### COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

**FOR NSF USE ONLY**

**NSF PROPOSAL NUMBER** 0538396

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**NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE**
University of New Mexico

**AWARDEE ORGANIZATION CODE (IF KNOWN)**
0026633000

**NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE**

**ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE**

**PERFORMING ORGANIZATION CODE (IF KNOWN)**

**IS AWARDEE ORGANIZATION (Check All That Apply)**
- SMALL BUSINESS
- MINORITY BUSINESS
- FOR-PROFIT ORGANIZATION
- WOMAN-OWNED BUSINESS
- IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

**TITLE OF PROPOSED PROJECT**
Track 1, GK-12: E-MRGE: Ecohydrogeology in the Middle Rio Grande Environment

**REQUESTED AMOUNT** $1,758,268

**PROPOSED DURATION (1-60 MONTHS)** 36 months

**REQUESTED STARTING DATE** 04/01/06

**HUMAN SUBJECTS (Check Here)**
- Exemption Subsection
- or IRB App. Date Pending

**INTERNAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j)**

**HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.G.1)**

**PI/PD DEPARTMENT**
Department of Biology

**PI/PD POSTAL ADDRESS**
Castetter Hall
Albuquerque, NM 87131 United States

**PI/PD FAX NUMBER** 505-277-5355

**NAMES (TYPED)**

<table>
<thead>
<tr>
<th>Name</th>
<th>Degree</th>
<th>Year</th>
<th>Telephone</th>
<th>Email Address</th>
</tr>
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<tbody>
<tr>
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Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the individual applicant or the authorized official of the applicant institution is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, and lobbying activities (see below), as set forth in Grant Proposal Guide (GPG), NSF 04-23. Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

In addition, if the applicant institution employs more than fifty persons, the authorized official of the applicant institution is certifying that the institution has implemented a written and enforced conflict of interest policy that is consistent with the provisions of Grant Policy Manual Section 510; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the institution’s expenditure of any funds under the award, in accordance with the institution’s conflict of interest policy. Conflicts which cannot be satisfactorily managed, reduced or eliminated must be disclosed to NSF.

Drug Free Work Place Certification

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Drug Free Work Place Certification contained in Appendix C of the Grant Proposal Guide.

Debarment and Suspension Certification

(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency?  
Yes ☐  No ☒

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Debarment and Suspension Certification contained in Appendix D of the Grant Proposal Guide.

Certification Regarding Lobbying

This certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding $100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding $150,000.

Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, “Disclosure of Lobbying Activities,” in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE

NAME  Rosa Gonzalez

SIGNATURE  Electronic Signature

DATE  Jun 2 2005 12:03PM

TELEPHONE NUMBER  505-277-7575

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FAX NUMBER  505-277-4185

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PROJECT SUMMARY

Title: Track 1, GK-12: E-MRGE: Ecohydrology in the Middle Rio Grande Environment.
Institution: University of New Mexico
PI/Co-PI: Scott Collins, PI; Laura Crossey and Doug Earick, Co-PI’s
Number of Fellow per year: 7, 9 and 9 Fellows in years 1-3.
Number of Classes Served: 10-12 Classes served per year
Number of Teachers: At any time 7, 9 and 9 “Tier 1” teachers will work directly with each Fellow. Tier 1 teachers will work with T2 teachers. This may rotate among teachers during the year increasing the number of classes and teachers
School District Partners: Socorro and Belen, New Mexico
Target audience: Middle school
Setting: Rural
NSF Discipline: Ecohydrogeology (Ecology, Hydrology, Climate, Geology)

Intellectual Merit: The University of New Mexico in partnership with the Socorro and Belen School Districts, the Sevilleta Long-Term Ecological Research Program, and The Sevilleta National Wildlife Refuge proposes to conduct a GK-12 Program in Ecohydrology in the Middle Rio Grande Environment (E-MRGE). Our E-MRGE Program is designed to address the overarching goals of NSF’s GK-12 Program. E-MRGE Fellows will work in partnership with middle school teachers in two rural New Mexico communities, Belen and Socorro. Fellows will rotate between school systems and the Sevilleta National Wildlife Refuge outreach program. We will develop and support field trip activities for teachers to learn about the Sevilleta Long-term Ecological Research Program. Fellows and teachers will then develop related inquiry-based schoolyard LTER projects that provide hands-on science experiences for middle schools students. These active learning projects will be designed to help teachers meet New Mexico science standards. Teachers will receive support and university credit through summer courses offered by UNM’s Summer Teachers Institute. Each year middle school students will present results of research projects during an Earth (Science) Day Colloquium held at UNM.

Broader Impacts: Through these partnerships, E-MRGE Fellows will acquire enhanced pedagogical skills while middle school teachers acquire enhanced scientific knowledge and a suite of inquiry-based curriculum activities. Fellows will receive formal training through a variety of workshops and classes at UNM and from informal interactions with public school teachers. Important outcomes of our GK-12 program will be enhanced science knowledge and skills in middle school children, and stronger connections among these rural students and teachers to the University of New Mexico and to their local environment. Through periodic internal and external evaluations we will determine how well E-MRGE is meeting its goals and develop course corrections as needed.
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<td>Appendix (List below.) (Include only if allowed by a specific program announcement/solicitation or if approved in advance by the appropriate NSF Assistant Director or designee)</td>
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*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.
PROJECT DESCRIPTION
A. Results from prior NSF Support.
PI Collins, DEB-021744 - Sevilleta LTER: Long-term ecological research in a biome transition zone. The Sevilleta Long-term Ecological Research Project (http://sev.lternet.edu) is located about 80 kilometers south of Albuquerque, New Mexico, in and around the Sevilleta National Wildlife Refuge (SNWR). The Refuge is managed by the Department of Interior U.S. Fish and Wildlife Service and its surroundings are situated at the intersection of several major biotic zones: Chihuahuan Desert grassland and shrubland, Great Plains grassland, Piñon-Juniper woodland, Colorado Plateau shrubsteppe, and riparian vegetation along the middle Rio Grande Valley. The Sevilleta LTER Program, managed by the Department of Biology, University of New Mexico, became part of NSF’s LTER Program in 1988. The overarching goal of the Sevilleta LTER Program is to understand how abiotic pulses and constraints affect ecological dynamics and stability in arid land ecosystems.

