University at Buffalo
The State University of New York

Office of the President

September 27, 2012

MEMORANDUM

To: **Dr. Nancy L. Zimpher**
Chancellor, State University of New York

From: **Satish K. Tripathi**
President

RE: **Shale Resources and Society Institute**

Per the September 12, 2012 request of the SUNY Board of Trustees, and based on consultation with the University at Buffalo Provost and College of Arts and Sciences Dean, below is a report summarizing the facts and circumstances regarding the formation of the Shale Resources and Society Institute (SRSI) at the University at Buffalo, the selection of its directors, and publication of its first report. For the Board's further information and context, the report provides an overview of university policies and practice regarding research centers and funding in general and their relevance to the Shale Resources and Society Institute in particular. We include a timeline of activities associated with the institute's formation.

There has been significant public misinformation and misunderstanding since the publication of the SRSI's May 15, 2012 report, "Environmental Impacts during Marcellus Shale Gas Drilling: Causes, Impacts, and Remedies." This report seeks to clarify any resulting confusion.

The University at Buffalo's Mission as a Research Institution

Impactful, groundbreaking research; transformative educational experiences; and deeply engaged service to our local, state, national, and international communities define the University at Buffalo's mission as a premier, research-intensive public university. UB views the three traditional pillars of the public higher education mission—research, education, and public service—as interdependent endeavors that continually enrich and inform each other. We are committed to bringing the benefits of our research, scholarship, creative, and educational excellence to the members of our local and global communities in ways that enhance both our understanding of our world and the quality of life for all people.

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University Research

External funding for university research generally comes from one of three sources: competitive (state, federal); philanthropic; or corporate/industry funding. Focusing on the third source, as that is a specific topic of inquiry by the Board of Trustees regarding this particular case, corporate/industry support is a common and essential source of university funding for research conducted by investigators across the disciplines, at universities around the world. As reported by the National Science Foundation for 2009, the most recent year that data is published, national university research expenditures funded by industry were almost $3.2 billion (of total expenditures equaling $54.9 billion).

Corporate support enables education, ensures that research is at the cutting edge, and focuses attention on timely issues. In addition, undertaking research sponsored by the private sector is a critical component of the university's contributions to the economic, social, and cultural vitality of our larger communities—a key outcome of our mission. The impact of university scholarship is enhanced by addressing concerns and exploring issues of importance to the public good.

Over the past several decades, university research has produced numerous breakthrough discoveries that have led to successful university-industry partnerships formed to maximize their profound scientific and societal impact. To cite just a few examples, university-industry partnerships have improved the quality of life for millions worldwide through the development and dissemination of tests used for earlier detection of various cancers so that survival rates could be improved, drugs used in cancer treatments, the MRI scanner and MRI technology — developed through the work of faculty at SUNY Downstate Medical Center and Stony Brook University—and the battery-powered implantable cardiac pacemaker—the work of former UB engineering faculty member Wilson Greatbatch.

Working with a broad array of partners, including the private sector, is therefore critical to advancing UB's research mission as well as SUNY's more broadly. The University at Buffalo is engaged in a number of major research projects that receive corporate and/or industry funding. Below are a few examples illustrating the scope of these projects and their impact:

- **Toshiba Research Stroke Center/CTRC**—The Toshiba Corporation, which funds the Toshiba Research Stroke Center, provides that center and UB's new Clinical and Translational Research Center with state-of-the-art imaging equipment advancing life-saving medical research, as well as funding translational research projects in the center.
- **Allstate Minority and Women's Emerging Entrepreneur (MWEE) program**—Supported by the Allstate Foundation, the program provides women and minority entrepreneurs with practical business tools, training, and one-on-one mentoring by local business executives to develop successful strategic business plans.

- **IBM**— IBM has donated key equipment items for a Clean Room in UB Engineering's new building (Davis Hall) as well as scientific equipment to be used for teaching and research in the UB Departments of Chemistry and Physics.
- **Center for Computational Research (CCR)**—A state-of-the-art supercomputing facility that supports groundbreaking work in bioinformatics, materials informatics, and other high-impact fields, the CCR was established in 1998 with a major equipment grant from SGI, along with university funds and a Major Research Instrumentation grant from the National Science Foundation. The CCR has also been enhanced with a prestigious Shared University Research grant from IBM, as well as equipment donated by Sun Microsystems.
- **Center for Protein Therapeutics**—Advancing treatment of major disorders like Alzheimer's, multiple sclerosis, and other central nervous system diseases, UB pharmaceutical sciences researchers have joined forces with scientists from six of the world's largest pharmaceutical companies (Abbott Labs, Amgen, Eli Lilly and Company, Merck & Company, Pfizer and Roche) to develop promising protein-based drugs—the most rapidly expanding class of drug treatments for many cardiovascular, renal, gastrointestinal, rheumatologic and neurological conditions and diseases—and to train the scientists needed to build an intellectual infrastructure in this developing field.

Academic Freedom and Conflict of Interest

The University at Buffalo's policies and practices require the reporting of all funding sources for sponsored research. As is the case at every major research university, some faculty research is funded in part by industry sources. To ensure transparency and adherence to rigorous standards of academic integrity, we focus on identifying and managing potential conflicts of interest. If the conflicts are determined to be unmanageable, UB will not accept the funding.

As with all research at UB, regardless of the source of the funding, it is neither the role of the university nor of the funding source to dictate the conclusions drawn by faculty investigators. This core principle is critical to the preservation of academic freedom. UB recognizes that conflicts—both actual and perceived—can arise between sources of research funding and expectations of independence when reporting research results. These conflicts are broadly recognized and, following national best practice, UB has established policies that govern disclosure of significant financial interests and sources of support that could impact the independence and integrity of the scholarship and research undertaken by faculty, staff and students. Our faculty, staff, and students are expected to follow international norms for disclosing financial interests and sources of support for their research when reporting the results of their scholarship.

There is increased national scrutiny regarding disclosure of financial interests when publishing results. In response, journals and funding organizations are requesting greater disclosure. As an example, last month, the U.S. Public Health Service (PHS) issued new conflict guidelines for PHS-funded university research. UB has adopted these disclosure standards **(See Attachment A: UB Conflict of Interest Policy and Public Health Service Policy)**.

Faculty sometimes undertake research in areas that are the subject of significant public debate. These activities are supported as an essential part of the research mission of the university. While UB does not adopt an institutional position on the outcomes of policy debates, we have every expectation that the faculty will conduct their public and policy-related activities as professionals, basing their conclusions on rigorous evidence and methodology.

University at Buffalo Department of Geology

The University at Buffalo Department of Geology, a unit within the College of Arts and Sciences, is an internationally known center for research and scholarship. Its major fields of education and research can be grouped into five large areas, including environmental geosciences; volcanology; climate change; integrated tectonics and stratigraphy; and ecology and evolution.

As the conversation on shale resources and their relevance to energy use has intensified on a national and global level, members of UB's faculty have considered it imperative to include topics on shale, hydraulic fracturing, and their societal impact in their teaching and research, examining this issue from all sides of the debate.

At the core of the geology department's academic mission is the education of its students to prepare for careers in geology-related fields, which can and does include jobs within the energy industry. With that in mind, an informed understanding of all the issues related to the extraction of fossil fuel resources from geologic formations is essential. For example, UB's Geology Department offers numerous courses where hydraulic fracturing may be included in the course content. Relevant courses include Mineralogy, Hydrology, Structural Geology/Global Tectonics, Geological Hazards and Risks, Geophysics, Stratigraphy, Advanced Environmental Hydrogeology and Economic Geology.

As part of its public service mission, the Geology Department also engages in a number of initiatives focused on increasing public awareness and providing a forum for public discussion of a number of timely scientific and societal issues, including issues related to hydraulic fracturing. Toward this end, in Spring 2011, the Department held the Marcellus Shale Lecture Series. Sponsored with $12,900 in funding from various industry sources, eight

public lectures were held on campus to discuss the gas industry, hydraulic fracturing and its relationship to the economy and environment in New York State. These industry funds financed only the Department's lecture series (**See Attachment B: Information Regarding the Marcellus Shale Lecture Series).**

Reflecting the interdisciplinary nature of the department and the university as a whole, UB's Geology faculty conduct active research programs in close collaboration with faculty in chemistry, geography, biology, environmental engineering, and several other departments, as well as with national research groups such as those affiliated with the National Science Foundation and NASA.

