimed at mitigating problems to the environment associated with acquisition of energy.

- Prepare students to make fundamental contributions in the areas of earth and energy research, including how to apply their understanding of energy and the environment to solve real-world problems and to advance decision-making in business and regulatory arenas.

These objectives will be achieved in a sequential manner, first by exposing students to a specially-designed, multidisciplinary foundation of core courses in Physics, Geophysics, and the Chemistry of Earth systems, and then by exposing them to elective courses in their future area of expertise. Dissertation research will provide students with extensive hands-on opportunities to apply concepts and principles learned in their coursework to solving real-world problems.

We expect these efforts to result in more translational research, increased technology transfer, more research commercialization, and new and stronger business partnerships that will provide increased economic benefits to the State of Louisiana and to the nation. The establishment of the doctoral program at UL Lafayette in Earth and Energy Sciences will substantially enhance the existing undergraduate and master's-level degree programs in Chemistry, Physics, Geology, and Environmental Science on our campus by providing new research opportunities, spurring new collaborations, and giving students new opportunities to further their education. Finally, building an interdisciplinary

doctoral program in Earth and Energy Sciences from four existing programs on our campus will enhance the recruitment and retention of top faculty in each of these disciplines and, as a result, improve the scientific infrastructure of the University and the State of Louisiana.

(b) Mode of Delivery

Initially courses will be taught using traditional delivery methods, but opportunities may arise in the future for online or hybrid delivery of some individual courses.

Map out the proposed curriculum, in sequence, identifying any incremental credentials and/or concentrations within the degree. Indicate which courses will be new, including those that would be offered in the new program as electives. Describe any special requirements (e.g., internships, comprehensive exam, thesis, etc.).

Individual Development Plan:

Faculty members selected from each academic unit of the proposed Ph.D. program in Earth and Energy Sciences will form an interdisciplinary Graduate Advisory Committee that will work with each newly admitted student: (1) to develop an individual development plan (IDP); and (2) to tentatively place the student in one of the graduate student offices located in each of the academic units based on the student's initial plans and interests. The Graduate Advisory Committee will monitor the progress of each student in the first year of his or her degree program and will assist each student as he or she navigates through early coursework (largely multidisciplinary), then transitions to working individually with a major professor for dissertation research. At that point, the major professor and student will form the dissertation committee. The dissertation committee will then assume responsibility for supporting the student's IDP and for monitoring the progress of the student until he or she graduates.

SCH Requirements and Program Structure:

A total of 72 credit hours will be required beyond the B.S. degree. Students with a M.S. degree may transfer up to 18 credit hours. The breakdown of course requirements is as follows:

Core Courses	12 hrs	These are four interdisciplinary courses that will be taught by faculty specializing in Chemistry, Environmental Science, Geology, and Physics.
Additional Coursework	30 hrs	These courses will consist of a combination of existing courses (relevant graduate-level courses in Biology, Chemistry, Engineering, Geology, Environmental Science, Mathematics, or Physics) and newly-developed courses (doctoral-level courses in Geology, Physics, Chemistry, and Environmental Science). Students, in consultation with their dissertation committee, will develop a plan of study and will select courses in which to enroll based on their specific career goals and interests. As mentioned above, students who are admitted to the program with an M.S. degree in a closely-related field will be eligible to transfer up to 18 credit hours towards this 30 hour course requirement. To ensure that students have a strong multi-disciplinary background, they will be required to take at least 6 hours of coursework each in Geology, Environmental Science, Chemistry, and Physics. The remaining 6 hours can be taken in any of the aforementioned disciplines.
Graduate seminar	6 hrs	These hours will be accumulated from 6 semesters of taking a 1-credit hour graduate seminar course offered each semester. Seminars will include invited presentations from internal and external speakers with relevant content expertise or professional experience. Several speakers will address Ethics in Science. Otherwise, external speakers will include a mix (approximately 50/50) of academic researchers and industry professionals so that students can gain insight into fundamental research and applied research topics. Each student will be required to deliver at least one presentation at the graduate seminar each year, as he/she progresses through the doctoral program.
Dissertation research and dissertation	24 hrs	A minimum of 24 credit hours in dissertation research and/or dissertation must be completed. Dissertation hours are intended for research and/or writing related to a student's dissertation topic and conducted in the last two years of the degree program, after the student has been admitted to candidacy, a dissertation committee has been established, and the dissertation proposal has been approved by the dissertation committee. Dissertation hours will be supervised by the student's primary advisor/mentor and coordinated with his/her dissertation committee.
Total	**72 hrs**	

Additional Requirements:

1) *Grades*: Students must maintain at least a 3.0 cumulative GPA over the entire course of their program of study. No more than one course in which a grade of "C" is earned may be applied to the fulfillment of the degree requirements.

2) *General comprehensive exam:* The comprehensive exam will be administered at the end of a student's third semester of study. This exam will focus on the student's mastery of the content obtained from the courses taken within the program, and the application of this content to structuring research and solving problems. The comprehensive exam will be designed and administered by a committee of three graduate faculty members of the Earth and Energy Sciences doctoral degree program of the student's choosing (preferably professors who have taught core courses). Graduate faculty representing at least two separate disciplines will be required to prepare and evaluate the exam. Exams will be assessed by the faculty members who administered the exams, using rubrics to ensure consistency. A student must receive a score of 70% or higher on two of three subject matter tests and have an overall average score of 70% or better to pass the comprehensive exam. If a student fails more than one subject matter exam, he or she can re-take the failed exams with new questions within a period of time not to exceed a semester. No student will be permitted a third attempt. If the student fails the second attempt, he/she will be ineligible to continue in the program.

3) *Dissertation committee*: After successfully completing the comprehensive exam and prior to the proposal defense, the student, in consultation with his/her major advisor, must choose a formal dissertation committee. The dissertation committee will consist of the primary advisor/mentor and at least three additional graduate faculty members. The committee must include at least two graduate faculty members from a discipline represented by the doctoral program, but not that of the primary advisor. **Thus, each and every dissertation committee with be interdisciplinary in its composition.** An external committee member from another institution is recommended.

4) *Dissertation proposal defense:* Prior to the initiation of the student's dissertation study, an oral defense of the dissertation proposal will be presented to the student's dissertation committee. This proposal defense will lay out the plan for the research topic, goals, methods, and expected results along with any preliminary data. During the dissertation proposal defense, a student is expected to demonstrate knowledge gained in his or her coursework and additional readings, and the application of this knowledge to the proposed research plan. Students should demonstrate an understanding of the relationships among fundamental research and applied research applications in relation to their chosen research topic. Acceptance of the proposal by the major professor and a majority vote of the dissertation committee will be required. The dissertation proposal defense is expected to be completed after the student has passed the comprehensive exam and no later than the end of the third year of study.

5) *Dissertation:* The final examination will be a public, oral dissertation defense administered after the written dissertation is completed and reviewed by the student's dissertation committee. This oral exam will follow a traditional dissertation defense format used with the majority of science Ph.D. programs. The dissertation is expected to represent an original contribution within Earth and Energy Sciences and to be of quality acceptable for publication in peer-reviewed journals in the appropriate field of study. Submission of at least one manuscript to a peer-reviewed journal is a requirement for graduation.

Core Interdisciplinary Course Requirements:

1. EES 600. Introduction to Earth Systems (3 credit hours). This course will provide students with a fundamental understanding of the surface, subsurface, and atmospheric systems on Earth and modern observational tools employed to study these systems.
2. EES 601. Fundamentals of Environmental Science (3 credit hours). This course will prepare students to understand environmental problems, data collection, and analysis from the multi-disciplinary perspective of the physical sciences.
3. EES 602. Energy Systems (3 credit hours). This course will provide an overview of energy production systems, emphasizing research and data analysis within the petroleum, bioenergy, and sustainable energy sectors.
4. EES 603. Research Challenges in Earth and Energy Sciences (3 credit hours). The course will introduce recent research progress and methodologies employed to address specific challenges and solve problems associated with energy exploration and environment sustainability.