In 1998, the Sevilleta LTER formed an exciting partnership with the Bosque Ecosystem Monitoring Program (BEMP, http://www.bosqueschool.org/BEMP/bemp.htm). Begun in 1996, BEMP is jointly coordinated by the UNM Department of Biology and the Bosque School in Albuquerque, with two main objectives. One is to involve citizen volunteers (K-12 students) and site representatives (usually teachers) in monitoring key variables that reflect ecosystem structure, functioning, and biodiversity at sites with different flooding histories in the Rio Grande Bosque (riparian zone). More than 400 volunteers participate each year. There are now 16 sites and participating schools, with hundreds of students, from Santa Ana and San Juan Pueblo schools (Native American schools) north of Albuquerque through the inner city and south to the Sevilleta National Wildlife Refuge. BEMP staff work with teachers to develop field and in-school learning activities designed to prepare students to meet state and national science testing standards. BEMP also offers field-training workshops and a summer course for undergraduate interns at UNM. Through these efforts BEMP volunteers learn to appreciate the Rio Grande ecosystem during their field data collection trips supervised by BEMP staff and UNM student undergraduate interns. Outreach in the form of inter-school conferences and presentations at local and national meetings is central to BEMP’s mission.

PI Crossey: DGE-9972810: Freshwater Graduate Studies Link Fundamental Science with Applications through Integration of Ecology, Hydrology and Geochemistry in Regions with Contrasting Climates. This Integrative Graduate Education and Research Training (IGERT) award supports a multidisciplinary, interregional graduate training program in ecohydrogeology at the University of Alabama-Tuscaloosa and the University of New Mexico. The program provides opportunities for students to study aquatic ecosystems in separate geographical regions that are at similar latitudes, but have very different climatic conditions. These ecosystems both exemplify and magnify the pressing need for interdisciplinary collaborations in the context of contemporary problems that are confronting us in the availability of fresh waters worldwide. Faculty at both institutions have parallel interests in key disciplines of freshwater ecology, hydrology, and geochemistry that are essential for effective understanding and management of aquatic ecosystems. The program includes novel components that strengthen students’ disciplinary, interdisciplinary, and practical problem-solving expertise as well as ensure responsible conduct in science, team-building and communication skills through inter-institutional education, and inter-site comparative projects. Internships with state/federal agencies such as the Bosque Improvement Group and BEMP in New Mexico provide opportunities for students to apply fundamental research to practical problem-solving. The training program also is deeply committed to participation of a truly diverse student group, and successfully attracts applicants that include students from locally large populations of underrepresented minorities such as Hispanic, African-American, and Native American.
students. Our proposed GK-12 activities are a natural extension of IGERT in that GK-12 Fellowship activities will prepare a diverse group of scientists to take advantage of a broad spectrum of career options, including those that connect them with K-12 education. IGERT has developed a new, well-focussed multidisciplinary graduate program that transcends organizational boundaries and unites faculty from several departments and institutions to create a highly interactive, collaborative environment for both training and research for participants.

B. Goals and Objectives.
The University of New Mexico – in partnership with the Socorro Consolidated Schools, Belen Consolidated Schools, the Sevilleta Long-Term Ecological Research (LTER) Program, and the Sevilleta National Wildlife Refuge – proposes to conduct a 3-year GK-12 Program entitled, “E-MRGE: Ecohydrogeology in the Middle Rio Grande Environment.” The overarching objective of E-MRGE is to build upon and draw together existing activities into a coordinated research, teaching and outreach program with the following quantifiable goals:

- **Goal 1.** Develop collaborations that will improve the teaching and outreach skills of the E-MRGE Fellows, and the content knowledge and its application for K-12 Teachers.
- **Goal 2.** Enable graduate teaching Fellows in disciplines related to ecohydrogeology to better understand the educational opportunities and practices of public schools.
- **Goal 3.** Strengthen existing partnerships and create new ones among the University of New Mexico and rural school districts.
- **Goal 4.** Provide the context for collaborations among K-12 Teachers and students and graduate teaching Fellows so that everyone can better understand and contribute to interdisciplinary scientific study, as well as teaching and learning about ecology and water resources, especially focused on regionally relevant topics.
- **Goal 5.** Actively involve K-12 Teachers and students in relevant inquiry to investigate interdisciplinary ecohydrogeology questions in the Middle Rio Grande Region using the processes, skills and tools of science, technology, engineering and mathematics.
- **Goal 6.** Familiarize K-12 Teachers and students with the literature, media, technology, and local community resources that will increase their STEM knowledge and their ability to access further knowledge.

C. Project Plan.
E-MRGE is designed to address the overarching goals of NSF’s GK-12 Program. UNM is in a unique position to change the culture by developing stronger ties to rural schools, and to have an impact in developing a prospective “pipeline” of rural New Mexico students aiming to go to college. UNM is one of only two Hispanic-Serving Institutions in the nation that are also a Carnegie Doctoral/Research Extensive University (formerly Research 1), with an undergraduate population that is 43.6 percent minorities, and a graduate student population with nearly 23 percent minorities. Indeed, UNM ranks in the top 25 institutions for enrollment of Hispanic graduate students and for the number of Master’s and Doctoral Degrees awarded to Hispanics. We will recruit E-MRGE Fellows from our growing number of minority students, who as part of their graduate training will work in partnership with middle school teachers in two rural New Mexico communities with large proportions of Hispanic and Native American students, Belen and Socorro (see demographics in Table 1 below). Through these partnerships, E-MRGE Fellows will gain enhanced pedagogical skills while middle school teachers acquire enhanced scientific knowledge and an array of inquiry-based learning modules. Fellows will receive formal training in educational methods and pedagogy through several workshops and classes at UNM and from formal and informal interactions with public school teachers. Important outcomes of our GK-12 program will be enriched training for graduate Fellows, enhanced science knowledge and skills for these middle school children, and the development of stronger connections for
these rural students and teachers to the University of New Mexico and to their local environment. Through periodic external evaluation and longitudinal surveys we will determine if E-MRGE is meeting its goals and develop course corrections as needed.

**Setting for GK-12 E-MRGE.** New Mexico is a large, rural, and relatively poor state. It is the 5th largest state in area in the U.S. with 1.8 million people. One half of the population lives in rural areas in which over 80% of the communities have populations of less than 10,000. New Mexico is the first majority minority state, with a population that is 44% Caucasian, 43% Hispanic, 9% Native American, and 1% African-American. The UNM student population reflects but does not yet have an equivalent percentage of minority students. This GK-12 E-MRGE project will work with middle school teachers in two school districts that experience difficulties in meeting state and federal educational standards, largely because of their economic settings. The GK-Fellows will help these teachers prepare their students to meet achievement standards, with an ultimate goal of college success. The Fellows will also be role models for these students by helping many of them to consider and pursue science careers.