Here is a small sample of recent research projects and departmental activities intended to give a sense of the scope of work conducted by UB Geology faculty:

- A 2012 study in the journal *Science* examined climate change and its impact on prehistoric glaciers on Canada's Baffin Island.
- A 2012 study of ancient sea creatures uncovered new evidence about their existence in virtually unchanged form for 500 million years.
- Since 2009, UB's Center for GeoHazards Studies has partnered with the government of Colombia and Pasto's Universidad de Narino on emergency preparedness measures and risk assessment related to volcano activity.
- A 2010 study investigated whether hydraulic fracturing could turn naturally occurring uranium into a soluble phase and thereby contaminate groundwater. Further testing demonstrated the uranium had indeed become soluble.

Research Centers

Why Universities Create Research Centers and Institutes

Academic, discipline-based departments have been and will continue to be the primary units for carrying out the mission of the University. However, new problems or areas of scholarly work often arise that need different organizational structures. Centers and institutes provide an important mechanism for innovation that keeps the University in the forefront as a research and scholarly institution. While bringing visibility to a particular area of scholarship, such centers may focus on research, instruction, service or some combination thereof; they are based on faculty interest and often are formed in response to a broader societal issue or concern. UB has established more than 150 such research centers and institutes, many of which are funded by state and federal agencies, individuals, philanthropies, and industries.

Below is a sampling of several established research institutes at the University at Buffalo, illustrating the scope of scientific, social, and cultural issues addressed by these centers. They are funded by multiple sources, including government agencies and non-profit foundations as well as corporate and industry support.

A Sampling of Research Centers and Institutes at the University at Buffalo

- Alberti Center for Bullying Abuse Prevention—Partners with schools in addressing bullying abuse by providing evidence-based tools to effectively change the language, attitudes, and behaviors of educators, parents, students, and society.
- Baldy Center for Law and Social Policy—An internationally recognized institute that advances interdisciplinary research on law, legal institutions and social policy.
- * Center of Excellence for Document Analysis and Recognition (CEDAR)—Having received sustained funding from the U.S. Postal Service since 1984, CEDAR was designated as a Center of Excellence by the USPS in 1991. Its innovative work in pattern recognition, machine learning, and information retrieval has applications from national defense to analysis of ancient documents.
- Center for 21st Century Music—Dedicated to the creation and production of innovative new work within a climate focused on excellence in creative research, the Center hosts 125 public performances per year and is home to world-class musicians at the vanguard of contemporary performance and composition.
- * Center for Unified Biometrics and Sensors (CUBS)—Advances the science of biometric technologies for both civilian and Homeland Security applications by integrating pattern recognition and machine learning algorithms with sensors technology.
- * Clinical and Translational Research Center (CTRC) –In an innovative partnership with Kaleida Health, this facility is an integrated academic home for clinical and translational science and medical breakthroughs as the hub of the Buffalo Translational Consortium, providing innovative research tools, support, training, resources and coordination.
- * Humanities Institute—Internationally renowned center for innovative cross-disciplinary research, teaching, scholarship, and community programs in the humanities, from partnering with city high schools to introduce cutting-edge material into the curriculum to advancing the global conversation in cultural studies.
- * Multidisciplinary Center for Earthquake Engineering Research (MCEER)—National center of excellence dedicated to equipping communities to become more disaster resilient in the face of extreme events, from the September 11 attacks to the recent earthquake devastation in Haiti.

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* Industry/corporate funding has supported this Center's research .

- * New York State Center of Excellence in Bioinformatics and Life Sciences—A state designated Center of Excellence that studies the mechanistic processes involved in human disease with the goal of developing diagnostic tools and therapeutic interventions, preventative treatment and other disease management devices and processes toward improving the quality of life for communities around the world.
- * Research Institute on Addictions (RIA)—A national leader in the study of alcohol and substance abuse, RIA has made major contributions to our understanding of the development, consequences and treatment of a wide range of addictive behaviors through the center's integration of research and treatment of addiction.

As in any active, vital research community, UB continually experiences disciplinary shifts reflecting evolving societal concerns and constantly emerging areas of inquiry. As a result, new societal concerns and intellectual trends periodically lead to the introduction of new research institutes that are devoted to studying them in an informed way.

History of the Shale Resources and Society Institute

Purpose:

UB's College of Arts and Sciences announced the establishment of the Shale Resources and Society Institute in April 2012 with the goal of providing objective scientific research and informed analysis on the topic of shale gas and hydraulic fracturing, a timely and consequential social issue. The establishment of the Shale Resources and Society Institute is the result of several years of conversations and research, involving the Department of Geology and faculty colleagues across UB and elsewhere, and the Geology Alumni Advisory Board (GAAB), a group of active and interested alumni who are charged to provide advice on the Department's education, research, and service missions.

Events leading to the creation of the SRSI:

Beginning in late 2007, the first departmental discussions related to the potential for a research center focused on energy resources took place. This dialogue, which would continue over the course of the next four years, involved conversations of faculty members and experts in the field, in consultation with the department's alumni advisory board and the offices of the dean and department chair.

Over the years, this evolving conversation explored various strategies for preparing the department's undergraduate, master's, and doctoral students for fields related to the energy industry and regulatory agencies, as well as maximizing faculty strength in stratigraphy and fracture systems, which are important in oil and gas exploration. Over a series of department and board meetings beginning in October 2007 and continuing through December 2011, department faculty and GAAB board members met regularly to discuss research areas of interest. As an outcome of these conversations, the faculty determined to focus on shale resources and their societal impact as a focused area of research **(See Attachment C: Timeline of Events Related to SRSI Creation).**

Selection of the Director and Co-Director:

Given the educational and research-intensive focus of the center and the importance of faculty-mentored student research to its mission, it was the College of Arts and Sciences Dean's original intention to have a tenured, full-time UB faculty member to direct the Shale Resources and Society Institute. This remains the ultimate intention of the Dean; toward this end, the Dean is engaged in a process to identify and appoint a full-time UB faculty member as the Institute's lead director.

To identify leadership to direct the center in its initial phase, the selection process involved a canvassing of faculty for potential candidates, discussion with advisory board members (some of whom have oil and gas corporate experience), and conversations with faculty at other institutions of higher learning. Criteria for directorship included service management experience, understanding of the oil and gas industry with particular emphasis on shale technologies, and a reputation for independent scholarship.

The selections of John Martin, Ph.D. as director and Robert Jacobi, Ph.D. as co-director of the SRSI were made based on their vast experience in this field **(See Attachment D: Curricula Vitae for Dr. John Martin and Dr. Robert Jacobi)**. Candidates outside of the university were considered to ensure a broader pool of expertise in energy geology to draw from.

An interim founding advisory board also has been established and is comprised of five UB faculty members and three UB alumni.

John Martin, Ph.D.

Dr. John Martin earned his Bachelor of Science degree in geology, Masters of Science in economics, and Doctor of Philosophy in urban and environmental studies, all from Rensselaer Polytechnic Institute. Dr. Martin also holds an MBA from Miami University and completed graduate work in mineral economics at West Virginia University. Dr. Martin spent 17 years working on energy and policy issues at the New York State Energy Research and Development Authority (NYSERDA), where he developed a series of projects targeting oil and gas resources,

renewable energy development, and environmental mitigation. As an authority on oil and gas resources, Dr. Martin has served on numerous state and national panels, including the U.S. Department of Energy's Unconventional Resources Technical Advisory Committee; co-director of the governor's Carbon Capture and Sequestration Working Group—an interagency committee organized in 2007; and as NYSERDA's point person on a series of technical studies looking at all aspects of hydraulic fracturing and multiwall pad development. In academia, Dr. Martin has held several faculty positions, including serving on the faculty of Southern Vermont College; as a visiting professor at Siena College; and as an adjunct assistant professor at Union College. Having significant breadth of experience in academia, consulting, and regional planning, Dr. Martin emerged as a highly qualified candidate to lead the institute in its initial phase.

Robert Jacobi, Ph.D.