Elective Courses that can Fulfill Remaining Course Requirements:

**New courses; BIOL = Biology; CHEM = Chemistry; CIVE = Civil Engineering; EMGT = Engineering Management; ENVS = Environmental Sciences; GEOL = Geology; PETE = Petroleum Engineering; PHYS = Physics; MATH = Mathematics.*

Physical Science Disciplines

1. CHEM 501. PHYSICAL CHEMISTRY. (3, 0, 3). Advanced topics in physical chemistry including thermodynamics and kinetics of surfaces. Physical transport processes and chemical surface reactions will be discussed.
2. CHEM 506. PHYSICAL CHEMISTRY OF SURFACES. (3, 0, 3). Interfacial characteristics including the determination of surface properties and thermodynamic relationships; adsorption at, electrical aspects of, and reactions at surfaces. Applied topics emphasize nucleation, friction and lubrication, detergents and flotation, and emulsions and foams.
3. *CHEM/EES. 605 BIOENERGY APPLICATIONS. (3, 0, 3). An overview of biofuel production related to technologies and feedstocks, economics of producing biofuels and impacts on the environment and the local economy.
4. ENVS 569. BIOGEOCHEMICAL CYCLES (3, 0, 3). Focus on the biogeochemical cycles of carbon, nitrogen, phosphorus, and sulfur on both water and soil resources. Emphasis will include dynamics of these elements in the critical zone.
5. ENVS 580. FATE OF POLLUTANTS IN SOILS AND NATURAL WATERS. (3, 0, 3). Thermodynamics and surface reactions affecting the presence, distribution, and fate of pollutants.
6. *ENVS 585/EES. RENEWABLE ENERGY SOURCES. (3, 0, 3). Scientific and economic understanding of renewable energy resources, including biofuels, solar, wind, hydrogen, etc.
7. GEOL 502. ADVANCED SEDIMENTATION. (3, 0, 3). Sedimentary environmental and facies, with special emphasis on fluvial, deltaic, shoreline, deepwater, and eolian clastic facies.
8. GEOL 504. EXPLORATION GEOPHYSICS. (2, 3, 3). Introduction to the techniques of exploration geophysics.
9. GEOL 505. GEOTECTONICS. (3, 0, 3). Tectonic theories, with special emphasis on plate tectonics.
10. GEOL 506. SEISMIC STRATIGRAPHY. (3, 0, 3). Appearance of stratigraphic features on modern exploration seismic sections. Theory and real life examples integrated.
11. GEOL 508. SHALLOW SUBSURFACE GEOPHYSICS (3, 0, 3). Methods and approaches used in geophysics to investigate the shallow subsurface. Principles of electrical resistivity, electromagnetic methods and ground-penetrating radar. Refraction and reflection seismology and exploration using gravity. Equipment, field procedures, and experiment design. Data analysis and processing with inverse and forward modeling.
12. GEOL 509. ADVANCED GROUND WATER HYDROLOGY. (3, 0, 3). Discussion of case histories and examples that apply the basic principles of ground water hydrology to specific sites and problems. A summary of current thoughts, ideas, and practical applications related to hydrology.
13. GEOL 510. ADVANCED ENVIRONMENTAL GEOLOGY. (2, 3, 3). Content varies. May be repeated for credit. Application of geology to problems resulting from the increasingly intense use of the earth and its resources.
14. GEOL 531. ADVANCED CARBONATE SEDIMENTOLOGY. (1-4). Carbonate facies belts, some emphasis on hydrocarbon exploration. Field examples studied; up to three field trips to selected carbonate outcrop areas.
15. GEOL 532. PETROLEUM GEOCHEMISTRY. (2, 3, 3). Concepts and principles of geochemistry. Course includes examination of natural samples.
16. GEOL 535. ADVANCED TOPICS IN GEOLOGIC COMPUTING. (2, 3, 3). Image analysis, digital mapping methods, digital modeling of geologic systems, and export systems.
17. GEOL 540. ADVANCED STRUCTURAL GEOLOGY I. (3, 3, 4). Applied interpretation concepts of contractional and strike-slip terrains. Includes field work, geophysical, and remote sensing approaches.
18. *GEOL/EES 605. STABLE ISOTOPE GEOCHEMISTRY. (3, 0, 3). This course will explore the principles of stable isotope fractionation, including the O, C, and H isotope systems, but will also explore non-traditional stable isotope systems such as Ca, Mg, Si, Fe, Zn, etc.
19. *GEOL/EES 610. UNCONVENTIONAL RESOURCES. (3, 0, 3). This course will focus on shale gas/oil exploration and development.
20. *GEOL/EES 620. ADVANCED GEOPHYSICAL TECHNIQUES. (3, 0, 3). Signal processing, interpretation, and hands-on field-based instruction for understanding seismic and other geophysical data.
21. PHYS 521. TOPICS IN APPLIED PHYSICS: Applied Ion Beam Methods (1,2,3) (3, 0, 3). A use of high energy particle beams at the Louisiana Accelerator Center for material analysis with emphasis on geophysical and geochemical applications.
22. *PHYS/EES 601. PHYSICAL PROPERTIES OF MINERALS. (2, 1, 3) Understanding the physical properties of minerals such as metallic elements, their alloys and compounds, rocks, and non-metallic solids. Properties such as elasticity, magnetism (iron is the most abundant element in Earth's composition), thermal conductivity, specific

heat, thermal expansion, piezoelectricity, and piezomagnetism, are to be discussed. The course will introduce students to concepts of solid-state physics needed for setting up a base for understanding the physical processes that affect the defined properties. Experimental methods used to determine the discussed physical properties will be described.

23. *PHYS 602/EES. CLIMATE PHYSICS. (3, 0, 3). The course is intended as a starting point for students wishing to understand the physics of Earth's atmosphere. The main topics addressed are atmospheric dynamics, atmospheric (photo-)chemistry, and climatology. During the course the students will learn how to use fluid mechanics, statistical physics, chemical models, radiation balancing, and energy transfer processes to characterize the atmosphere. Time-permitting, a number of various interesting phenomena such as lightning and thunder, internal gravity waves, and the acoustic heating of the thermosphere will be addressed as applications.

Supporting Disciplines

1. BIOL 502. QUANTITATIVE ECOLOGY. (3, 0, 3). Quantitative methods for analysis in Ecological studies including ecological models, model selection, maximum likelihood estimation, and mark-recapture analysis.
2. BIOL 503. ECOLOGICAL MODELS AND DATA. (3, 0, 3). Theory and application of models and empirical analyses in ecology.
3. BIOL 575. STATISTICAL ECOLOGY. (4, 0, 4). Design, analysis, and presentation of results of ecological experiments and field studies, with emphasis on hypothesis testing and statistical modeling.
4. BIOL 580. MARINE ECOLOGY. (3, 0, 3). Discussions of basic principles of marine ecology, including productivity, dynamics of populations, factors affecting distribution, and interactions between organisms.
5. BIOL 605. ADVANCED TOPICS IN ENVIRONMENTAL BIOLOGY. (3, 0, 3). Research problems in environmental biology in areas other than that of the student's thesis or dissertation.
6. BIOL 615. BIOCHEMICAL ADAPTATION TO THE ENVIRONMENT. (3, 0, 3). Modification of basic biochemical structure and function that enable organisms to exist in extreme environments; enzymatic and metabolic adaptation to hypoxia, salinity, temperature, pressure, humidity, and light.
7. CIVE 506. ADVANCED HYDROLOGY. (3, 0, 3). Quantitative approaches for modeling rainfall-runoff processes. Topics include lumped and distributed models, treatment of spatial and temporal hydrologic variability, hydrologic data quality control, and design of hydrologic networks.
8. CIVE 546. PROBABILISTIC METHODS IN HYDROSCIENCE. (3, 0, 3). General review of advanced probability and statistics concepts, Monte Carlo simulation of hydro-systems, probabilistic models of observed hydrologic data, optimal estimation and interpolation of geophysical fields. Use of data-intensive computer applications is emphasized.
9. CIVE 561. WATER TREATMENT. (3, 0, 3). Design of domestic and industrial water treatment facilities with emphasis on the basic scientific principles underlying the design procedures.
10. CIVE 563. SOLID AND HAZARDOUS WASTE MANAGEMENT. (3, 0, 3). Current issues and legislation. Collection, storage and disposal. Treatment technologies including incineration and sanitary and hazardous waste landfills.
11. CIVE 567. EXPERIMENTAL ANALYSIS FOR ENVIRONMENTAL ENGINEERS. (0, 6, 3). Examination of laboratory techniques for assessing water quality and sludge contamination. Optical, electrical, gas chromatography, and x-ray methods are included.
12. CIVE 646. PROBABILISTIC METHODS IN HYDROSCIENCE. (3, 0, 3). Advanced probability and statistics concepts, Monte Carlo simulation of hydro-systems, probabilistic models of observed hydrologic data, optimal estimation and interpolation of geophysical fields. Use of data-intensive computer applications is emphasized.
13. EMGT 502. PROJECT ECONOMICS. (3, 0, 3). Procedures for conducting economic analyses used by technical managers. Fundamental methods followed by more advanced topics such as capital budgeting, leveraged investments, decision under risk and uncertainty, and use of modern software systems.
14. EMGT 550. ENGINEERING AND TECHNOLOGY MANAGEMENT. (3, 0, 3). Management principles and practices applicable to technical organizations.
15. PETE 501. FORMATION DAMAGE CONTROL (3, 0, 3). Fundamentals of formation damage mechanisms, damage characterization and control, basic clay minerals engineering, control of screen entrance velocity, well treatment design, and well flow back analysis.
16. PETE 502. HORIZONTAL WELL ENGINEERING. (3, 0, 3). Environmental remediation with horizontal wells, reservoir or acquirer fluid flow to horizontal wells, modern downhole assemblies and production/injection/completion of horizontal wells.
17. PETE 578. ADVANCED PRINCIPLES OF NATURAL GAS. (3, 0, 3). Covers the theory and practice involving natural gas from its initial location in the reservoir to its final destination, including the design of an optimum