At UNM, education and training in the interdisciplinary field of ecohydrogeology currently draws upon class work and field studies at the intersection of hydrology, geochemistry, and ecology. Major ongoing activities in ecohydrogeology and related infrastructure at UNM include (1) an IGERT program in freshwater sciences (in collaboration with the University of Alabama) that emphasizes interdisciplinary research in aquatic ecology, environmental geology and hydrology in contrasting aquatic environments in New Mexico and Alabama, (2) the Sevilleta Long-term Ecological Research Program that investigates the linkages between climate, hydrology and ecosystem dynamics in and around the Sevilleta National Wildlife Refuge (Fig. 1) and BEMP (Bosque Ecosystem Monitoring Program), its associated schoolyard LTER, and (3) the U.S. Fish and Wildlife Service (US-FWS) Sevilleta National Wildlife Refuge that has strong formal and informal public education and outreach programs. Throughout this GK-12 E-MRGE project, the Socorro and Belen Public Schools and the US-FWS will serve as the primary liaisons between the proposed GK-12 Fellows, the Sevilleta LTER Program, and the University of New Mexico. In contrast to the other NSF GK-12 funded program (Photonics and Optics) at UNM, this project focuses on rural communities rather than urban, and has a complementary disciplinary focus (ecohydrogeology with a strong field component, compared to engineering and physics with a strong laboratory component). Working together (see attached letter from Fleddermann) the two programs will significantly impact UNM STEM graduate training in two Colleges, and forge new partnerships with the College of Education in STEM-related activities.
**Background.** It is widely documented that scientific performance in U.S. public school children begins to decline in middle school environments. This problem is particularly true in New Mexico where both 4th and 8th grade science performance scores are some of the lowest in the nation (NCES 2000). The issue is exacerbated by the fact that scores for underrepresented groups, such as Hispanics and Native Americans, who make up more than 50% of the State’s population, are significantly lower than for whites. According to the National Center for Education Statistics Science Report Card for New Mexico, 73% of white students perform at or above basic comprehension levels, whereas only 37% of Hispanic and 27% of Native American students are performing at basic science levels. A further complication is that only about 50% of science teachers in New Mexico have degrees in science or science education, one of the lowest proportions in the U.S. (NCES 2000). Thus, extraordinary efforts are needed to provide opportunities to improve science learning throughout the state. In this proposed GK-12 program, E-MRGE Fellows will work directly with teachers and school children in communities within the Middle Rio Grande Valley to enhance the middle school science learning environment.

**School Partners.** Our partner school systems will be the Belen Consolidated Schools and the Socorro Consolidated Schools. Both are rural school districts located about 60 and 100 kilometers south of Albuquerque, New Mexico, respectively (Fig. 1, Table 1). Although travel time ranges from only 45 minutes to an hour, the distance between Socorro, Belen and Albuquerque is such that these rural schools rarely benefit from year long targeted STEM programs in partnership with UNM. In response to this need, a workshop was organized by Vannetta Perry, Curriculum Coordinator for the Socorro Public Schools, and Kim King-Wrenn, Education Coordinator for the US-FWS Sevilleta National Wildlife Refuge (SNWR), and was held in September 2003 to explore potential partnerships between science teachers in Socorro and Belen, the SNWR, and the Sevilleta LTER. More than 20 classroom teachers and school administrators attended the meeting. Based on the interest expressed during this initial interaction, and follow-up meetings with district science coordinators, superintendents, FWS representatives, and PIs, we together developed an E-MRGE plan, emphasizing middle school education in the two partner school districts.

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science. In 2005, we again met at the SNWR with middle school teachers to present our proposal and to receive feedback and input from the teachers. This proposal contains revisions in response to both the reviews and feedback from the science teachers who remain eager to participate. The key component, thus, is having E-MRGE Fellows work with Socorro and Belen middle school teachers to develop standards-based and benchmarked science activities modeled on actual scientific research at the SEV LTER (see sample activity, Box 1).

There are significant logistical challenges for collaborating with rural communities such as Belen and Socorro, such as the time commitment to drive to and from the districts. But, we believe the benefits of working in these rural school systems far outweigh the challenges. Belen is 30 kilometers north and Socorro is 30 kilometers south of the Sevilleta National Wildlife Refuge. This allows us to develop, with appropriate support and planning, field-based learning activities in the Refuge in association with the LTER research sites and projects. Graduate students in ecohydrogeology routinely travel to the Sevilleta and other more remote field sites for their research activities. Long-distance (>1 hour) travel is common throughout the rural west. Also, for context, the time it takes to drive by Interstate from UNM to Belen is similar to the time to drive from UNM to a school on the west side of Albuquerque. To determine if travel is an issue, our evaluation team will frequently ask our E-MRGE Fellows to assess potential problems and develop solutions. As for the local school districts, both Belen and Socorro Schools already participate in some organized activities at the Refuge and the Sevilleta LTER, so the feasibility of working in SNWR is well established. This would also benefit the Refuge, which has plans to increase its education and outreach activities with local schools. The headquarters of the SNWR contains a small display area and a well-equipped teaching laboratory (e.g., microscopes, computers). Thus, there are numerous opportunities for middle school students to work with Fellows, teachers, and Refuge staff to conduct both field- and laboratory-based exercises within the Refuge, and to develop schoolyard activities based on what they observe in the Refuge.

Although working in Socorro and Belen may create some travel and scheduling issues for E-MRGE Fellows, significant interest has been expressed by potential Fellows (see vignettes below), science teachers, school administrators, Faculty Mentors and Refuge staff to create a program such as this that will result in a quality experience for all involved. Strong UNM connections with programs and personnel in Belen and Socorro have been established, as described above, and we are dedicated to making this work. Essentially, we believe that rural schools in New Mexico and their teachers and students need this type of attention, we are committed to it, and we believe this effort will be valuable for all involved.