Dr. Robert Jacobi's experience is equally impressive. A full professor at UB, Dr. Jacobi joined the university in 1980. He earned his bachelor's degree in geology and music from Beloit College in 1970, and master's (1974) and doctoral (1980) degrees in geology from Columbia University, where he has continued to serve as a visiting research associate and adjunct research scientist from 1981 until present. Actively engaged in his field at a national level, Dr. Jacobi is a member of the American Association of Petroleum Geologists—who honored him with an "Outstanding Educator Award"—as well as the Geological Society of America and the Society of Economic Paleontologists and Mineralogists. He has been an invited speaker at 30 symposia, and a referee as a research and proposal reviewer for nearly two dozen scientific organizations including the National Science Foundation, Geological Society of America, NATO Scientific Affairs Division, United States Geological Survey, American Association of Petroleum Geologists, and Society of Economic Paleontologists and Mineralogists. In addition to his academic appointments and affiliations, he has conducted consulting work for research centers and companies including Lamont-Doherty Geological Observatory, Norse Energy, and EQT Corporation, where he is Senior Geology Advisor. Dr. Jacobi has also published as an author or co-author of dozens of research reports and abstracts.

Funding for the SRSI:

To date, the University at Buffalo has received no industry funding for the Shale Resources and Society Institute. Its expenses, including the salary of its part-time director and co-director, have been paid entirely by the university's College of Arts and Sciences through discretionary funds. The sources for these discretionary funds include indirect cost recovery from research grants, investment income, and unrestricted gifts **(See Attachment E: Funding Breakdown for the SRSI).**

Institutes are often organized around areas where progress requires a focused funding source. Institute funds are used to cover administrative activities, education, and scholarship. Funds can be developed from university-based, philanthropy, and private sector sources.

By developing expertise and visibility for scholarship in shale technologies and their impact on society, UB anticipates that SRSI will generate research support through competitive grants, philanthropy, and from the private sector. Establishing a track record is often a prerequisite for receiving external funding. Toward this end, SRSI co-directors undertook a process of identifying potential funding streams; one outcome of their early work was the first SRSI report.

Points of clarification

No concerns were raised by the relevant scientific community about the data used in developing the report's conclusion.

Below is a summary of the chief subjects of inquiry raised by critics, followed by a brief clarification of the circumstances involved.

- **Conclusions of the SRSI May 15 Report:** The first SRSI report reviewed the impact of regulations on the incidence of environmental policy violation. The report's main conclusion is that "the odds of non-major environmental events and the much smaller odds of major environmental events are being reduced even further by ***enhanced regulation*** and improved industry practice" (emphasis added).

- **Funding Sources for the SRSI**: UB's College of Arts and Sciences has been the sole source of funding for the SRSI. There has been no industry funding of the Shale Resources and Society Institute. SRSI can solicit support for the institution from external sources, including state and federal agencies, individuals and philanthropies, and corporations, however, none of its funding has come from these entities **(See Attachment E: Funding Breakdown for the SRSI)**. Note: a faculty proposal around shale research was submitted to the provost through a competitive university program designed to launch new research and educational initiatives in the last academic year but was not ultimately selected for funding.

- **Selection of SRSI Directors**: As previously discussed, Dr. John Martin was selected based on his body of work and peer recommendations. In consideration of Dr. Martin's part-time status, Dr. Robert Jacobi brought the knowledge and scientific skills to compliment Dr. Martin as a co-director **(See Attachment D: Curricula Vitae for Dr. John Martin and Dr. Robert Jacobi).**

- **Disclosure of Sponsored Funding for the SRSI May 15 report:**
  Concerns were raised in the press and by the public questioning whether standard academic procedures were practiced in this report. Under standard academic practice, faculty members are obliged to disclose sponsored funding for research that contributed to a publication. A thorough review by the university confirmed that no sponsored funding was received by the University at Buffalo for director Dr. John Martin's work on this report. If the institutions of the other authors received sponsored funding for their work on the report, sound academic practice would dictate that they disclose it in this report.

  UB policies require annual disclosures of significant financial interests and significant obligations once a year in November, or prior to submission of a grant proposal. Any person who holds a UB appointment and who is a principal investigator, co-principal investigator, or who is responsible for the design, conduct, or reporting of university programs or projects, including part-time faculty members, must disclose in this manner. The directors of SRSI are in compliance with UB disclosure policies and time commitments **(See Attachment A: UB Conflict of Interest Policy and PHS Policy).**

- **Conflicts of Interest**:
  UB encourages faculty to transfer their knowledge to the private sector through policy development, allowing for consulting up to 1 day in 5, or up to 20% of their faculty appointment. Part-time faculty members are allowed to consult within the constraints of their time commitments to UB.

  The fact that the co-authors of the May 15 SRSI report have known industrial experience, having worked in the field for many years, in no way invalidates the results of the research reported in the May 15 SRSI report. Practices of disclosing potential conflicts vary across disciplines. The authors of the SRSI report follow common practice in engineering and the physical sciences. **(See Attachment A: UB Conflict of Interest Policy and PHS Policy).**

- **Report Errata**: The initial report of the Shale Resources and Society Institute contained two typographical errors that were subsequently corrected:
  - Page 3, paragraph 1: The units shown were corrected to be expressed in trillion cubic feet (TCF) rather than billion cubic feet (BCF).
  - Page 30, fourth bullet: In the report's conclusion, the phrase "number" was corrected to read "rate."

  An errata noting and correcting these editorial errors appears prominently on the first page of the published report **(See Attachment F: SRSI Report Issued 5/15/12).**

- **Peer Review:** A press release associated with the report stated it was 'peer reviewed.' The report followed an open peer-review method; five reviewers publicly identified in the published report had been asked for comment prior to publication.

  If a publication is submitted to a peer-reviewed journal, the editor of the journal sends the manuscript to an anonymous set of reviewers. The reviewers offer comments, the authors respond, and the editor determines if the article should be published. However, since the first SRSI report was self-published, that form of review process could not be used.

  Centers often internally publish reports. These reports can later form the basis of journal publications. This is the case of the first SRSI report. Two papers based on material in that report have since been submitted to peer-reviewed journals for publication.

- **University Response to Inquiries:** There has been some public misunderstanding regarding the establishment and funding of the Shale Resources and Society Institute. In order to clarify points of confusion, UB has provided several public statements regarding the establishment, purpose, and funding of the center **(See Attachment G: University Response to Inquiries and Statements Regarding the SRSI).**

In the specific case of the SRSI, and as a general academic principle, it is not the role of SUNY, or any university, to dictate the conclusions drawn by faculty from their research, or to review faculty research before it is published. Standards of academic conduct are articulated according to our policies related to research integrity and conflict of interest and commitment.

Moving Forward

Ensuring the integrity of all research conducted under the auspices of the university remains a priority of paramount importance for UB. Protecting the academic freedom of our faculty members across the disciplines remains a core principle of our commitment to academic excellence and integrity. Providing a forum for the free and open exchange of ideas, and enabling our faculty to explore and publish research on any topic—including controversial ones—without administrative interference is essential to sustaining a campus environment characterized by scholarly integrity, rigor, and informed debate.

In a rapidly evolving world, we are continuously exposed to complex issues and events that challenge us to be ever-responsive in reexamining and refining our policies and practices. With that in mind, the Provost has asked the Vice President for Research and Economic Development and Faculty Senate Chair to establish a joint committee to provide advice on university policies and practices related to research, scholarship and publication practices across the disciplines, with the goal of offering recommendations to develop and strengthen our policies in these areas. Our faculty body is the appropriate place for such a policy debate to occur, and the university is confident that, with this approach, any modifications to existing policies will be made in a thoughtful and careful manner **(See Attachment H: Provost Zukoski's 9/12/12 Letter to the University at Buffalo Community Regarding Research Policies and Practices at UB).**

UB attracts and retains world-class scholars—and nurtures the excellence and impact of their work—by sustaining extraordinary standards of excellence. The university continuously upholds our principles and policies pertaining to research, and we remain vigilant in our commitment to intellectual and academic excellence.

xc: Mr. William Howard, SUNY Senior Vice Chancellor, General Counsel, and Secretary of the University

Dr. Timothy Killeen, President, SUNY Research Foundation and SUNY Vice Chancellor for Research

Dr. Charles Zukoski, University at Buffalo Provost and Executive Vice President for Academic Affairs

Enclosures

Attachment-A

UB Conflict of Interest Policy

and

Public Health Service Policy

Investigator Disclosure Policy

I. Introduction

The University at Buffalo (UB) as a community and as a public institution of higher learning is committed to performing the highest quality research and creative activity. In meeting this commitment, the University encourages interaction of its faculty, administrators, students, staff and fellows with the public and private sectors as an important component of its educational, research and public service missions. External funding through grants, contracts and gifts from public and private sources is necessary to provide essential support for University activities.