development plan for a natural gas field. Unconventional gas sources also covered.

18. PETE 586. SECONDARY RECOVERY PROCESSES. (3, 0, 3). Theory of multiphase flow, miscible and immiscible displacement mechanisms in porous media. Analysis of various improved recovery methods such as water flooding, gas flooding on digital computer.
19. PETE 587. NATURAL WATER DRIVE SYSTEMS. (3, 0, 3). Theory of natural aquifer expansion and water encroachment in porous media using classical influence functions for finite and infinite aquifer of linear and radial extent. Numerical simulation of water encroachment in arbitrary shaped patterns with irregular well distributions.
20. PETE 590. DRILLING OPTIMIZATION TECHNIQUES. (3, 0, 3). Methods and techniques to optimize drilling hydraulics, bit weight and rotary speed, penetration rates, and minimize drilling costs. Prereq: PETE 491.
21. PETE 591. TRANSIENT PRESSURE BEHAVIOR. (3, 0, 3). Mathematical development and analysis of transient behavior in well and reservoir systems. Factors influencing skin effect evaluation in heterogeneous porous media. Effect of horizontal and vertical factors, anisotrophy and shale barriers on reservoir limits tests.
22. PETE 592. ADVANCED PETROLEUM PRODUCTION SYSTEM AND OPTIMIZATION. (3, 0, 3). Principles of the development and operation of petroleum production system. Considers the combined behavior of the reservoir, the producing strings, the surface equipment, and pipeline system. Optimization of such a production system for various schedules.
23. PETE 593. ADVANCED GEOLOGIC WELL LOG ANALYSIS. (3, 0, 3). Study of advanced well logging methods and techniques for qualitative and quantitative use of well logs as geological mapping tools in hydrocarbon and mineral exploration.
24. PETE 595. THEORY AND TECHNIQUES OF MATHEMATICAL RESERVOIR SIMULATION. (3, 0, 3). Comprehensive coverage of the mathematical reservoir simulator with special emphasis on the practical application of theoretical techniques on modern-day computers.
25. MATH 495G. ADVANCED MATHEMATICS FOR ENGINEERS AND SCIENTISTS. (3, 0, 3). Systems of first order differential equations, partial differential equations, Fourier series, Sturm-Liouville systems, Hemholtz equation, Green's functions, applications in engineering and sciences.

2. Need

Outline how this program is deemed essential for the wellbeing of the state, region, or academy (e.g., how is it relevant, how does it contribute to economic development or relate to current/evolving needs).

WELL-BEING OF THE STATE

The proposed doctoral program in Earth and Energy Sciences acts on recommendations put forth in the FIRST Louisiana report and the BOR 2011 Master Plan, targeting the need for a skilled interdisciplinary workforce that can address current and future challenges associated with the Earth Sciences and Energy. More recent recommendations to the Louisiana Board of Regents presented by the Master Plan Research Advisory Committee in 2014 highlight the need for the development of new academic programs in interdisciplinary sciences such as the one we present here. Several of the specific advantages for Louisiana are presented below:

- This doctoral program will increase the production of advanced STEM degrees in the state by providing more upper-level educational and research opportunities in areas of high growth, where more intellectual capacity is needed. There is no doubt that the citizens of Louisiana and the rest of the world will need, in the near future, improved acquisition and utilization of energy while, at the same time, needing to minimize detrimental effects of acquiring and utilizing energy on the environment. While these goals are admirable, they will not be easily attained. The problems are complex and, accordingly, will require careful study by highly-qualified scientists. We propose to prepare the next generation of scientists to address these goals by using a multidisciplinary approach that emphasizes the development of problem solving skills. We expect that graduates of this program will assume prominent, leadership positions in industry and government and, accordingly, will be in position to directly impact these goals. Graduates will learn to foster more technology transfer, research commercialization, and new and stronger business partnerships, thereby providing a healthy return on investment for the State of Louisiana. The proposed doctoral program will provide educational and research activities at the doctoral level that are fundamental in the sense that they will involve education and research opportunities inherent to the core disciplines, but also will include applied research that involves more than one discipline. The program will emphasize a problem-solving approach to preparing students. For example, our capstone core course, EES 603: *Research Challenges in Earth and Energy Sciences,* will emphasize problem-solving and application-based research. In addition, students will be exposed to applied research through our graduate seminars that will include a mix of industry professionals in addition to academic researchers. Understanding and articulating the

relationships among fundamental research and applied research applications associated with their dissertation topics will be an expectation for passing the dissertation proposal defense.

- The proposed doctoral program will serve as a catalyst for greater collaborations among four existing degree programs at UL Lafayette. These new collaborations will be manifested in the doctoral degree program in Earth and Energy Sciences. The development of this doctoral degree program, its successful implementation as evidenced by student recruitment, extramural funding of academic research, and graduation of students, will elevate the academic profile of these departments and, therefore will lead to an enhanced ability to recruit and retain top faculty in the State of Louisiana. The scientific infrastructure of UL Lafayette and the State of Louisiana will improve with the development and implementation of the proposed doctoral program in Earth and Energy Sciences. **At UL Lafayette, we are strongly committed to interdisciplinary research and education and to preparing a strong faculty foundation for successful implementation of interdisciplinary programs.** In particular, two of our recent hires in the College of Sciences are interdisciplinary faculty who hold joint appointments in two departments. Dr. Gabrielle Morra holds a 2/3 appointment in the Department of Physics and a 1/3 appointment in the School of Geosciences. Dr. Rui Zhang holds a 2/3 appointment in the School of Geosciences and a 1/3 appointment in the Department of Physics. These faculty hires align perfectly with the proposed, interdisciplinary doctoral degree program in Earth and Energy Sciences. In the College of Sciences, our hiring plan includes making strategic, interdisciplinary faculty hires once existing faculty lines become available (for example after a retirement). Along these lines, our next planned interdisciplinary hire will be in the area of geochemistry. This faculty member will hold a joint appointment in the Department of Chemistry and in the School of Geosciences. Interdisciplinary faculty hires such as those currently in place and planned for the near future will help to ensure the successful implementation of our interdisciplinary degree program in Earth and Energy Sciences because the interdisciplinary faculty will be natural advocates for the interdisciplinary doctoral degree program. Consequently, the "academic silos" that might otherwise jeopardize an interdisciplinary degree program will not form here at UL Lafayette. Additionally, our faculty members who engage in interdisciplinary research, including the faculty members listed above, will serve as positive role models for our doctoral students. Finally, the successful implementation of the proposed doctoral program in Earth and Energy Sciences will bring positive national and international recognition to the University and the State of Louisiana.

The proposed doctoral program in Earth and Energy Sciences specifically addresses the following goals and objectives in the **BOR 2011 Master Plan**:

Goal 1, Objective 1.7: "*Develop a Skilled Workforce to Support an Expanding Economy*."
The proposed doctoral program will prepare a new generation of scientists to support technical management and problem-solving in areas critical to the State of Louisiana in the energy sector as well as in environmental areas. Contributing to the development of a qualified labor pool in the domain of Earth Sciences will facilitate the attraction of new businesses to the area.