Through targeted partnerships among GK-12 Fellows, Socorro and Belen middle school teachers, BEMP (the Sevilleta Schoolyard LTER program), and UNM faculty mentors, E-MRGE will develop and implement a set of inquiry-based learning activities in the topical areas of ecology, hydrology and geology. Through a recently submitted EdEn supplement to the Sevilleta LTER, BEMP will develop science and environmental education kits that include hands-on, interdisciplinary activities with Spanish translation. Potential topics focus on The Changing River, how land use change affects water chemistry, insect communities, climate, soils and plants in the Rio Grande riparian zone. These educational kits will be made widely available on-line. E-MRGE teachers and fellows will be involved in the development of these learning kits and the Socorro and Belen middle schools can serve as a testbed for using and improving these learning activities. Other E-MRGE activities will encompass in-classroom, schoolyard, and field trip programs centered on the Rio Grande Valley and the Sevilleta National Wildlife Refuge. Together these activities will strengthen the “pipeline effect” by involving a diverse population of middle school students in an exciting science learning experience, help us to develop and improve a variety of environmental education learning kits
useful for K-12 science education, involve UNM graduate students in developing hands-on learning activities, and most importantly, engage students in research activities and the pursuit of science careers.

**Focus on the Middle Rio Grande Valley.** Water is the lifeblood of the desert Southwest. The Rio Grande in central New Mexico is a focus for on-going scientific research at UNM, especially in Biology and Earth & Planetary Sciences. Ecohdrogeology is an interdisciplinary research and education area that emphasizes the interfaces among aquatic and riparian ecology, ecosystem process studies, ecophysiology, hydrology, biogeochemistry, and geomorphology. Water availability and use are becoming key resource issues worldwide, particularly in arid regions where human population growth is occurring at unprecedented rates (Naiman et al. 1995, Vitousek et al. 1997). The need for relevant understanding of hydrology, geochemistry, and ecology in arid land ecosystems has increased exponentially as humans appropriate an ever-increasing proportion of fresh water for agriculture, and urban and industrial activities (Baron et al. 2002, Palmer et al. 2004). Future advances in the environmental sciences depend upon strong interdisciplinary collaboration among biological and geoscientists (Hedin 2002).

Mounting concerns related to water use and contamination highlight the growing need for a public that is better educated about these issues, and an increasing number of well-trained scientists. A recent NSF report on environmental research and education (Pfirman and AC-ERE Committee 2003) urged scientists and educators to develop creative interdisciplinary programs that couple biological and geological sciences. In central New Mexico, ecohydrogeology provides an exceptional educational opportunity for interaction among public school teachers and their students and graduate students and faculty at the University of New Mexico. A GK-12 program would allow us to address the vast need to enhance education and training in environmental sciences at all educational levels (Pfirman and AC-ERE Committee 2003).

Challenges in teaching environmental science differ across the K-16 continuum. In the K-12 setting, teachers may recognize the need for more environmental education; however, their training in traditional scientific disciplines limits their ability to integrate biology, geology and hydrology or to select appropriate content for their classes. Collaborating with graduate students on regional topics will help these teachers to cover required science content with an engaging, locally relevant curriculum. In addition, K-12 teachers may lack experience with scientific research, which limits their ability to design inquiry-based lesson plans. Graduate students can work with teachers on crafting creative hands-on activities for New Mexico students.

While graduate students are the disciplinary experts, K-12 teachers are the education experts. This partnership benefits both the research and education endeavors. Working with K-12 faculty, particularly on interdisciplinary environmental science instruction, will be a valuable way for graduate students to learn inquiry-based teaching skills (Handelsman et al. 2004). Middle school students are engaged in inquiry when they act as scientists – they make observations, ask questions, collect and analyze data and draw conclusions. Through inquiry-based learning modules and environmental learning kits, our interdisciplinary curriculum in ecohydrogeology can address some recurring problems in teaching science, such as fragmentation and isolated skill instruction. Students and teachers alike learn that science doesn’t just happen in a beaker; it happens in the river. It also supports important learning goals for middle school education, including transfer of learning, teaching students to think and reason, and providing a curriculum that is more relevant to students. In the process, E-MRGE Fellows gain greater team building and communication skills, inquiry-based teaching skills, an appreciation for science teaching in the public schools, and the satisfaction of helping to improve science education in New Mexico.
Our E-MRGE GK-12 Program will address these challenges and opportunities by linking UNM faculty and graduate students with public school teachers and students to provide hands-on experiences and learning opportunities for all participants. The aim is to promote communication among participants to greatly enhance research, education, and training at all levels.

**Ecohydrogeology Research and Education in the Middle Rio Grande.** The Middle Rio Grande region (see Figure 1) around Albuquerque, New Mexico, is an excellent setting in which to study the consequences of human population growth and land use change on water quality and quantity in an arid land region. More than 50% of the state’s population lives along the Rio Grande. This river provides 61% of the water for agricultural, industrial and residential uses (Bartolino and Cole 2002). The riparian environment, threatened by overuse, invasive species, and drought, is also an important habitat for many species, including some endangered species such as the snail darter. As the state’s population continues to increase, particularly around Albuquerque and the middle Rio Grande valley, there are greater demands on ecosystem services to provide sufficient clean surface and ground water, and this demand has significant consequences for the region’s freshwater ecosystems. That, coupled with the potential for periodic extended regional droughts (Milne et al. 2003), underscores the need for E-MRGE, a broadly based research and education program that highlights the region’s freshwater resources.

**Research-based classroom activities in ecohydrogeology.** Fellows and teachers will work with the extended E-MRGE network to adapt current best practices and develop a set of ecohydrogeology modules analogous to the Scope, Sequence and Coordination modules for secondary science (accessible through the National Science Teachers Association at [http://dev.nsta.org/ssc](http://dev.nsta.org/ssc)). The modules will be based on actual scientific research underway at the Sevilleta LTER, and integrated with summer workshop activities. The modules will be benchmarked to New Mexico state science standards in multiple areas, and provide lists of materials and a conceptual guide for teachers in addition to evaluative materials. The modules will be made available through the Schoolyard LTER, BEMP schools, and the wider mid-school community. Box 1 contains a sample activity based on meteorological measurements.

**Box 1: Sample Classroom Activity/Module**

**Background:**
Automated weather stations monitor an array of meteorological variables across the Sevilleta Wildlife Refuge and at some satellite sites. These stations provide hourly measurements of precipitation, temperature, humidity, wind, solar radiation, as well as soil temperature and moisture. Daily, monthly and annual summaries of many of these variables can be found at [http://sevilleta.unm.edu/research/local/climate/meteorology/summaries/](http://sevilleta.unm.edu/research/local/climate/meteorology/summaries/).

**Activity:**
Using the annual summary data (precipitation, temperature, etc.) from a micro-meteorological station located in the major research sites within (the woodlands, grasslands and deserts) the Sevilleta NWR, students are to investigate and draw conclusions concerning the relationship between rainfall patterns over a 30-year period and to the corresponding changes that have occurred in vegetation patterns of a particular biome over that same 30-year period. Students are then asked to make predictions on changes they anticipate will occur over the next 30 years.