Professional interactions with public agencies, private businesses, non-profit organizations and individuals advance the University's ability to provide research and educational opportunities for our students, to contribute to the economic well being of our community, and to add to our store of knowledge and understanding. Similarly, technology transfer in the form of patents, licensing agreements, and consulting opportunities for University members are important means of meeting the needs of society and fostering the welfare of the citizens of the State of New York.

II. Policy

Members of the University community, in pursuing UB educational, research and public service missions, must meet high ethical standards and minimize the risks of conflict between private interests and the public interests the University serves.

The responsibilities and obligations of Investigators to the University must be clearly separated from their personal financial interests and their personal obligations to others. Prudent stewardship of public resources requires protecting University research, educational and public service missions from being compromised by conflicts of interest and the appearance of conflict of interest.

To meet these objectives and to ensure compliance with federal and state regulations, the University at Buffalo requires an Investigator to disclose his/her financial interests and non-university obligations and the financial interests and non-university obligations of his/her spouse and dependent children by completing and submitting Annual Disclosure of Significant Financial Interests and Significant Obligations1.

This Policy sets forth requirements and guidelines for:

1. disclosure of outside financial interests and obligations by Investigators at the University at Buffalo who engage in University activities funded by any external entity and funded internally through specified internal programs;
2. review of Investigator disclosures by designated University officials; and
3. identifying, reporting and resolving conflicts of interest.

This Policy applies to all external and specified internal support for University programs, projects, activities and services, solicited and unsolicited, including gifts and donations with the exceptions noted below.

1. Internal Support - This Policy applies only to those internal programs which require formal application in response to a request for proposals (for example, the UB Multidisciplinary Pilot Project Program or the UB Invention Commercialization Enhancement Program).
2. Gifts and Donations - This Policy applies to all gifts and donations made to support the activities of named individuals at UB. It does not apply to unrestricted gifts and donations to support the activities of administrative units (e.g., decanal, departmental or other organized units) where individuals at UB are not named.

III. Definitions

1. **Conflict of Interest:** A conflict of interest exists when a designated official at UB reasonably determines that a significant financial interest2 of an Investigator or a significant external obligation of an Investigator could directly and significantly affect the design, conduct, or reporting of research or creative activity.

A conflict of interest in the conduct of externally and selected internally supported activities may take several forms, but typically arises when an Investigator at the University is, or may be, in a position to influence activities or University decisions in ways that could lead to personal gain for the Investigator or the Investigator's immediate family (spouse and dependent children), or give an improper advantage to third parties in their dealings with the University or the State. Conflicts may also arise when Investigators have outside obligations of any kind which are in substantial conflict with the Investigator's University responsibilities or the public interest. The potential for conflicts of interest may arise from specific actions taken by Investigators, or by the nature of positions they hold in and outside the University, or by the financial interests they or their immediate family hold.

For example, a conflict of interest can result when:

1. A significant financial interest of an Investigator would reasonably be expected to be affected by the design, conduct or reporting by the Investigator of a University research, educational or public service activity;
2. An Investigator has a significant non-University obligation to an individual or entity that provides support for a University research, educational or public service activity involving the Investigator; or
3. An Investigator has a non-University obligation to an individual or an entity to which the University provides support through an agreement to perform a program project, activity or service involving the Investigator.

Protecting against conflicts of interest requires careful review of the following types of situations, among others:

1. Consulting arrangements or agreements between an Investigator and a business enterprise that supports or is supported by University programs involving the Investigator;
2. Consulting arrangements between an Investigator and a business enterprise that is licensed to commercialize University technologies invented by the Investigator;
3. Significant financial interests of an Investigator in a business enterprise that supports or is supported by the Investigator's University research;
4. A position held by an Investigator as consultant, officer, director, trustee or owner of a non-University business enterprise that supports or is supported by the Investigator's University research;
5. Significant financial interests of an Investigator in a business enterprise that owns or has applied for the patent, manufacturing or marketing rights to a drug, device or procedure that is a subject of, or will predictably result from, the Investigator's University research;
6. Significant financial interests of an Investigator in a business enterprise that is known by the Investigator to own or have applied for patent, manufacturing or marketing rights that can reasonably be expected to compete with a device, product or procedure that will predictably result from the Investigator's University research.

2. **Investigator:** Any person who holds a University at Buffalo appointment and who is a principal Investigator, co-principal Investigator or who is responsible for the design, conduct, or reporting of University programs, projects, activities or services described in an application or prospective application for external and/or selected internal support, or in an award made to the University without application.

3. **Significant Financial Interest:** Anything of monetary value to the Investigator or the Investigator's spouse and/or dependent children that would reasonably appear to be affected by work externally funded or proposed for external funding or selected types of internal funding, including but not limited to:

1. salary, royalties or other payments for services (e.g., consulting fees or honoraria) that, when aggregated for the Investigator and the Investigator's spouse and dependent children over the next twelve months, are expected to equal or exceed $10,000;
2. equity interests (e.g., stocks, stock options, warrants or other ownership interests) that meet both of the following criteria: equals or exceeds $10,000 in value as determined through reference to public prices or other reasonable measures of fair market value and represents more than a 5% ownership interest in the single entity; and
3. intellectual property rights (e.g., patents, copyrights and royalties from such rights).

Examples of significant financial interests include ownership of stock, stock options, or any equity, debt, security, capital holding, salary or other remuneration, or financial consideration, or thing of value for services as an employee, consultant, officer, or board member in:

1. the entity to which the application will be submitted;
2. any entity that owns or has applied for the patent manufacturing or marketing rights to a product or procedure involved in, or which will predictably result from, the work described in the application;
3. any entity that is known by the Investigator to own or have applied for such rights in any product that can reasonably be expected to compete with the product or procedure that will predictably result from the work described in the application; or
4. any entity that will be a sub-recipient from the University of funding resulting from the application.

Significant financial interests do not include the following:

1. salary, royalties or other remuneration paid to an Investigator by the University;
2. income from seminars, lectures, or teaching engagements sponsored by public or nonprofit entities;
3. income from service on advisory committees or review panels for public or nonprofit entities;

4. **Significant Obligation:** Significant obligations include positions held by the Investigator (or the Investigator's spouse and dependent children) as an officer, trustee, director, employee or consultant of an entity whether the entity is for profit or not-for-profit and whether the position is paid or unpaid, that would reasonably appear to be affected by the work funded or proposed by the University for all external and selected types of internal funding.

IV. Disclosure and Review of Disclosures

1. The Annual Disclosure of Significant Financial Interests and Significant Obligations will serve as the mechanism for disclosing financial interests and obligations by all Investigators at the University.
2. Disclosure statements (Annual Disclosure of Significant Financial Interests and Significant Obligations) must be

submitted to the cognizant dean(s) or cognizant vice president(s) not later than the time applications for external and selected types of internal support are submitted by the University, or prior to acceptance of an award made without prior submission of a proposal. Disclosure statements may also be submitted at any other time, but must be updated whenever significant financial interests or obligations change during the period of the proposal and the performance period of the award.