Goal 2, Objective 2.1: "*Maintain and Build Strength in Foundational Science and Technology Disciplines Identified in FIRST Louisiana."*
Earth Sciences and Physical Sciences are targeted by FIRST Louisiana and these are precisely the areas we combine for the proposed doctoral degree program in Earth and Energy Sciences.

"Recruit, cultivate, and retain research talent in the foundational sciences."
The addition of a doctoral program in Earth and Energy Sciences will allow UL Lafayette to greatly expand research and research training in Chemistry, Earth Sciences, and Physics. The establishment of a new doctoral degree program in Earth and Energy Sciences will create the necessary academic infrastructure to attract quality research-active faculty and, furthermore, provide an incentive for them to develop successful research careers at UL Lafayette. In particular, the addition of this doctoral program will allow graduate faculty in four degree programs (Geology, Environmental Science, Physics, and Chemistry) new access to doctoral students. Such access to doctoral students will significantly enhance the scope, quality, and productivity of faculty research.

"Develop and maintain cutting-edge infrastructure and facilities for fundamental science and technology research."
We plan to leverage the doctoral program to secure new instrumentation through federal grants and plan to rely on doctoral students to help operate and maintain equipment.

Goal 2, Objective 2.2: ***"Promote Multidisciplinary and Multi-Institutional Collaborative Research Efforts."***
The proposed doctoral program in Earth and Energy Sciences integrates Chemistry, Environmental Science, Geology, and Physics. The program is multidisciplinary by design.

"Address multi-disciplinary and multi-institutional collaborations in campus research plans."
The proposed doctoral program in Earth and Energy Sciences employs a multidisciplinary approach to prepare scientists. Accordingly, the proposed doctoral program is consistent with the University of Louisiana at Lafayette's strategic plan for advancing interdisciplinary and multidisciplinary research and research collaboration.

Goal 2, Objective 2.3: ***"Sustain and Advance Research Commercialization and Translational Activities that Promote Economic Development in Louisiana."***
We are embracing translational research as a focus area in our program with the aim of bridging the gap between fundamental research and applied research. In particular, doctoral students will be prepared to solve problems associated with the acquisition and utilization of energy in ways that minimize deleterious effects on the environment.

"Promote Multidisciplinary and Multi-Institutional Collaborative Research Efforts."
As described in Goal 2, Objective 2.2 (above), the proposed doctoral program in Earth and Energy Sciences will require doctoral students to complete coursework and research training derived from multiple disciplines. Such preparation will foster joint research efforts. Many of our faculty members already are collaborating across these disciplines, both within and outside of the university. The addition of the interdisciplinary doctoral program in Geosciences will further expand multi-institutional research opportunities, as we anticipate involving high-caliber research faculty from other institutions as 'outside faculty members' serving on the dissertation committees of our doctoral students. Their involvement in student dissertation research projects will foster collaboration between our research faculty and these 'outside faculty members'.

"Foster networking and strategic collaborations between higher education, government, and Louisiana's existing and prospective high-growth industry sectors."
Louisiana's high-growth industry sectors include *Energy Production* and *Coastal Resilience*. Our concentration areas include Energy and the Environment (which includes coastal environmental systems). Hence, the framework and educational approach of the proposed doctoral program in Earth and Energy Sciences will embrace translational research that will readily foster productive collaborations between higher education, industrial and government partners. We have established partnerships with more than a dozen companies and businesses that offer internships for our students at the undergraduate and M.S.-degree levels. These relationships will be strengthened and expanded with the implementation of the proposed doctoral program in Earth and Energy Sciences.

"Build capacity in areas of competitive advantage and target niches which align with campus and State research priorities."
As described above, the target niches of this program are closely aligned both with the research priorities of UL Lafayette and the State of Louisiana. By filling these niches, we add new educational opportunities and value to our students, our community, and society.

EMPLOYMENT PROJECTIONS
State Demand
The data in Table 1 suggest that 370 new positions that overlap with skillsets of our Earth and Energy Sciences Ph.D. graduates will be available annually from 2014 to 2024. Much of this growth will be satisfied by a workforce with Bachelor's and Master's Degrees and the extent to which Ph.D.-level candidates will be preferred is not known. The doctoral-level graduates will be suitable for leadership and management positions. Hence, the strong overall need for scientists in these physical science fields is a good indication of the need for qualified job candidates at all levels. For example, the need for academic (post-secondary) positions in these areas, where a Ph.D. is frequently required, is expected to increase by 70 positions by 2024 in Louisiana alone. Moreover, some of the demand for in-state Ph.D. scientists of this type is not captured in the current demand projections for Louisiana because state job projections do not account for state/federal agencies and private research groups that may have headquarters located outside of Louisiana. Nor do these projections include consultants and self-employed professionals, an exponentially growing employment segment in geosciences. Finally, there may be considerable growth in the energy sector outside of the oil and gas industry. Start-up companies will need scientists in these areas of biofuel technology and development as

well as conventional energy companies that aim to expand their operations.

Table 1.
Physical Sciences occupational projections for Louisiana
(Source: Louisiana Workforce Commission – Long-term Occupational Projections)

SOC Code	Occupational Projections for Louisiana	Projected annual openings 2014-2024
19-2042	Geoscientists	70
19-2041	Environmental Scientists and Specialists	220
11-9121	Natural Science Managers	20
19-2031	Chemists	60
TOTAL		370

National Demand

By 2024, almost 2,000 academic positions that require a Ph.D. are projected to open annually in the United States in areas represented within the Earth and Energy Sciences program (Table 2). Considering the strong national focus on inter- and multi-disciplinary research associated with Energy (fossil fuel, biofuels, and other renewables) and the Environment (pollution, water resources), our graduates will be in a strong position to fill growing academic demand in these sectors. We also expect substantial growth in demand at the national level for Ph.D. level scientists at research Institutes and within federal government agencies (e.g., USGS, EPA, DOE, etc.).

Table 2.
Academic job estimates nationally
(Source: US Bureau of Labor Statistics)

Occupational Code	Occupational Title	Projected average annual openings 2014-2024
25-1051	Atmospheric, Earth, Marine, and Space Sciences Teachers, Postsecondary	350
25-1053	Environmental Science Teachers, Postsecondary	180
25-1054	Physics Teachers, Postsecondary	580
25-1052	Chemistry, Postsecondary	880
TOTAL		1990

The supply of newly-trained geoscientists falls remarkably short of future geoscience workforce demand and replacement needs. Forty-three percent of the current geoscience workforce is at or near retirement age. AGI's 2014 *Workforce Report* illustrates that the majority of current researchers at federal agencies are at retirement age or are rapidly approaching it. The Bureau of Labor Statistics indicates that all Geoscience jobs will increase by 10% from 2014 to 2024. In addition, a 2011 article in the journal *Nature* (Perkins, 2011; Nature 473, 243-244 doi:10.1038/nj7346-243a) explains that one of the geoscience employment sectors poised for the most growth is consultancy. This anticipated job growth will provide opportunities for geoscientists equipped with a strong set of fundamental skills, particularly postdocs with several years' worth of experience who elect to leave academia, and mid-career researchers who choose to leave government positions. The article goes on to state that "*many of today's senior geoscientists were trained as specialists in relatively narrow disciplines, but in the future, most demand will be for researchers who have been trained to appreciate the interdisciplinary nature of the Earth sciences*.**" The focus of the proposed Ph.D. degree program is to provide interdisciplinary courses and research opportunities to our students in order to prepare them to become the next generation of interdisciplinary scientists in Geosciences.**

According to statistics provided by the U.S. Bureau of Labor, employment of physicists is projected to grow seven percent from 2014 to 2024. According to several surveys conducted by the National Science Foundation over the last four decades, the private sector is the largest single employment base of Physics Ph.Ds. Having an interdisciplinary doctorate degree will make our graduates more competitive for private sector jobs, particularly in Louisiana. The median starting salary for these jobs is $90,000 for Physics Ph.D. recipients, which is considerably higher than $51,000 for B.S. degree and $60,000 for M.S. degree recipients in the same sector. This is indicative of a greater economic value of the Ph.D. degree for future careers. "*Physics Ph.D.s in potentially permanent positions experienced the greatest diversity concerning the field in which they are working. Forty-four percent of the Ph.D.s who accepted potentially permanent positions are working outside the field of physics, with the field of engineering comprising the largest portion of this group*" (Source: www.aip.org/statistics). Physics graduates have one of the lowest unemployment rates. In 2015, the *Fortune* magazine ranked Ph.D. degree in Physics as the 5th best graduate degree for the job market.