**Sample of NM State Science Standards Met By Activity**
- Use appropriate technologies perform scientific tests and to collect and display data.
- Use graphic representations (e.g., charts, graphs, tables, labeled diagrams) to present data and produce explanations for investigations.
- Justify predictions and conclusions based on data.
- Describe how scientific information can help to explain environmental phenomena.
Program participants. In 2005-2006 freshman entering high school in New Mexico will be required to take 3 credits of science to graduate (up from current 2), which underscores the importance of having quality middle school science teachers and a positive science learning experience so that students are prepared to meet this new requirement. We have selected two rural school districts, Socorro Consolidated Schools and the Belen Consolidated Schools, as our partner school systems for E-MRGE based on location, interest and need. These rural schools are some distance from Albuquerque so they generally have less exposure to and interactions with career scientists. The needs of many rural school systems often differ from those in Albuquerque where many education and outreach partnerships with UNM currently exist. Indeed, a GK-12 program in optics and photonics at UNM (funded in FY04) is currently working with Albuquerque Public Schools. We plan to collaborate with this project to sponsor activities to enhance the experience of Fellows and teachers in both programs. One advantage for working with the Socorro and Belen schools is that each district is located within 30 kilometers of the Sevilleta National Wildlife Refuge, site of the Sevilleta Long-term Ecological Research Program. Some teachers already bring their classes to the Refuge, but through E-MRGE, we will expand and strengthen the educational content of these activities.

A total of 2031 students are enrolled in the Socorro Consolidated Schools in 2004-2005, with 642 in middle school (grades 5-8). The district is 28.7% Non-Hispanic white, 64.6% Hispanic, 3.4% Native American and 1.2% African American. 55.2% of the students are on free or reduced lunches and 33% of children are classified as living in poverty. The district has 20 middle school science teachers and a student:teacher ratio of 13.6. In 2004 R. Sarracino Middle School was on probationary status for not effectively meeting state educational standards (Table 1).

In 2004-2005, enrollment in the Belen Consolidated Schools is 4847 students, with 1546 middle school children. The district is 68.0% Hispanic, 28.3% Non-Hispanic white, 1.6% Native American and 2.1% African American. 69.0% of students are on free or reduced lunches and 21.2% are living in poverty. The student:teacher ratio is 15.8. In 2005-2006, Belen will add a new middle school that we can build into E-MRGE. Belen operates on a "vertical alignment" model in their curriculum: what teachers and students do in elementary classes feeds directly into what they will do in middle school, which feeds directly into the high school curriculum.

Program structure and implementation. We will start E-MRGE with seven Fellows in year 1, increasing to nine fellows in years 2 and 3. Each Fellow in year 1 and 2 will be offered up to two years of support. We will seek additional sources of funds (e.g., LTER) to provide two years of funding for any new recruits we attract in year 3. Continued funding will be based on evaluations and feedback from the Fellows and teachers. Students admitted to our graduate programs are guaranteed a total of 5 years of support. Thus, while not on E-MRGE funds, the Fellows are assured TA support from their home departments. Although two years of support will be offered, we will consider a flexible support plan should some students choose to divide their time by serving as a Fellow for one full year and then perhaps only during Fall Semester of year 2 and
3. We believe this flexibility will help to resolve potential issues with travel, burnout or other time commitments. The teachers who have already worked with Fellows in the past will facilitate integration of new Fellows into the schools. Again, this management strategy is designed to address some of the concerns about student burnout raised in evaluations of our first submission as well as of the GK-12 program in general (Thompson 2002). We want to emphasize, however, that the Fellows we are recruiting are field-oriented scientists, many of whom already drive regularly to the Sevilleta and other field sites throughout New Mexico. Also, comfortable housing is available for the Fellows at the Sevilleta Research Field Station, which is located in the SNWR between Socorro and Belen (see Facilities section for descriptions). Table 2 presents project timelines.

During the first year E-MRGE Fellows and faculty mentors will develop learning modules in collaboration with Socorro (3 Fellows) and Belen (3 Fellows) middle school science teachers. One E-MRGE Fellow will work directly with Kim King-Wrenn at SNWR to develop educational activities for students who visit the Refuge. In the second year, we will increase the number of E-MRGE Fellows to nine, with four Fellows dedicated to in-class activities in Socorro, four in Belen, and one working with SNWR staff.

Each semester, Fellows will rotate among teachers within and between school systems so that teachers can benefit from the different scientific backgrounds and skills (biology, hydrology, geology) of the E-MRGE Fellows. Within each school district, each E-MRGE Fellow will partner with a primary teacher-collaborator (Tier 1 Teacher) with whom they regularly and frequently interact. The teacher-collaborator will serve as a node for connections and communications with other science teachers (Tier 2 Teachers). Through this rotational plan and the Tier 1 and Tier 2 connections, each Fellow will actually work directly and indirectly with numerous teachers throughout the year. Given the relatively small size of the these school districts, this “nodal”

<table>
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<tr>
<th>Table 2: Annual Timeline for Administering the E-MRGE Program</th>
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<tbody>
<tr>
<td><strong>2006</strong></td>
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<tr>
<td>January-May</td>
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<tr>
<td>Internal recruitment of E-MRGE Fellows</td>
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<tr>
<td>Recruitment of Tier 1 Teachers from Belen and Socorro middle schools</td>
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<tr>
<td>May-July</td>
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<tr>
<td>Review of applicants and selection of Fellows and Tier 1 Teachers</td>
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<tr>
<td>August</td>
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<tr>
<td>Three-day Orientation at the Sevilleta LTER for Fellows and Tier 1 Teachers</td>
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<tr>
<td>September – December</td>
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<tr>
<td>Bi-weekly Fellows seminars</td>
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<tr>
<td>Fellow / Teacher cohort interactions in participating schools and at Fish and Wildlife Service (minimum of 10 hours per week)</td>
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<tr>
<td>December</td>
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<tr>
<td>Fellow / Teacher cohort development of school yard activities (minimum of 5 hours per week)</td>
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<td><strong>2007</strong></td>
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<tr>
<td>January – April</td>
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<tr>
<td>Continued seminars; Continued Fellow/Teacher interactions</td>
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<tr>
<td>Development of school project presentations for Earth Day activities at participant schools</td>
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<td>Recruitment/selection of Fellows for Year 2</td>
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<td>Recruitment of new Tier 1 Teachers for Year 2</td>
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<td>Recruitment of Tier 2 Teachers for summer ATI seminar</td>
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<td>April 22</td>
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<td>Earth Day Activity</td>
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<td>June</td>
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<tr>
<td>A&amp;S Teachers’ Institute Seminar on Ecohydrogeology topics</td>
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<tr>
<td>July</td>
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<td>Annual Evaluation</td>
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E-MRGE program cycle will repeat beginning with the Year 2 Orientation in August 2007.