3. To ensure compliance with this policy, each proposal for external or selected types of internal support must be accompanied by a list of all Investigators.
4. The cognizant dean(s) or cognizant vice president(s) shall be the University's designated officials responsible for reviewing Investigator financial disclosure statements in the context of each proposal and/or award and for determining whether a conflict of interest or appearance of conflict of interest exists, and shall determine what conditions or restrictions, if any, should be imposed by the institution to manage, reduce or eliminate such conflicts. Cognizant deans and cognizant vice presidents have primary responsibility for assisting investigators to identify areas of potential concern and, whenever possible, for instituting remedies that permit affected research, creative activity or public service activity to proceed. Remedies instituted by cognizant deans and cognizant vice presidents to manage, reduce or eliminate conflicts of interest shall be in writing, signed by all affected parties, and a copy shall be forwarded to the Vice President for Research.
5. All applications for external support submitted by the University and for selected types of internal support must be accompanied by written certification by the cognizant dean or cognizant vice president that the appropriate disclosure form has been submitted. Applications for support of a University program, project, activity or service will not be submitted to an outside party, unsolicited support will not be accepted by the University and selected University internal support will not be awarded unless accompanied by the cognizant dean or cognizant vice president's certification that the appropriate disclosures have been made.
6. In instances where a cognizant dean or cognizant vice president is an Investigator on an application for external or selected types of internal support, the Vice President for Research shall be responsible for reviewing financial disclosure statements, determining whether a conflict of interest exists, and shall determine what conditions or restrictions, if any, should be imposed by the University to manage, reduce or eliminate such conflicts.
7. On receipt of a grant award, the Office of Sponsored Programs Administration shall request that the cognizant dean's or cognizant vice president's office (or their delegate) certify that no conflict of interest or conflict of obligation exists, or that any such conflict has been resolved. No funds for externally or selected types of internally funded projects may be expended until all conflicts of interest have been managed, reduced or eliminated.
8. The Vice President for Research (VPR) shall report to the appropriate funding source any instance where an Investigator participating in funded research or creative activity has not complied with the this Policy, and the specific corrective measures taken by the University.
9. The review of financial disclosure forms requires all participants to exercise the utmost discretion. To the maximum extent permitted by federal and state law and by University policy, all elements of this process are to be treated as strictly confidential. The purpose of confidentiality is to assure that the integrity of the research and the privacy of the Investigator as well as the interests of the University are protected at all times.
10. When and as required by an external sponsor and prior to the expenditure of any funds, the Vice President for Research will report to the sponsor the existence of a conflict of interest (but not the nature of the interest or any other details) and provide assurance that the conflict has been managed, reduced, or eliminated, and if a conflict is identified subsequent to receiving an award, a report to the sponsor will be made and the conflicting interest will be managed, reduced or eliminated, at least on an interim basis, within sixty (60) days of identification.
11. The Vice President for Research shall inform all sponsoring entities of cases in which the University is unable to satisfactorily manage a conflict of interest.
12. The University will maintain all disclosures and records of actions taken to resolve conflicts of interest for three (3) years after the termination or completion of the award to which they relate, or until after the resolution of any state or federal government action involving those records whichever is later. Maintenance of these materials will be the responsibility of the cognizant deans and cognizant vice presidents.

V. Remedies

Any or all of the following conditions or restrictions may be applied to manage, reduce or eliminate actual or potential conflicts of interest:

- Public disclosure of significant financial interests;
- Monitoring of the project or activity by independent reviewers;
- Modification of the project or activity plan;
- Disqualification from participation in the portion of the externally funded project or activity that would be affected by the significant financial interests or significant obligations;
- Divesture of significant financial interests;
- Severance of relationships or significant obligations that create actual or potential conflicts.

If the University is unable to resolve a conflict of interest, it may decline to perform the activity in question.

VI. Waivers

With the exception of activities sponsored by the United States Public Health Service (PHS), the cognizant dean or cognizant vice president may recommend in writing to the Vice President for Research that an activity go forward without imposing conditions or restrictions if the dean or vice president determines that imposing such conditions or restrictions would be ineffective and that the potential negative impacts that may arise from a significant financial interest are outweighed by interests of scientific progress, technology transfer, or the public health and welfare. Research, training or educational activity in question may not commence until a final decision has been made in writing by the VPR.

VII. Appeal

Should an Investigator disagree with the cognizant dean's finding in determining that an actual or potential conflict of interest exists, or disagree with the proposed remedy, the investigator may appeal to the Associate Vice President for Research (AVPR) within ten (10) working days3 of the dean's or vice president's decision. The AVPR will review the case, seek the advice of the Advisory Panel on Responsible Conduct4, and render a judgment within ten (10) working days of receipt of the appeal. No expenditures for external and selected types of internal support of a program, project, activity or service may be made by the University until a final decision has been made.

When a cognizant vice president serves as the reviewer of a disclosure statement, the appeal shall be to the Vice President for Research. When the Vice President for Research serves as the reviewer of a disclosure statement (see IV, F), the appeal shall be to the Provost.

VIII. Compliance

The VPR shall report promptly in writing to the Provost all cases in which an Investigator has failed to comply with the University's Investigator Disclosure Policy or the means determined to resolve a conflict of interest. In such cases, the Provost shall, at the direction of the President, institute disciplinary proceedings against an Investigator who has failed to comply with the disclosure policy.

1. Disciplinary sanctions may include termination or alteration of the employment or academic status of persons against whom charges have been substantiated, and must be consistent with established UB and State University of New York Board of Trustees policies, and applicable collective bargaining agreements. Article 19 of the UUP Agreement shall be the sole source of University discipline for members of the UUP-represented unit.
2. Upon completion of disciplinary proceedings, the Provost or appropriate vice president shall report to the appropriate University officers or bodies, to cognizant federal agencies when federal funds are involved, and to other parties as necessary.
3. The University shall require the Investigator to include a notice, with each public presentation of research and creative activity, of conflicts of interest that were not disclosed or resolved prior to the expenditure of funds or which arose during the course of the activity.

IX. Program to Inform the University Community

All persons subject to this Policy shall be informed of its contents as well as understand the meaning of conflict of interest. To those ends, the Vice President for Research will ensure that all unit heads receive a copy of this Policy with instructions that copies be made available to all its members (faculty, administrators, students, staff and fellows). Each unit head shall make his or her members aware of the Investigator Disclosure Policy on a annual basis and provide a copy of the Policy to new members as soon as possible after the start of their association with the unit. The VPR shall determine whether there are members of the University who would not be covered by such a distribution procedure and ensure that those individuals also receive a copy of the Policy. Any failure of this distribution process should not be construed as relieving any individual member of the University of obligations under this Policy for Investigator Disclosure.

X. Review and Evaluation

This Policy shall be periodically reviewed by the University to determine if it is working as intended and if any modifications are needed. This review and evaluation should occur every two (2) years, unless circumstances warrant review in a shorter period of time.

1See Section IV, page 5 and Appendix A.
2Italicized items are defined in 2, 3, and 4 below/on this section.

3"Working days" shall mean days on which University offices are open.
4The Advisory Panel on Responsible Conduct serves in an advisory capacity to the Vice President for Research on allegations of misconduct and issues arising from the Investigator Disclosure Policy. The Panel consists of one faculty member from each decanal unit, one member from the University Libraries, one member nominated by the chair of the Faculty Senate, and the VPR who also serves as Chair of the Panel. (see **Policy on Responsible Conduct in Intellectual and Creative Activity**).

University at Buffalo

Public Health Services
Investigator Disclosure Statement of
Significant Financial Interests, Significant Obligations, and Sponsored Travel
(Replaces the former SUNY 2-UB)

As part of its commitment to promoting objectivity in research and in compliance with Public Health Service (PHS) regulations, the University at Buffalo (UB, University) has adopted an *Investigator Conflict of Interest for PHS Funded Research* Policy[1]. This Policy will enable faculty entrepreneurship and external partnerships to proceed with the reasonable expectation that the design, conduct, or reporting of PHS funded research by UB faculty, students, or staff will not be biased by a conflicting significant[2] financial interest, significant obligation, and/or sponsored travel of any investigator.

The Policy requires each PHS funded investigator to submit a *Disclosure Statement* to his/her cognizant dean or vice president, no later than the following:

- submission of an application to PHS or prior to the release of grant funds, whichever comes first
- submission of a human study protocol for review by an Institutional Review Board (IRB),
- within 30 days of discovering and/or acquiring significant financial interests or significant obligations that have not been previously disclosed.

The completed *Disclosure Statement*, as well as any subsequent updates, should be placed in a sealed envelope, marked ***CONFIDENTIAL***, and mailed or delivered to your cognizant dean or vice president.

The cognizant dean or vice president cannot approve an application for submission to PHS unless s/he has received your Disclosure Statement. Sponsored Projects Services cannot release awarded grant or contract funds until the University's designated official has determined that the design, conduct, or reporting of PHS funded research by UB faculty, students, or staff will not be biased by a conflicting significant financial interest, significant obligation, and/or sponsored travel of any investigator.