The demand for chemists, notably those with advanced degrees, is expected to increase at a 3% rate until 2024 (Source: U.S. Bureau of Labor Statistics). In practice, the demand for recent Chemistry graduates will be significantly higher, due to an over-aged workforce: in 1990, 43.5% of all chemists were under the age of 40, compared to only 25.8% in 2015. During the same time frame, the fraction of chemists within the labor force who hold a Ph.D. has increased from 56.3% to 69.6%, indicating a steady shift towards more highly-trained chemists (Source: ChemCensus 2015, American Chemical Society). In 2015, the median salary for Ph.D. chemists was $105,000, as compared to $77,000 for B.S. chemists and $87,000 for M.S. chemists, reflecting the economic value of a Ph.D. (Source: American Chemical Society). Currently, chemists fill 23,000 direct jobs in Louisiana and generate $2.2B in payroll, making it one of the leading states to offer employment opportunities for chemists (Source: American Chemistry Council).

Finally, because our doctoral graduates will have extensive, interdisciplinary coursework and research experience in Geology, Environmental Science, Physics, and Chemistry, they will be more competitive for a larger number of job opportunities than doctoral graduates from more-conventional degree programs that offer training in only a single discipline (e.g., Geology, Environmental Science, or Physics, or Chemistry). Furthermore, because our interdisciplinary program in Earth and Energy Sciences emphasizes translational research, our doctoral graduates will be competitive for industrial, governmental agency, and academic job opportunities.

Describe how the program will further the mission of the institution.

The University of Louisiana at Lafayette is the largest member of the University of Louisiana System and is designated within the Carnegie classification as a Doctoral Research University with Higher Research Activity. In addition to the pursuit of excellence in education and research at all levels, the mission of the University is to promote regional economic and cultural development, to explore solutions to national and world issues, and to advance its reputation among its peers. The proposed doctoral program in Earth and Energy Sciences will advance UL Lafayette's existing status as a research university and support UL Lafayette's mission by producing graduates who will strengthen the local and regional economy, but who will also bring honor and prestige to Louisiana as they find employment in other regions of the U.S. and internationally.

The proposed Ph.D. program in Earth and Energy Sciences is an institutional priority for UL Lafayette because it will integrate and strengthen four separate science degree programs, provide new opportunities for our students and faculty, increase the number of students receiving STEM degrees, and support the strategic directions for research at the University. Among other key disciplines, UL Lafayette aims to become a leader in research and education focused on Energy and the Environment, and aspires to become a leader in translational research in Earth and Energy Sciences by bridging the gap between fundamental research and application-based research. Hence, the focus of this doctoral program fits perfectly within the strategic research and educational interests of our University.

Identify similar programs in the state and explain why the proposed one is needed: present an argument for a new or additional program of this type and how it will be distinct from existing offerings.

According to the Louisiana Board of Regents degree inventory, Louisiana State University has individual Ph.D. programs in Geology, Environmental Science, Physics, and Chemistry. The University of New Orleans has a Ph.D. program in Chemistry and an interdisciplinary Ph.D. program in Engineering and Applied Science. The latter degree is an umbrella program for 9 disciplines, which include Physics and Earth and Environmental Science. Table 3 summarizes the Ph.D. programs at UNO and LSU that have partial overlap with our proposed program.

Table 3.
Ph.D. degree programs at LSU and UNO
that are related to the proposed Ph.D. in Earth and Energy Sciences

Institution	Degree	Administered by	Concentrations or focus areas
Louisiana State University	Ph.D. in Environmental Science	Department of Environmental Science in the College of the Coast and Environment	Biophysical Systems; Environmental Planning and Management; Environmental Assessment and Analysis
Louisiana State University	Ph.D. in Geology	Department of Geology and Geophysics	Evolution of Sedimentary Systems and Earth Materials and Solid Earth Processes
Louisiana State University	Ph.D. in Physics and Astronomy	Department of Physics and Astronomy	Astronomy, astrophysics, gravitation and relativity, nuclear and particle physics, medical physics, materials physics, atomic/molecular/optical physics, and quantum optics and computing.
Louisiana State University	Ph.D. in Chemistry	Department of Chemistry	New methods for synthesis of biomedically important compounds, nanomaterials, energy storage, computational models for assorted phenomena, ultra-fast lasers, and designer polymers.
University of New Orleans	Ph.D. in Chemistry	Department of Chemistry	Analytical Chemistry, Biochemistry, Inorganic, Medicinal, Materials, Organic, and Physical Chemistry.
University of New Orleans	Ph.D. in Engineering and Applied Science	Jointly run by Colleges of Science and Engineering	Civil and Environmental Engineering, Electrical Engineering, Mechanical Engineering, Naval Architecture/Marine Engineering, Engineering Management, Physics, Mathematics, Earth and Environmental Science, Computer Science.

Why our program is different:

The proposed doctoral program in Earth and Energy Sciences will benefit students who desire an inter-disciplinary and multi-disciplinary doctoral degree in the Physical Sciences with particular applicability to Environmental research. The proposed doctoral degree program provides coursework and research training opportunities pertinent to each of the partnering disciplines. **Thus, each student in this program will receive 12 hours of structured interdisciplinary coursework that integrates Chemistry, Environmental Science, Physics, and Geology. This approach of requiring a core set of interdisciplinary courses for every student in our program is unique to our program and distinct from traditional Ph.D. degree programs in a single discipline.** This approach will ensure that every student will receive adequate 'breadth of interdisciplinary training' in the Earth and Energy Sciences. An additional 30 hours of coursework and dissertation research will ensure that the students receive adequate 'depth of training' in the Earth and Energy Sciences. Although it is possible for students to seek out interdisciplinary interactions within a traditional Ph.D. program at other universities by taking some courses in other disciplines or programs, it is not part of their required curriculum structure. This proposed approach is also distinct from umbrella programs that encourage interdisciplinary coursework but do not require a specific set of interdisciplinary courses for all of the students. By requiring a core inter-disciplinary or multi-disciplinary foundation, our graduates will be especially well prepared to engage and solve problems across disciplines because they will have been prepared in Physics, Chemistry, Geology, and Environmental Science with an emphasis on problem solving. **Each student admitted to the proposed doctoral program in Earth and Energy Sciences will be advised by interdisciplinary faculty committees.** Incoming students will meet with the graduate advising committee in order to prepare an Individual Development Plan for the student. By design, the graduate advisory committee is interdisciplinary in its composition. The graduate advising committee will monitor and advise each student through the early phase of the degree program until that student selects a major professor. In consultation with the major professor, the student will then form a dissertation committee, the composition of which must be interdisciplinary. The dissertation committee will mentor the student through the remainder of his/her degree program until graduation. Thus, the proposed Ph.D. degree program requires: (1) that students receive a consistent core of interdisciplinary coursework and; (2) that students be advised and mentored by interdisciplinary committees of faculty members. This approach

ensures that each student has ample opportunity to access interdisciplinary information and ample opportunity to access faculty expertise across disciplines in the physical sciences. Accordingly, graduates of this program will be ideally suited to pursue a wide range of career options in a variety of Physical Science and Environmental Science disciplines (e.g., academic careers in Chemistry, Geology, Physics, and Environmental Science programs, research scientists with organizations such as the EPA, DOE, and USGS, state government positions with organizations such as LDEQ and LDNR, and industry jobs in oil and gas, bio-fuel/tech, environmental management/consulting).

If approved, will the program result in the termination or phasing out of existing programs? (Is it a replacement?) Explain.

The program will not result in the termination or phasing out of existing programs, nor is it a replacement for any existing programs.

If a Graduate program, cite any pertinent studies or national/state trends indicating need for more graduates in the field. Address possibilities for cooperative programs or collaboration with other institution(s).