- Throughout the project, the E-MRGE project management team will have bi-weekly meetings for planning purposes, to review program activities, and discuss outcomes with the program evaluator.
- Various synergistic activities will occur on a yearly basis with other GK-12 programs in NM and with other UNM programs working with graduate students (see Figure 1).
structure will allow some degree of collaboration of E-MRGE Fellows with all interested middle school science teachers in Socorro and Belen over the three year funding period.

In year 1, Fellows, teachers and students will establish BEMP monitoring sites (see Results from Prior NSF Support) along the Rio Grande Bosque in Socorro and Belen. This will serve several purposes. First, it will provide a local access point for developing place-based learning modules about water and the Rio Grande environment. Place-based knowledge is important because it is culturally-inclusive. Many Native educators (Cajete, 1994, 2000; Kawagley & Barnhardt, 1999; Deloria & Wildcat, 2001) recommend such culturally-based approaches to increase the participation of Native Americans, who remain the most underrepresented of all minority groups in science (Riggs & Semken, 2001; Mervis, 2003). Yet, place-based learning is a valuable mechanism to enhance the education of all students regardless of background and ethnicity. Through a series of data collection campaigns by teachers and students, classes will accumulate data that can be used in a broad set of science and math learning activities. Also, these place-based activities serve as a means for the students to learn about the ecology of the Rio Grande in their town and how land use and development in New Mexico impacts the river and its environs. Finally, establishing and maintaining BEMP sites will integrate Socorro and Belen teachers and students into a regional network of 16 environmental sites and science learning programs. Once these BEMP sites have been established, they can serve as a source of ideas for readily accessible schoolyard experiments and monitoring pursuits.

During the academic year, E-MRGE Fellows will be required to take a bi-weekly class each semester in which they will present and exchange ideas about classroom activities; learn the basics of state and national science testing standards; learn the basics of inquiry instruction; learn from guest lectures by science teachers about best practices, needs, and limitations in urban in contrast to suburban and rural classrooms; and learn new communication and teaching skills. The Project Manager will organize this course with assistance from the PIs. Some class periods will be coordinated with the new (FY04) GK-12 Program in Optics and Photonics at UNM so our Fellows benefit from sessions taught by UNM College of Education faculty, to share experiences with Fellows working in Albuquerque Public Schools, and to expose all UNM Fellows on campus to a broader range of STEM classroom experiences. Should the Optics and Photonics GK-12 program end after the initial funding period, E-MRGE will continue to organize these classes in cooperation with College of Education faculty. Also, through an additional half day workshop each semester, former Optics and Photonics and E-MRGE Fellows will serve as informal “peer mentors” by sharing their experiences and advising current E-MRGE Fellows.

In June, E-MRGE Fellows will participate in a seminar class offered through the Arts & Sciences Teachers Institute (A&STI), a teacher enhancement program at UNM. Each summer, a seminar focusing on various ecohydrogeology topics will be offered for K-12 teachers (both Tier 1 and Tier 2 Teachers) from Belen and Socorro school districts, enabling these teachers to better integrate curriculum on the topic into their classroom practice. This seminar will allow the collaborating school districts to better utilize the materials and activities developed by the Fellows and their cohort teachers, as well as help in “vertical alignment” of curriculum from the elementary through high school levels. Vertical alignment and communication between teachers and schools at the various levels has been established as a priority for both districts, and incorporating this approach into the project will help the districts meet established goals. Each Teachers Institute seminar will meet for a total of 40 hours and carry three hours of graduate credit in the College of Arts & Sciences, so the teachers meet newly established requirements under the federal No Child Left Behind Act and helping them to make progress toward graduate level degrees. In the seminar, teachers will work closely with an Arts & Sciences faculty member in a close examination of the topic in a seminar-style setting. E-MRGE
Fellows will serve as co-instructors in these seminars. All teacher participants will receive books and resource materials free of charge. The goal of these seminars is for teachers to create challenging science and mathematics curriculum units that are tailored to their needs and those of their students. Curriculum Units will be made available through the Internet to all teachers in the local school districts, and to teachers throughout New Mexico and the nation.

We plan to hold two workshops each year. In August, prior to the start of the school year, we will hold a three-day meet-and-greet workshop in which GK-12 teachers and administrators, E-MRGE Fellows and their Faculty Mentors will meet to begin to establish collaborations and to generate ideas for inquiry-based projects. These annual workshops will include short presentations by Faculty Mentors, teachers and Fellows on their background and current interests, and how those interests relate to the goals of E-MRGE and NSF’s GK-12 program. There will be short presentations by faculty and graduate students on research projects in ecohydrogeology and tours of the Sevilleta LTER sites and research infrastructure. These tours will be used to generate ideas for activity modules to be developed and implemented in a schoolyard format. Breakouts into small teacher-Fellow groups followed by reporting sessions will be used to develop ideas for module activities. Because activity modules will be developed based on these Teacher-Fellow interactions, skills and interests, we can not specify what the content will be at this time. We believe that teachers and Fellows will have more invested in such an approach rather than our predefining the module content. This will also be an opportunity for evaluation surveys. This three-day workshop will be held at the conference facility at the SNWR. Other presentations will provide information on state and national science standards, and fundamentals of the learning environment, classroom instruction and limitations in the middle school environment. We will invite a PI or participant from another environmentally oriented GK-12 Program (e.g., Cornell University, New Mexico State University) to this workshop. The goal would be to use their past experience to build teacher-Fellow partnerships, and to describe and demonstrate learning modules they have developed, etc.

The second workshop on the UNM campus will be held in late April each year in conjunction with Earth Day. In this case, our “Earth Science Day” will focus on the scientific study of the Earth, its geology, hydrology and ecology and how these topics apply to everyday life in New Mexico. We will invite a state education or environmental official to present a keynote address. Middle school students will present the results of research projects they have developed in their classes around a set of environmental challenges, such as delivery of freshwater, or the causes and consequences of land use change, that are faced by people living along the Rio Grande and throughout the State. During the school year, these students will be encouraged to develop presentations for this workshop. Although it is extremely difficult to put into practice, we will strongly encourage the students to develop these projects and presentations in collaboration with a parent or an adult mentor. Science is becoming increasingly collaborative, so we want to encourage that behavior among students in middle school science classes whenever possible.