Questions concerning the *Investigator Conflict of Interest for PHS Funded Research* Policy or the *Disclosure Statement* may be sent to coiofficer@buffalo.edu.

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[1] The *Investigator Conflict of Interest for PHS Funded Research* Policy is found at: http://policy.business.buffalo.edu/Policy Library/PHS Investigator Conflict of Interest Policy-Draft.pdf

[2] Underlined terms are defined in the *Investigator Conflict of Interest for PHS Funded Research* Policy

University at Buffalo

Public Health Services
Investigator Disclosure Statement of
Significant Financial Interests, Significant Obligations, and Sponsored Travel

Part I

1. a. Do you, or any of your immediate family members[3] currently work as an employee, independent contractor, or consultant (paid or un-paid) for any organization(s) other than UB that reasonably appear to be related to your institutional responsibilities? (Do **not** include seminars, lectures, or service on advisory panels or review groups for a federal, state, or local government agency, an institution of higher education, an academic teaching hospital, a medical center, or a research institute that is affiliated with an institution of higher education.) ☐ Y ☐ N

   b. Have you or any of your immediate family held any such position in the last 12 months? ☐ Y ☐ N

2. Do you or any of your immediate family members hold a management position (including service as a director, trustee, partner, or officer) with any organization(s) other than UB? ☐ Y ☐ N

3. With regard to any ***publicly traded entity***, during the past 12 months, have you, or any of your immediate family members received income (payments, royalties, consulting fees, or honoraria) related to your institutional responsibilities that when combined with the value of any equity interest exceeded $5,000?
   (Do not include remuneration from investment vehicles, such as mutual funds and retirement accounts, as long as you do not directly control the investment decisions made in these vehicles; or income from seminars, lectures, or teaching engagements sponsored by and service on advisory or review panels for a federal, state, or local government agency, an institution of higher education, an academic teaching hospital, a medical center, or a research institute that is affiliated with an institution of higher education.) ☐ Y ☐ N

4. With regard to any ***non-publicly traded*** entity, during the past 12 months, have you, or any of your immediate family members, received income (payments, royalties, consulting fees, honoraria, or other payments) related to your institutional responsibilities that when added together exceeded 5,000?
   (Do not include remuneration from investment vehicles, such as mutual funds and retirement accounts, as long as you do not directly control the investment decisions made in these vehicles; or income from seminars, lectures, or teaching engagements sponsored by and service on advisory or review panels for a federal, state, or local government agency, an institution of higher education, an academic teaching hospital, a medical center, or a research institute that is affiliated with an institution of higher education.) ☐ Y ☐ N

5. With regard to any ***non-publicly traded*** entity, during the past 12 months, have you, or any of your immediate family members, held any equity interest in a non-publicly traded entity? ☐ Y ☐ N

[3] Immediate Family Members – include an individual's spouse or domestic partner or person in a civil union or similar relationship, dependent children, and any other family members residing in the same household.

6. During the past 12 months, have you received any reimbursed or sponsored travel (i.e., travel which is paid for on your behalf and not reimbursed to you directly) related to your institutional responsibilities? (Do not include travel that is reimbursed or sponsored by a federal, state, or local government agency, an institution of higher education, an academic teaching hospital, a medical center, or a research institute that is affiliated with an institution of higher education). ☐ Y ☐ N

If you answered *No* to **Questions 1-5** above, your disclosure is complete. Please sign and date the certification below and forward to your cognizant dean or vice president.

If you answered ***Yes* to Questions 1, 2, 3, 4, or 5 above**, please complete a separate Part II for **each** outside organization with which you have the relationship(s) indicated above.

If you answered *Yes* to **Question 6**, please complete Part III.

Investigator Certification:

- The information provided in this *Disclosure Statement*, including any attached forms, is true and complete to the best of my knowledge.
- I will update this *Disclosure Statement* within 30 days of discovering and/or acquiring significant financial interests that have not been previously disclosed so that the *Disclosure Statement* remains current and complete.

Investigator Signature: _____ Date: _____

Investigator Name (please type or print): _____

Department: _____

Phone: _____

Email Address: _____

University at Buffalo

Public Health Service
Investigator Disclosure Statement of
Significant Financial Interests, and Significant Obligations

Part II

Complete Part II only if you answered "Yes" to any of the Questions 1-5 in Part I.

Complete one **Part II** form for each organization
with which you have the relationships indicated in Part I.

Investigator Name: _____

Number of Part II forms submitted: _____ of which this is number: _____

1. Name of organization: _____

2. Financial relationship(s) with the organization (check all that apply):

☐ Consultant	☐ Employee
☐ Equity Interest	☐ Recipient of Honoraria
☐ Recipient of Royalties	☐ Other:_____

3. The financial relationship is between the organization and (check all that apply):
   - ☐ Self
   - ☐ Spouse/Domestic Partner/Person in a Civil Union or similar relationship
   - ☐ Dependent Child(ren)
   - ☐ Family member(s) residing in the same household

4. For ***publicly traded entities***, during the past 12 months, have you, any of your immediate family members received income related to your institutional responsibilities from this organization where any such payments, royalties, consulting fees, honoraria, the value of any equity interest in this organization, and/or the receipt of any income related to intellectual property rights and interests when added together with this and any other organization exceeded $5,000? ☐ Y ☐ N ☐ N/A

   a. If yes, please provide below the approximate dollar value of the financial interest in this organization.

☐ $5,000 - $9,999	☐ $10,000 - $19,999	☐ $20,000 - $39,999	☐
☐ $40,000 - $59,999	☐ $60,000 - $79,999	☐ $80,000 - $99,999	☐ $100,000 - $149,999
☐ $150,000 - $199,999	☐ Greater than $200, 000 – please specify amount:		

b. If yes and the interest is one whose value cannot be readily determined through reference to public prices or other reasonable measures of fair market value, lease indicate by checking the following box: ☐.

Please provide an explanation as to why such value cannot be ascertained.

5. For **non-*publicly traded entities***, during the past 12 months, have you or any of your immediate family members received income related to your institutional responsibilities from this organization where any such payments, royalties, consulting fees, honoraria, and/or the receipt of any income related to intellectual property rights and interests when added together with this and any other organization exceeded $5,000? ☐ Y ☐ N ☐ N/A

a. If yes, please provide below the approximate dollar value of the financial interest in this organization.

☐ $5,000 - $9,999	☐ $10,000 - $19,999	☐ $20,000 - $39,999	☐
☐ $40,000 - $59,999	☐ $60,000 - $79,999	☐ $80,000 - $99,999	☐ $100,000 - $149,999
☐ $150,000 - $199,999	☐ Greater than $200, 000 – please specify amount:		

b. If yes and the interest is one whose value cannot be readily determined through reference to public prices or other reasonable measures of fair market value. Please indicate that by checking the following box: ☐.

Below, please provide am explanation as to why such value cannot be ascertained.

6. For ***non-publicly traded*** entities, please list any equity interest below. ☐ N/A

Please provide below the approximate dollar value of the equity in this organization.

☐ $5,000 - $9,999	☐ $10,000 - $19,999	☐ $20,000 - $39,999	☐
☐ $40,000 - $59,999	☐ $60,000 - $79,999	☐ $80,000 - $99,999	☐ $100,000 - $149,999
☐ $150,000 - $199,999	☐ Greater than $200, 000 – please specify amount:		

a. If yes and the interest is one whose value cannot be readily determined through reference to public prices or other reasonable measures of fair market value. Please indicate that by checking the following box: ☐.

Please provide an explanation as to why such value cannot be ascertained.

7. What relationship, if any, is there between the business or activities of the organization and your current institutional responsibilities?

University at Buffalo

Public Health Service
Investigator Disclosure Statement of
Sponsored Travel

Part III

Please specify the details of all reimbursed and sponsored* travel occurrences. Do not include travel that is reimbursed or sponsored by a federal, state, or local government agency, an institution of higher education, an academic teaching hospital, a medical center, or a research institute that is affiliated with an institution of higher education.

Purpose of the Trip	Sponsor/Organizer Name	Destination	Duration	Monetary Value (if known)

* For the purposes of this *Disclosure Statement*, "sponsored travel" applies to travel which is paid for on your behalf and not reimbursed to you directly so that the exact monetary value may not be readily available.