As was discussed above, considerable job opportunities are anticipated at the state (370 annually) and federal levels (approximately 2,000 annually) for Ph.D. level scientists in Geosciences. Additional opportunities are likely to be available to Ph.D. level physicists and chemists, where significant salary incentives distinguish Ph.D.-level scientists from M.S.-level scientists. In addition to academic appointments, job opportunities are anticipated in state and federal agencies concerned with regulating energy acquisition or with mitigating environmental impacts of energy acquisition. Finally, job opportunities are anticipated in the private sector where our graduates will serve as consultants or as experts in the energy sector as well as in environmental arenas. The involvement of research faculty from other institutions as 'outside members' of dissertation advisory committees will foster collaborative research initiatives.

3. Students

Describe evidence of student interest. Project the source of students (e.g., from existing programs, or the prospects of students being recruited specifically for this program who might not otherwise be attracted to the institution).

We plan to recruit students on our campus who receive B.S. or M.S. degrees in Chemistry, Environmental Resource Science, Geology, and Physics (more than 115 students annually). We will also strongly recruit B.S. and M.S. students from other universities in our state, as well as nationally and internationally. By combining four separate programs in our interdisciplinary Ph.D. program, we will greatly expand the student population from which we can recruit. One of our initial strategies will be to disseminate recruiting information to the relevant programs (including HBCUs) that offer B.S. and M.S. degrees in the Gulf Coast region. We will additionally use resources such as the GRE exam search service, the McNair Scholars Directory, and online directories to identify potential candidates who have demonstrated graduate-level readiness for our program and we will reach out to all of them via e-mail. Such efforts have been a successful recruiting approach for our other graduate programs. In addition to these efforts, we plan to build social media and SEO-based recruitment initiatives.

To assess demand for such an interdisciplinary Ph.D. program among our current students, we conducted surveys of undergraduates and graduate students majoring in Geology, Physics, and Environmental Sciences at UL Lafayette. Of the 169 student respondents, 38% expressed intent to continue their graduate education on a full-time basis. When asked "if UL Lafayette offered a Ph.D. program in your field of study that would prepare you for success in either the academic environment or in industry, would you be interested in enrolling," 47% responded "yes." Corroborating this strong expression of interest, 39% of the respondents indicated (on a 1 to 10) scale that they would likely pursue a Ph.D. in Geosciences at UL Lafayette, while 17 students indicated they would definitely enroll in such a program (by indicating a 9 or 10, where 10 represented "complete certainty"). We also inquired about geographic preferences for school location in pursuing a Ph.D. in Geosciences. Fifty-six percent expressed a definite interest in staying in the State of Louisiana, and 32% (or 54 students) indicated an absolute preference for continuing on to their doctoral education at UL Lafayette. Interestingly, 33% of the sample indicated that they would pursue a Ph.D. in Geosciences but *only if* it was offered at UL Lafayette. The primary two motivators for students seeking a Ph.D. in Geosciences were: (1) the chance to learn more about their profession, (2) the opportunity to earn a higher salary. Results also suggest that about 55% of respondents would intend on working in academia and 45% in industry upon completion of a Ph.D. in Geosciences. Ten students indicated they had already decided to pursue a Ph.D. immediately following graduation as a definite career plan. A separate survey administered to students in Chemistry. Of the 32 respondents, 27 (79%) were considering graduate studies either at the M.S. or Ph.D. level.

Project enrollment and productivity for the first 5 years, and explain/justify the projections.

Projected Student Enrollment:

Table 4.
Projected enrollments and student funding mechanisms for years 1-5.

Year	Total Enrolled	Funding			
		Industry-Funded	Self-Funded	Research-Funded	University-Funded Graduate Assistantships[1]
1	5	0	0	1	4
2	10	1	0	2	7
3	15	3	1	3	8
4	18	3	2	5	8
5	20	4	2	6	8

[1]This includes 4 new, continuing assistantships in year 1 and 3 new, continuing assistantships in year 2 (for a total of 7). One additional assistantship originally allocated to the Geology M.S. degree program will be shifted for use in the Ph.D. program.

The enrollment projections in Table 4 appear to be in line with other Ph.D. programs in the Physical Sciences. For example, LSU's Ph.D. program in Geology had enrollments of 16, 17, 20, 26, and 29 in the Fall semesters of the 2010-2011, 2011-2012, 2012-2013, 2013-2014, and 2014-2015 academic years, respectively. We plan to continue to grow enrollment after the program has been established in the first five years.

Provide enrollment/completer data for closely related programs currently offered at the institution.

UL Lafayette's undergraduate programs in Chemistry, Geology, Environmental Science, and MS degree programs in Geology, Physics, and Environmental Resource Science are the most closely related in that they may serve as feeders into our Ph.D. program. Enrollment data for these programs are compiled from 2011 through 2015 in Table 5 and graduation data are presented in Table 6. There is no competition with this newly proposed Ph.D. program and other Ph.D. programs on our campus.

Table 5.
Enrollment by Semester

	SP12	FA12	SP13	FA13	SP14	FA14	SP15	FA15	SP16	FA16
Chemistry (BS)	159	174	152	167	143	161	130	169	138	140
Geology (BS)	63	85	80	91	89	98	90	103	94	87
ENV Sci (BS)	22	31	37	52	57	66	55	73	66	64
Physics (MS)	4	6	6	8	4	7	5	11	11	13
Geology (MS)	49	49	49	66	64	69	72	88	83	87
ENV Res Sci (MS)	This program will begin in fall 2017									

Table 6.
Degrees Awarded by Year

	2011/12	2012/13	2013/14	2014/15	2015/16	5 year Ave
Chemistry (BS)	16	14	18	24	17	18
Geology (BS)	6	5	23	8	14	11
ENVS Sci (BS)	NA	NA	2	5	10	NA
Physics (MS)	3	3	4	1	2	3
Geology MS	11	11	12	10	18	12
ENVS Res Sci (MS)	This program began in Fall 2017.					

What preparation will be necessary for students to enter the program?

Admission:
UL Lafayette uses a portfolio approach to graduate admission that involves a thorough evaluation of student capabilities measured by several metrics inclusive of the GRE Exam (Graduate Record Exam), TOEFL (Test on English as a Foreign Language), written essays (e.g., both writing samples and personal statements), reference letters, and evaluation of transcripts from previous educational institutions. Of these, only academic record, TOEFL scores, and GRE results are directly measurable. Hence, for direct admission (B.S. to Ph.D.), the proposed program in Energy and Earth Sciences will require students to hold a B.S. in Geology, Environmental Science, Physics, or Chemistry (or a related field as determined by program faculty), with at least a 3.0 cumulative GPA in their B.S. program. Post-M.S. students who apply must also have their degrees in Geology, Environmental Science, Physics or Chemistry, and have a cumulative graduate GPA of at least 3.3. All incoming students must have completed (at a minimum) two classes and associated labs each in Geology, Physics, and Chemistry (i.e., a total of six lecture classes and six lab classes) and must have completed Calculus I and II. The preferred GRE score expectations for all applicants for the proposed doctoral program will be a verbal score of 145 and total verbal + quantitative score of 294.

If a Graduate program, indicate & discuss sources of financial support for students in the program.

By year two, UL Lafayette will support seven new and continuing Ph.D.-level graduate teaching assistantships for this program, which include monthly stipends as well as tuition waivers. Four assistantships will be made available for the first year of the program, and three additional assistantships will be granted for the second year, for a total of seven assistantships henceforth. As the program grows beyond initial projections (Table 4), the additional tuition revenue may support additional assistantships. Graduate assistantships are important for recruiting and retaining highly qualified students. Graduate assistantships help to offset faculty workloads, which are expected to increase with the inception of the doctoral program proposed. The cost of the requested four assistantships will be offset by in-state and out-of-state tuition revenue from full-time students enrolled in the program.

Additionally, a significant number of graduate assistantships are funded by external research funding. Indeed, the Office for Research provides incentives for including graduate student funding in such proposals. In this instance, it is the University's expectation that, in addition to the graduate assistantships funded by the Graduate School, a significant percentage of the students funded as GRAs will be supported by the faculty's external research funding and industry-funded initiatives. The average annual research funding for the academic units participating in the proposed Ph.D. program in Earth and Energy Sciences is $2,566,180 (based on the most recent 6-year average). These data suggest that from eight to twelve doctoral students could be supported through external funding based on our current rate of research funding, depending on other budgetary needs of the grant awards.