UNM has numerous, highly successful programs to support minority student research and academic development. Through the UNM “Unified Plan,” E-MRGE PIs and the Program Manager will work closely with directors of these other training programs, to coordinate activities to support the common, shared goals of graduate and undergraduate programs across New Mexico. Especially important will be the ties that will be strengthened among Fellows and teachers of our E-MRGE project and the College of Engineering GK-12 program on Optics and Photonics (see letter of support from PI Fleddermann), through which Fellows are working with teachers in the Albuquerque Public Schools. Together, we will co-sponsor activities that will maximize the benefits to be gained by GK-12 Fellows and teachers in both programs. The other programs that participate in this coordinating effort/plan, usually with the Program
Directors and PIs involved in quarterly discussion sessions, include the MARC, the IMSD, Bridges, NM-AMP, and NM-AGEP.

D. Recruitment and Selection Plan

GK-12 Fellows Recruitment and Selection. A general announcement about the fellowship opportunity will be issued through department chairs and faculty members in Biology, Earth and Planetary Sciences, Chemistry and Civil Engineering. In addition, we will develop an E-MRGE web site that will describe the program and on-going activities, serve as an outlet for distributing materials developed by E-MRGE Fellows, and advertise opportunities for graduate fellows and teachers. This site will be linked to the UNM Department of Biology and Department of Earth and Planetary Science web sites, the Sevilleta LTER web site, the LTER Network website, the ATI Website, and others that are frequented by graduate students or GK-12 teachers. Given that the student population in both of our partner school systems is >50% Hispanic and Native American, we will attend the annual Society for the Advancement of Chicanos and Native Americans in Science (SACNAS) National Conference to advertise E-MRGE, to recruit fellows and to demonstrate and disseminate products and lessons learned from our GK-12 activities. The 2003 Conference was held in Albuquerque and included several activities that were presented by participants in this GK-12 proposal (Collins, King-Wrenn, BEMP).

Faculty members will nominate candidates. We estimate that each year we can recruit applicants from a pool of 75 to 100 graduate students (from departments such as Biology, Earth and Planetary Sciences, Civil Engineering, Chemistry) to select a qualified and dedicated cohort of fellows. Indeed, several graduate students who are currently enrolled at UNM have already expressed a strong desire to be E-MRGE Fellows (Box 2). Therefore, we are confident that we can recruit an enthusiastic, highly qualified and diverse cohort of E-MRGE Fellows.

We anticipate that most fellows will be graduate students who have already started their graduate programs at UNM, although highly qualified and interested new graduate-level students will also be recruited. All Fellows must meet the entrance requirements of the departments to which they apply, based on academic record, graduate record exam (GRE) scores, letters of reference, and a statement of interest/intent. Fellowship applicants will be asked to write a 2-page letter that describes their excitement about their research in ecohydrogeology and ideas for conveying this enthusiasm to K-12 students, experience in working with K-12 students and their interest in making a difference in science education, willingness to collaborate with a teacher and a faculty mentor, and thoughts about how the fellowship might enhance their professional development. The Project Management Team will screen applications, review recommendations made by faculty members knowledgeable about the applicants, and conduct interviews. We will strive to attain a balance of fellows in the various research sub-areas of ecohydrogeology.

Teacher Selection and Participation. Teachers will be recruited through in-school visits, and with the help of the district Points-of-Contact (see Project Management section). Our August meet-and-greet workshop will be open to all middle school teachers in Belen and Socorro. During this workshop sessions will be held in which teachers effectively self-organize into T1 and T2 participants. It is anticipated that teachers will rotate in and out of these two categories over the year and between years. Thus, teachers will be allowed to create interaction nodes and participate at whatever level accommodates their interests and abilities. Stipends will be provided for T1 teachers to encourage their participation and to compensate them for the extra time involved in organizing T2 interactions and working with Fellows.
E. Project Management.
The project management team will consist of PIs Collins and Cossrey, and the Project Manager (Earick). PI Collins, UNM Professor of Biology, will be responsible for the overall administration of the award, preparation and submission of reports to NSF, cooperation with NSF on overall evaluation and any other interactions with NSF and UNM administrative and fiscal personnel. Collin’s role as PI for the Sevilleta LTER will facilitate program interactions with the Field Station. All PIs will be integral participants in E-MRGE education and training activities, including on-campus seminars, biennial workshops and evaluations. Cossrey and Collins will coordinate the recruitment and selection of Fellows. This includes interacting with graduate selection committees (Biology, EPS, Chemistry, Civil Eng.), sending letters of offer, and generally bridging UNM graduate structure and E-MRGE.

A 0.5 FTE Project Manager (Douglas Earick) will run the weekly seminar for the Fellows, organize teacher Institute activities within the project, provide a "location" for the administration of the project and to recruit participants (both graduate students and teachers/schools), and finally to help with data collection and record keeping. Point of contact for Socorro is Vannetta Perry, Curriculum Coordinator for the Socorro Consolidated Schools. Our point of contact for Belen Consolidated Schools will be identified during the upcoming school year. The Points-of-Contact will each receive a $2000 stipend each year to cover their time commitments on the project. The Points-of-Contact will help to recruit teachers within their districts, as well as to facilitate connections and communications between E-MRGE Fellows and Tier 1 teachers, and between Tier 1 and Tier 2 teachers. Kim King-Wrenn, Education Coordinator for the Sevilleta National Wildlife Refuge, a full time federal employee, will serve as the education liaison between E-MRGE Fellows, the Refuge and the Belen and Socorro middle school teachers.

Each GK-12 Fellow will be teamed with an interested faculty mentor(s), and either a Socorro or Belen middle school science teacher and/or the Education Coordinator at FWS. Faculty Mentors for GK-12 Fellows will be drawn from the fresh water sciences faculty primarily located in the Departments of Biology, Earth and Planetary Sciences, Chemistry, and Civil Engineering. These faculty already have developed a graduate training plan and curriculum in ecohydrogeology based on the current IGERT Program in Freshwater Sciences at UNM. In addition to the weekly seminar, our GK-12 Fellows will take coursework within the Freshwater Sciences curriculum, which is not an added burden given its relevance to their research interests in ecohydrogeology.
Evaluation. Our external evaluation team includes Dr. Paul Guerin, a Senior Research Scientist in UNM’s Institute for Social Research, and Dr. Charlene D’Avanzo, Dean of the School of Natural Sciences at Hampshire College and Editor of TIEE: Teaching Issues and Experiments in Ecology. Guerin and D’Avanzo will work together to give us frequent feedback on program structure and progress so that we can make changes as needed. Both formative and summative analyses will be conducted to determine if our overall program is achieving its goals.