Attachment-B

Information Regarding the

Marcellus Shale Lecture Series

Marcellus Shale Lecture Series

March 31 to May 19, 2011

All lectures held in Room 250, Baird Hall, UB North Campus

The following is a list of dates, speakers, and lecture titles:

- March 31, 2011; Rayola Dougher, senior economic advisor of the American Petroleum Institute; "Natural Gas and the Energy Future of the U.S."
- April 7, 2011; Langhorne Smith, the New York State Geologist with the New York State Museum; "Geology of the Black Shales of New York"
- April 14, 2011; Michael Joy, partner at Biltekoff & Joy, LLC, and adjunct faculty member in the UB Law School; "Land Leasing and Property Rights,"
- April 21, 2011; Greg Sovas, president of XRM Consulting and former director of the New York Department of Environmental Conservation Division of Mineral Resources; "Permitting and Regulation"
- April 28, 2011; Rich Nyahay, vice president of geological exploration for Gastem, an oil and gas exploration company based in Quebec; "Drilling and Fracking"
- May 5, 2011; Gary Marachiori, vice president of Constellation New Energy, based in Baltimore; "Production, Pipelining and Long-Term Build-out"
- May 12, 2011; Roger Willis, chief executive officer of Universal Well Services, a provider of hydraulic fracturing, cementing, nitrogen and acidizing services in the Appalachian Basin; "Completion"
- May 19, 2011; John Martin, former senior project manager for the New York State Energy Research and Development Authority; "Energy and the Environment: Gas and the Green Earth"

Source: UB Department of Geology

For the Marcellus Shale Lecture Series, the UB Department of Geology received the following sponsorships, which were used only for the seminar series:

$2,000 from Lenape Enterprises
$5,000 from Otis Eastern Service, Inc.
$250 from Chautauqua Energy
$200 from Reserve Energy Exploration Co.
$250 from Tectonic Engineering
$200 from Minard Run Oil Co.
$5,000 from Independent Oil & Gas Assoc. of NY

Source: Office of the Dean, College of Arts and Sciences at the University at Buffalo

Attachment-C

Timeline of Events

Related to SRSI Creation

Following is a timeline of the events related to the creation of the SRSI:

- **October 2007:** Advisory board meeting, involving faculty members, alumni, experts in the field, and representatives of the chair's and dean's offices, addresses energy industry issues and their relation to departmental research and education.

- **May 2009:** At a meeting of the advisory board, focused discussion begins regarding the creation of an academic center dedicated to objective research in the area of natural gas and shale resources. This conversation continues to evolve over the next three years.

- **February 2010:** Advisory board members discuss efforts to develop an "unbiased" Marcellus Center in WNY, not associated with any specific policy objectives.

- **May 2010:** An advisory board member reports on a 503(c) framework for a possible institute and notes that several agencies, including state and federal agencies, have expressed interest in playing a role in a Marcellus Center.

- **November 2010:** Advisory board members meet to continue a discussion of a Marcellus Center that would provide a focus for objective research in energy resources and environmental studies, drawing students and faculty together with regional organizations, industry, and governmental agencies.

- **March-May 2011**: On the recommendation of the advisory board, the Marcellus Shale Lecture Series is held, including a set of eight public seminars addressing the U.S. energy picture, geology of New York black shale, leasing and property rights, regulation, drilling and hydraulic fracturing, gas production, and energy sustainability.

- **October 2011:** A faculty proposal to create a shale institute is made to the Dean of the College of Arts and Sciences. Further discussions clarified board support.

- **October 2011:** Announcement in a Geology Department faculty meeting is made regarding the possible formation of an institute, including the possible hiring of Dr. John Martin as its director and a possible increase in Dr. Robert Jacobi's UB commitment.

- **November 2011:** Discussion with the College of Arts and Sciences Dean regarding issues related to the potential formation of an institute, including Dr. Jacobi's potential role.

- **December 2011:** Geology Department approves Dr. John Martin's appointment as a research professor in the department and forwards the appointment to the Dean of the College of Arts and Sciences.

- **April 2012:** The creation of the Shale Resources and Society Institute is announced.

- **May 2012:** The Shale Resources and Society issues its first report.

Attachment-D

Curricula Vitae for

SRSI Director John Martin, Ph.D. &

Co-Director Robert Jacobi, Ph.D.

John P. Martin, Ph.D.
23 Warren Street
Saratoga Springs, New York 12866
□

Office (518) 450-1639, (518) 636-7485
Cell [redacted]
jpm@alum.rpi.edu

Biographical Sketch

John is the founder of JPMartin Energy Strategy LLC which provides strategic planning, resource evaluation, project management and government/public relations services to the energy industry, academic institutions and governments and serves as Director of the Shale Resources and Society Institute at the University at Buffalo. Prior to forming JPMartin Energy Strategy LLC in 2011, John spent 17 years working on energy research and policy issues at the New York State Energy Research and Development Authority and developed a series of projects targeting oil and gas resources, renewable energy development and environmental mitigation. He has served on various state and national panels including the USDOE's Unconventional Resources Technical Advisory Committee. He co-directed the Governor's Carbon Capture and Sequestration (CCS) Working Group, an interagency committee organized in 2007 to address CCS issues and was NYSERDA's point person on a series of technical studies looking at all aspects of hydraulic fracturing and multiwell pad development. In addition, he completed the initial research on the natural gas potential of New York's Utica Shale that helped stimulate significant industry investment in this resource. John regularly lectures and publishes on such diverse topics as the development of shale gas resources, carbon capture and sequestration, compressed-air energy storage, renewable energy resource development, and research policy. Prior to joining NYSERDA, he worked in academia, consulting and regional planning. He holds a Ph.D. in Urban and Environmental Studies, an M.S. in Economics and a B.S. in Geology, all from Rensselaer Polytechnic Institute. He also holds an M.B.A. from Miami University and completed graduate work in mineral economics at West Virginia University.

Highlights

Founded JPMartin Energy Strategy LLC in 2011 to provide consulting services for a diverse client base.

Appointed to the Cornell University Applied Research and Extension Program Council, 2010-.

Appointed to the USDOE's Unconventional Resources Technical Advisory Committee by Secretary of Energy Steven Chu, 2010-2012.

Member of the Operations & Environment Task Group (OETG) for the National Petroleum Council's (NPC) "Prudent Development of North American Natural Gas and Oil Resources" study, 2010-2011.

Twice a panelist for *Popular Science Magazine's* Future of Energy and the Environment Roundtable (2009, 2008).

Served on the National Energy Technology Laboratory's 2009 Expert Peer Review Panel assessing a "Benefits Estimation Methodology for Unconventional Natural Gas and Small Producer Projects."

Coordinated the Governor's Carbon Capture and Sequestration (CCS) Working Group-Science and Technology, an interagency committee organized in 2007 to help New York State address CCS.

Completed and published the initial research on the natural gas potential of New York's Utica Shale Formation and developed a research program that led to exploratory drilling.

Negotiated NYSERDA's participation and managed the state environmental review of the Madison Windpower Project, New York State's first commissioned wind plant.

Negotiated NYSERDA's participation in the U.S. Department of Energy's Stripper Well Consortium and served on the governing Executive Council.

Managed the development of commercial energy technologies (cryogenics, downhole well tools, geological analysis software, and gas compression).

Testified at the public hearing *Strategic Review of the Department of Energy's Oil and Gas Technology Programs,* a review of USDOE's programs.

Taught college/university courses in geology, management, organizational behavior, finance, marketing, marketing research, government, and physics.

Served as an advisor to the West Valley Demonstration Project (former nuclear fuel reprocessing site); participated in the seismic data acquisition and geologic review.

Received two New York State gubernatorial commendations (2008 and 1996).

Education

Ph.D., Rensselaer Polytechnic Institute, 1991, Urban and Environmental Studies. Concentrations: Earth and Environmental Sciences, Economics, Management). Research area: technological change. Dissertation: *U.S. demand for copper, iron and steel, lead, and zinc: an input-output analysis.*

M.S., Rensselaer Polytechnic Institute, 1986, Economics. Research area: Industrial Organization. Thesis: *Recent changes in industrial structure: copper, lead, zinc, and iron and steel.*

M.B.A., Miami University, 1983. Concentration: Decision Sciences.