We have secured substantial support for the Ph.D. program from a variety of industry partners (listed below). Most of our students in our existing B.S. and M.S. programs in the physical sciences participate in internships. We expect to continue these relationships by extending internship opportunities to Ph.D. students.

The following organizations indicated their support for the creation of this program.

- Chevron
- Halliburton
- Schlumberger
- Stone Energy
- KourCo Environmental Services
- Fugro Geoservices
- ASV (Autonomous Surface Vehicles)
- Ion Energy
- Eni US Operating Co.
- Fenstermaker

4. Faculty

List present faculty members who will be most directly involved in the proposed program: name, present rank; degrees; courses taught; other assignments.

Primary Faculty are listed below, all with doctoral degrees and the appropriate graduate faculty status

- Dr. Katie Costigan, Assistant Professor, Environmental Science
- Dr. August A. Gallo, Professor, Chemistry
- Dr. Raphael Gottardi, Assistant Professor, Geology
- Dr. Aubrey Hillman, Assistant Professor, Geology
- Dr. William A. Hollerman, Professor, Physics
- Dr. Thomas Junk, Professor, Chemistry
- Dr. Gary Kinsland, Professor, Geology
- Dr. Febee Louka, Associate Professor, Chemistry
- Dr. Gabrielle Morra, Assistant Professor, **Physics/ Geology (Interdisciplinary joint faculty hire)**
- Dr. Andi G. Petculescu, Assistant Professor, Physics
- Dr. Gabriela L. Petculescu, Associate Professor, Physics
- Dr. Durga Poudel, Professor, Environmental Science
- Dr. Carl Richter, Professor, Geology
- Dr. Brian Schubert, Assistant Professor, Geology
- Dr. Natalia Sidorovskaia, Professor, Physics
- Dr. Radhey Srivastava, Professor, Chemistry
- Dr. Jenneke Visser, Associate Professor, Environmental Science
- Dr. Harry Whitlow, Professor, Physics
- Dr. Xu Wu, Associate Professor, Chemistry
- Dr. Hui Yan, Assistant Professor, Chemistry
- Dr. Rui Zhang, Assistant Professor, **Geology/Physics (Interdisciplinary joint faculty hire)**

Project the number of new faculty members needed to initiate the program for each of the first five years. If it will be absorbed in whole or part by current faculty, explain how this will be done. Explain any special needs.

The program will be taught by current faculty.

Describe involvement of faculty – present and projected – in research, extension, and other activities and the relationship of these activities to teaching load. For proposed new faculty, describe qualifications and/or strengths needed.

The Departments/programs in the College of Science at UL Lafayette have in place a highly-structured framework for determining teaching loads, as per research, extension, and other activities. All new faculty who teach at the Graduate level are required to hold a terminal degree, and must demonstrate success in research, teaching, and service.

Scholarly activity within the programs supporting the Ph.D. is high and capable of supporting multiple graduate students. Over the last 6 years, the faculty of the academic units participating in the proposed Ph.D. program published an average of 47 peer-reviewed publications annually (1.67 articles annually per each faculty member). Research activity of these faculty members will increase naturally, as doctoral students join the program and take on dissertation research projects. New, interdisciplinary and collaborative research proposals will be developed by these faculty members as dissertation projects are devised and their doctoral students acquire pilot data. It is anticipated that the successful implementation of the proposed Ph.D. degree program in Earth and Energy Sciences will significantly enhance research productivity of these faculty, as their doctoral students complete and publish their dissertation research, as external funding supports these research endeavors, and as the doctoral program in Earth and Energy Sciences grows to capacity. We have data from our existing doctoral programs in Mathematics and Environmental and Evolutionary Biology at UL Lafayette that is consistent with this projection that faculty members in Earth and Energy Sciences will increase research activity once the degree program is implemented.

5. Library and Other Special Resources

Are present library holdings in related fields adequate to initiate the program? To meet program needs in the first 5 years, what will be needed? Do other institutions have library resources available to faculty & students for the proposed program?

Present library holdings in the related fields of Geology, Environmental Science, Physics, and Chemistry are adequate to initiate the Ph.D. in Earth and Energy Sciences. The library supports instruction and research with collections in a variety of formats. The library provides electronic access to materials through the library's website.

Other institutions' resources are available to faculty and students for the Ph.D. in Earth and Energy Sciences through Interlibrary Loan and LOUIS: The Louisiana Library Network. The library participates in formal arrangements in order to supplement the collections owned by the library. This includes participation in LOUIS: The Louisiana Library Network, a consortium that allows Louisiana academic libraries to share library resources, collaboratively purchase resources, and extend borrowing privileges across the state. Through the library's membership in LOUIS, students and faculty may obtain a LOUIS card and borrow materials directly at all of the colleges and universities throughout the State of Louisiana.

Indicate/estimate total expenditure for the last two fiscal years in library acquisitions for fields or departments offering or related to the proposed program.

Total Library Expenditures 2016/2017

Print and Electronic Serials Subscriptions: $1,003,362.17

Online Research Databases (includes LOUIS Consortium Membership): $972,294.22

Print and Electronic Books: $56,056.73

Project library expenditures needed for the first 5 years of the program.

No additional library expenditures are anticipated.

What additional special resources, other than library holdings, will be needed?

There are no anticipated additional special resources, other than library holdings, needed.

6. Facilities and Equipment

Describe *existing* facilities (classrooms, labs, offices, etc.) available for the program. Describe present utilization of these facilities that are assigned to the sponsoring department.

The administrative center of the Ph.D. program in Earth and Energy Science will be housed within the School of Geosciences in Hamilton Hall. Faculty meetings related to managing the Earth and Energy Sciences doctoral program will be held in Hamilton Hall. Individual faculty members and their doctoral students may be housed in the School of Geosciences, in the Department of Chemistry, or in the Department of Physics, depending on the primary appointment of the faculty member. In the School of Geosciences located in Hamilton Hall, there are seven classrooms available for lecture classes, totaling almost 7,000 ft^2 and accommodating 491 students. This space includes a 236-person auditorium, which can be used for large classes and our graduate seminar series. An additional 4,200 ft^2 of laboratory teaching space is available for "hands-on" laboratory-based courses. Every faculty member and instructor in the School of Geosciences has office space on the 3rd floor of Hamilton Hall. Several additional offices are available to accommodate further expansion. Laboratory research space in Hamilton Hall includes two large (>1,000 sq ft) rooms in the basement (B08/B09). These include extensive bench space, available gas, vacuum and air lines, fume hoods, and wireless internet access. Additional research laboratory space on the 2nd floor is dedicated to geochemical investigations, including isotope ratio mass spectrometry.

Research labs and additional space for graduate students will be provided in the Department of Chemistry and Physics. The Department of Chemistry is located in Montgomery Hall, a two-story building exclusively dedicated to departmental needs with two auditoria, three additional classrooms and seven teaching labs. The chemistry program is accredited by the American Chemical Society and has a full complement of major scientific equipment. In addition, 6,000 ft^2 of dedicated research space is available to faculty and students, equipped to accommodate research in all major sub-disciplines (analytical, organic, inorganic, polymer, physical). Teaching and research are further supported by two well stocked, fully staffed stockrooms, individual office space for all faculty and a student study lounge.

The Department of Physics is located in Broussard Hall and will offer modern research laboratories to conduct dissertation research and student/faculty office space. Broussard Hall offers over 3,000 ft^2 of dedicated research space which include fully equipped environmental nuclear physics laboratory, ultrasonic and applied acoustics laboratory, materials research laboratory, underwater acoustics equipment maintenance space (this equipment gets deployed in the field), a fully-equipped machine shop, and the Grant and Melissa Gibson's research laboratory (includes optical and nuclear physics instrumentation for applied research and a 3-D printing station). In addition, the department of Physics leads the operation of the Louisiana Accelerator Center (LAC), 14000 ft^2 space that houses the low-energy Van de Graff accelerator with three beam lines for material's analysis and microfabrication. Dr. Harry Whitlow, Professor of Physics, serves as the director of this multidisciplinary research center that is utilized by physics, geosciences, biology, chemistry, and engineering faculty.

In summary, more than 21,000 square feet of laboratory, classroom and office space is available for the Ph.D. program in Earth and Energy Sciences with the School of Geosciences and the Departments of Chemistry and Physics. Additional space and resources are available at the University-affiliated Louisiana Accelerator Center.