Evaluation of the proposed GK-12 Program will target the 6 goals listed above. The evaluation will rely on tested techniques and instruments used for the evaluation of other NSF-funded projects (e.g. Frechtking 1993) and on modifications of tested instruments (e.g. the Views on Science-Technology Society – VOSTS). In addition, we will use locally-developed instruments and ones developed by other GK-12 projects for similar purposes. These include the UMASS GK-12 STEM Online questionnaire which targets inquiry teaching with questions such as “Inquiry-based teaching takes more time than is realistic given the science topics that need to be covered” and “Middle school students are capable of developing investigations based on their own questions.” Another example is the set of Vanderbilt GK-12 classroom surveys.

Evaluation will be both formative and summative. Formative evaluation will begin early and continue through the life of the project to provide timely feedback about interactions between Fellows and teachers plus Fellows and Fellows, the UNM course for Fellows, the use of inquiry projects on ecohydrogeology in the schools, the effectiveness of summer workshops, and attitudes/observations of graduate mentors towards the Fellows. Formative feedback in year 2 and 3 will also target aspects of project expansion. Instruments for this evaluation will include ethnographic observations of classrooms and workshops, focus groups, pre- and post-surveys (e.g. workshops and mentors) and interviews (e.g. Fellows and Teachers). Summative evaluation will include a focus on enhanced science knowledge and skills in middle school children, and stronger connections among these rural students and teachers to UNM and to their local environment. We will also evaluate how the teachers acquire and use their enhanced scientific knowledge and the extent to which they receive an array of learning modules.

Evaluation of Fellows, Teachers, and Middle School Students – Methods to be Used.

Observations: Observations will be conducted of workshops (e.g. Teachers Institute and meet and greet workshop), classrooms and other activities in order to document the implementation of the program and report its process. (Targets goals 1,2,4,5)

Focus Groups: Focus groups will be used to collect information from the Fellows and teachers regarding their perception of the project and findings will be used to help inform the surveys.

Surveys: Pre- and post-surveys will be used to investigate participants’ beliefs and attitudes about science, teaching/learning, and inquiry; teaching in public schools; their knowledge about environmental science and regional environmental scientific issues concerning water; and the projected/actual benefits of the proposed collaboration. (Targets all 6 goals).

Interviews: Interviews make clear a participant’s experiences and how he or she understands them. Interviews will focus on participants’ beliefs and attitudes about learning and teaching science and especially environmental science, their experiences within the project, the importance of activities they have engaged in, benefits they received from the project, the issue of burnout, and obstacles and limitations. A semi-structured protocol will be used (Campion et al. 1994, Patton 2002; Targets all 6 goals).

Portfolios: Each K-12 teacher and graduate fellow will document their instructional approaches and students’ learning in a portfolio (Campbell et al. 2000). Portfolios will include course syllabi, lesson and unit plans, teaching materials, examples of students’ work, students’ assessments, and photographs. Use of rubrics will enable the evaluator to use the portfolios to assess realization of the project goals. (Targets Goals 1,2,4,5,6).
Social Network Analysis: A social network analysis will be completed in order to discover the extent of the network and its density and how the established network has affected the project. Within one month of receiving the award a research plan for the evaluation will be designed in collaboration with project staff. This plan will be revised as necessary and will guide the evaluation. Meetings with project staff will be held routinely to provide feedback.

Sustainability. At the end of year 3, we will collect, document and carefully describe all curriculum activities developed through E-MRGE and create a “how-to” guide on CD ROM, to be posted on the Teachers Institute web site (www.unm.edu/~abqteach). These resources will be widely publicized, particularly through the Teachers Institute, and made available free to school systems in New Mexico, and distributed to the 23 other schoolyard LTER programs around the country. Through on-going programs at SNWR and the Sevilleta LTER and its Schoolyard LTER program (BEMP), we will continually seek ways to collaborate with middle school teachers throughout the middle Rio Grande Valley to implement, modify and develop inquiry-based science activities. The Sevilleta LTER is committed to maintaining GK-12 activities with funding graduate training Fellowships. Currently, the Sevilleta LTER supports approximately 10 graduate students’ research each summer. Based on the success and outcomes of E-MRGE, we will dedicate funding for activities to continue to link SEV graduate students with middle school teachers and students in Socorro and Belen, and to broaden outreach through UNM’s Summer Teachers Institute. Should the project be successful, we would seek Track 2 funding to continue our interaction with Belen and Socorro schools, and to expand E-MRGE throughout the middle Rio Grande Valley, highlighting both academically underperforming schools and rural Native American Pueblo schools north of Albuquerque.

Impact. Our E-MRGE Program has the position and mechanisms in place to change the culture of K-12 interactions between the UNM research community in ecohydrogeology (representing two large departments at UNM) and teachers from rural school communities in adjacent districts. Our graduate training in the proposed area has substantial momentum, and a good cohort of potential Fellows and opportunities to continue attracting a diverse pool of applicants. Program elements such as ATI courses also enable us to improve the number of highly-qualified mid-school teachers in target districts. Through Fellow activities in the classroom and activities with mid-school teachers, we can increase the pipeline of our diverse constituency to consider STEM career paths, from the mid-school through undergraduate (AMP) involvement. Additional benefits include increased content knowledge for teachers, and the transfer and application of current STEM research excitement and methodologies to classroom activities.

Summary. In this GK-12 Program, our E-MRGE objective is to draw upon and enhance existing activities at UNM and in public school systems to create a coordinated research, teaching and outreach collaboration that will provide seamless interactions between participants ranging from K-12 students to university faculty. The components are clearly in place: an interdepartmental program in ecohydrogeology, the Freshwater Sciences IGERT, LTER, BEMP, Socorro and Belen Schools, and the Sevilleta National Wildlife Refuge. What is needed now is a stronger and more diverse mechanism to link UNM scientists, graduate students, and public school teachers and students. We believe our proposed E-MRGE program will develop and complete that connection. We expect the communication and learning pathway to be bi-directional, from UNM scientists and Fellows to the teachers and students in the classroom and vice versa. Such strong linkages and collaboration across levels will create a more enlightened general public, improve formal and informal science education, and recruit the next generation of environmental scientists.
C. Literature cited