Describe the need for new facilities (e.g., special buildings, labs, remodeling, construction, equipment), and estimate the cost, proposed sources of funding, and estimated availability for program delivery.

We do not require additional room for research space, classrooms, or faculty and staff offices at this time. We will, however, require additional office space for graduate research assistants and teaching assistants. Therefore, funds are requested in the amount of $20,000 per academic unit (Geosciences, Chemistry, and Physics) that total $60,000 in order to remodel space that will accommodate an influx of doctoral graduate students. These funds will create or enlarge shared office space in each academic unit. In addition, $15,000 is requested to purchase computers to be located in the three graduate student offices. These computers will be shared among the graduate students. The graduate advisory committee, in consultation with the incoming students, will place the students into one of the three graduate student offices. Once the students identify a major professor, they will relocate (if necessary) to the academic unit primarily responsible for that professors' academic appointment. We recognize the importance of teaching assistants holding office hours at a consistent location where students from their courses can come for academic support. It is also important that graduate research assistants have office space located conveniently to the labs where they work so that faculty can appropriately supervise them.

7. Administration

In what department, division, school, college, or center/institute will the proposed program be administered? How will the new program affect the present administrative structure of the institution?

The Ph.D. degree program in Earth and Energy Sciences will be administered by the School of Geosciences, and by the Departments of Chemistry and Physics in the Ray P. Authement College of Sciences. The new program will have little to no impact on the present administrative structure of the institution.

Describe departmental strengths and/or weaknesses and how the proposed program will affect them.

The individual academic units participating in the proposed degree program are the School of Geosciences (with 11 tenure-track faculty); the Department of Chemistry (with 11 tenure-track faculty); and the Department of Physics (with 7 tenure-track faculty). These units are too small individually to support a conventional doctoral program focusing solely on their individual core subject matter. Expanding the size of each of these academic units to permit the development of singularly focused doctoral degree programs would be prohibitively expensive. On the other hand, each of these academic units consists of highly qualified faculty members, each of whom is a highly productive researcher and talented instructor and mentor of students. Data summarizing the research productivity of these faculty members was provided above. The proposed interdisciplinary Ph.D. degree program in Earth and Energy Sciences aims to combine the faculty members of these academic units in such a way that will direct their energy and talents toward a cohesive interdisciplinary mission. That mission will be to prepare interdisciplinary Ph.D. level scientists in Earth and Energy Sciences. The individual teaching loads of the concerned faculty will not substantially increase because the necessary courses will be spread among 29 faculty members, reflecting the sum of the academic units involved. Likewise, the number of new courses needed to implement the degree program will be spread among the academic units, thereby reducing the impact on the individual academic units. Whereas the impact of implementing the proposed degree program on teaching loads will be modest, the impact of implementing the proposed degree program on faculty research productivity will be highly significant. At the present time, none of these academic units has direct access to doctoral students. Thus, implementing the proposed degree program will infuse these academic units with new students eager to learn and then to apply their newly acquired knowledge to their dissertation research. In the short term, implementing the proposed degree program will increase the number and quality of faculty publications and externally funded research grants. In the long term, implementing the proposed doctoral degree program will allow UL Lafayette to build a highly-competitive and well-respected doctoral degree program in Earth and Energy Sciences. This program will enhance the State and the University by attracting significant external funding to enable the acquisition of new scientific infrastructure including state-of-the-art instrumentation, by attracting highly-talented graduate student applicants, and by attracting and retaining highly-talented and dedicated research active faculty members.

In conclusion, implementing the proposed degree program in Earth and Energy Sciences will enable faculty members in Chemistry, Physics, Geology and Environmental Science to maximize their research productivity by enabling them to directly mentor doctoral students and their dissertation research, while, at the same time, not substantially increasing their individual teaching loads. The graduates of this degree program will directly impact some of the most pressing issues facing society, namely how best to acquire energy while at the same time minimizing detrimental impacts of energy acquisition on the environment. Consequently, the University of Louisiana at Lafayette, the State of Louisiana, and the entire nation will benefit from implementing the proposed degree program.

8. Accreditation

Describe plan for achieving *program* accreditation, including: name of accrediting agency, basic requirements for accreditation, how the criteria will be achieved, and projected accreditation date.

There currently is no existing program accreditation body for this discipline.

If a graduate program, describe the use of consultants in developing the proposal, and include a copy of the consultant's report as an appendix.

Consultants were not used for the development of this proposal.

9. Related Fields

Indicate subject matter fields at the institution which are related to, or will support, the proposed program; describe the relationship.

Because the proposed program in Earth and Energy Sciences is interdisciplinary, students with undergraduate degrees in Chemistry, Physics, Biology, Civil Engineering, Environmental Science, and Geology will have the academic

background necessary for admission into the program. Moreover, faculty from these disciplines will be directly involved in our program through research, mentorship, and teaching. We plan to leverage courses that are already being routinely taught, so that changes in teaching loads will be minimal. Faculty from any of these disciplines will be eligible to serve on dissertation committees.

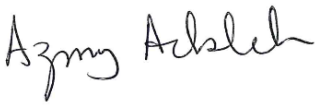
10. Cost & Revenue

Summarize additional costs to offer the program, e.g., additional funds for research needed to support the program; additional faculty, administrative support, and/or travel; student support. How will the program affect the allocation of departmental funds?

Our proposed program can be fully implemented with limited cost to UL Lafayette. This includes no new funds required for faculty, supplies, operating expenses, or travel. Costs incurred by seven new and continuing graduate assistantships represent a necessary investment in the success of the program. In addition to the seven graduate assistantships requested from UL Lafayette, students will be funded by external research funds and by industry partners, either through the creation of company-sponsored assistantships or corporate funding as a business recruiting tool for graduates. Finally, Ph.D. students will have full access both to the UL Lafayette and the LSU libraries, as well as resources provided through the LOUIS consortium, so little or no additional library costs are anticipated.

*On the separate budget form, estimate *new* costs and revenues for the projected program for the first four years, indicating need for additional appropriations or investment by the institution.

CERTIFICATIONS:



Dr. Azmy Ackleh, Dean of the Ray P. Authement College of Sciences
Primary Administrator for Proposed Program Date: 9/28/17

Dr. Fabrice Leroy, Assistant Vice President for Academic Programs
On behalf of Provost/Chief Academic Officer Date: 9/28/17

_____ _____
Management Board/System Office Date

SUMMARY OF ESTIMATED ADDITIONAL COSTS/INCOME FOR PROPOSED PROGRAM

Institution: University of Louisiana at Lafayette **Date: 9/28/17**

Degree Program, Unit: Ph.D. in Earth and Energy Sciences

FTE = Full Time Equivalent (use the institution's standard definition and provide that definition).

EXPENDITURES								
INDICATE ACADEMIC YEAR:	**FIRST**		**SECOND**		**THIRD**		**FOURTH**	
	AMOUNT	**FTE**	**Amount**	**FTE**	**AMOUNT**	**FTE**	**AMOUNT**	**FTE**
Faculty	$		$		$		$	
Graduate Assistants (university funded)	$76,000		$136,500		$140,000		$143,500	
Support Personnel								
Fellowships and Scholarships								
SUB-TOTAL	$76,000		$136,500		$140,000		$143,500	
	AMOUNT		**AMOUNT**		**AMOUNT**		**AMOUNT**	
Facilities	$ 60,000		$		$		$	
Equipment	$18,760		$2,820					
Travel								
Supplies	400		700		700		700	
Other (specify)								
SUB-TOTAL	$ 79,160		$3,520		$ 700		$ 700	
TOTAL EXPENSES	$ 155,160		$140,520		$140,700		$144,200	
REVENUES								
Revenue Anticipated From:	**AMOUNT**		**AMOUNT**		**AMOUNT**		**AMOUNT**	
*State Appropriations	$71,658		$143,317		$167,203		$210,198	
*Federal Grants/Contracts								
*State Grants/Contracts								
*Private Grants/Contracts								
Expected Enrollment	5		10		15		18	
Tuition	$27,553		$55,106		$64,290		$80,822	
Fees (undedicated)	2,203		4,406		5,140		6,462	
*Other (specify)								
TOTAL REVENUES	$101,414		$202,829		$236,633		$297,482	

* Describe/explain expected sources of funds in proposal text.