B.S., Rensselaer Polytechnic Institute, 1981, Geology major with a Political Science minor.

Graduate Student, Mineral and Energy Resource Economics, West Virginia University, 1983-84.

Employment

Consultant, 2011-

JPMartin Energy Strategy LLC provides strategic planning, resource evaluation, project management and government/public relations services to the energy industry, academic institutions and governments. John P. Martin, the Principal Consultant, is available for speaking engagements on a wide range of topics including energy policy, oil and gas exploration, renewable energy development and environmental issues. Recent contracts include a flaring and venting emissions study, a market study for a water management technology, a research project for enhanced gas recovery using carbon dioxide in shale, a shale play analysis, a marketing plan for a college-based geodata repository, and a strategic marketing plan for a consulting firm. Helping to start two companies; responsible for developing their marketing and financing strategies. Recent speaking engagements include the keynote address for the New York Geological Association, Vassar College, Cornell University, New York University, the University at Buffalo and the American Institute of Professional Geologists.

Senior Project Manager, 1999-2010
Project Manager, 1995-1999
Associate Project Manager, 1993-1995

New York State Energy Research and Development Authority (NYSERDA)*, Research and Development – Natural Gas Program, Albany, New York.* Managing NYSERDA's Subsurface Resources Program; creating an extensive project portfolio in the areas of natural gas, petroleum, geothermal, solar, wind, and environmental research. Coordinated the Governor's Carbon Capture and Sequestration Working Group–Science/Technology and NYSERDA's participation in the Midwest Regional Carbon Sequestration Partnership. Developed an international reputation as a researcher on the resource potential of fractured black shale and hydrothermal dolomite resources, including the first work targeting the Utica Shale in New York. Developed a successful working relationships with the U.S. Department of Energy, the Environmental Protection Agency, N.Y.S. Department of Environmental Conservation, the Gas Technology Institute, the Independent Oil and Gas Association of New York, a number of public utilities, and many private businesses. Working with companies and academic research programs to develop innovative technology, reduce operating costs, identify new reserves, and manage risk. Accepted an early retirement package in December, 2010.

Project Manager / Senior Economist, 1991-1993

***The Saratoga Associates**, Saratoga Springs, New York.* Conducted mineral resource valuations, environmental assessments, economic analyses, and feasibility studies. Managed proposal development, work schedules, budgets, and project staff. Designed, conducted and analyzed market research surveys.

Research Economist, 1988-1990

***Center for Economic Growth**, Albany, New York.* Served as project manager and chief researcher for the Center's economic analysis program. Conducted economic research studies. Presented to business leaders through workshops and press briefings. Managed the Center's research staff and information resources.

Information Specialist, 1986-1988

***Capital District Regional Planning Commission**, Schenectady, New York.* Developed resources for use in development and planning activities. Analyzed technical, economic, and demographic trends to assist in business and municipal land use development planning. Published demographic data and studies through Commission recurring publications.

Academic Appointments

Director, Shale Resources and Society Institute, the University at Buffalo, SUNY, 2012-

Lecturer, College of St. Rose, 2004-06, Geology.
Adjunct Assistant Professor, Union College, 1996-98, Geology.
Visiting Professor, Siena College, 1992, Finance.
Research Staff, Statistical Information, New York African American Institute, State University of New York, 1990-1991.
Faculty / Management Program Coordinator, Southern Vermont College, 1985-86, Management, Marketing, Organizational Behavior, Economics, and Government.
Teaching Assistant, Rensselaer Polytechnic Institute, 1984-1986, Economics.
Research Assistant, West Virginia University, 1983-84, Resource Economics.
Research Assistant, Miami University, 1983, Economics.
Teaching Assistant, Miami University, 1981-83, Physics.

Invited lectures include New York University (2011), Vassar College (2011), Hamilton College (2011), Pace University Law School (2011), Cornell University (2011, 2010), Union College (2010), University at Buffalo Geology Department (2011, 2010, 2002), Rensselaer Polytechnic Institute (2011, 2009, 2008), Colgate University School of Science (2008), University at Buffalo School of Law (2008), Columbia University Department of Earth and Environmental Engineering (2008), McGill University Department off Earth and Planetary Sciences (2002).

Publications, Published Abstracts and Accepted Conference Presentations

Martin, John, "Hydraulic Fracturing: Some Things to Consider," *Advanced Energy 2011*, Advanced Energy Research and Technology Center, Buffalo, NY, October 12-14, 2011.

Martin, John P., "From Nanoporosity to Macroeconomics: Understanding the Challenges of Shale Gas (and Oil) Development," *5th International Symposium on the Oil & Gas Resources of Western Newfoundland*, Steady Brook, Newfoundland, Canada, August 23-25, 2011.

Martin, John P., "From Nanoporosity to Macroeconomics: Understanding the Challenges of Shale Gas (and Oil) Development," *AAPG Geoscience Technology Workshop - Success in the Marcellus and Utica Shales: Case Studies and New Developments*, American Association of Petroleum Geologists, Baltimore, MD, May 23-25, 2011.

Martin, John P., "The Benefits of Integrated Environmental and Community Planning Practices and Context Sensitive Design Principles in Lessening the Impacts of Shale Development." *The Marcellus Shale: Energy Development and Enhancement by Hydraulic Fracturing Conference*, American Institute of Professional Geologists, Pittsburgh, PA, April 13-14, 2011.

Martin, John P., "Gas Shales: Energy Rocks with Big Implications," *2011 AAAS Annual Meeting*, American Association for the Advancement of Science, Washington, DC, February 17-21, 2011.

Martin, John, "New York State Geothermal Overview," *Advanced Energy 2010*, Advanced Energy Research and Technology Center, New York City, November 8-9, 2010.

Martin, John, "Carbon Sequestration in New York," *Advanced Energy 2010*, Advanced Energy Research and Technology Center, New York City, November 8-9, 2010.

Martin, John P., "Shale Development: Economic and Policy Perspectives," *The 26th Annual International Conference on Soils, Sediments, Water and Energy*, Association for Environmental Health and Sciences Foundation, Amherst, MA, October 18-21, 2010.

Martin, John P. and Kathleen F. Sanford, "Innovation and Regulation Can Coexist: New York's Approach to Regulating Shale Gas Development," *2010 Eastern Section Meeting, American Association of Petroleum Geologists*, Kalamazoo, MI, September 25-29 2010.

Martin, John P., "The Regulatory Tornado: Managing the Environmental Aspects of Shale Gas Field Development," *5th International Symposium on the Oil & Gas Resources of Western Newfoundland*, Steady Brook, Newfoundland, Canada, September 22-24, 2010.

Martin, John P. "Onsite Reprocessing and Reuse of Hydraulic Fracture Stimulation Flowback Fluid," *2010 1st Annual World Congress of Hydraulic Fracturing & Acidizing*, BIT Petroleum Biotech Division, Xi'an, China, August 26-28, 2010.

Martin, John P. "Lifecycle Water Management for Hydraulic Fracture Stimulation Operations: Challenges And Developments," *2010 1st Annual World Congress of Hydraulic Fracturing & Acidizing*, BIT Petroleum Biotech Division, Xi'an, China, August 26-28, 2010.

Martin, John P. and F. Charles Dayter, "Conducting Operations in a Shale Play: A Brief Review of Technical, Environmental and Legal Issues," presentation and paper prepared for the *Short Course on the Law of Shale Gas Plays*, Institute for Energy Law, June 2-3, 2010.

Martin, John P., "Shale Development: Economic and Policy Perspectives." *The Marcellus Shale: Energy Development and Enhancement by Hydraulic Fracturing Conference*, American Institute of Professional Geologists, May 5-6, 2010.

Martin, John P., "Is it Time to Revisit the Eastern Overthrust Belt of New York and New England?" presented at *Annual Convention of the American Association of Petroleum Geologists*, New Orleans, LA, April 10-14, 2010.

Martin, John P., "The Oil and Gas Industry in the Empire State: Past, Present and Future," presented at *Annual Convention of the American Association of Petroleum Geologists*, New Orleans, LA, April 10-14, 2010.

Fisher, Jodi L., Robert D. Jacobi, and John P. Martin, "Compilation of Structural Features in the northern Appalachian Basin of New York State to Assist in Site Evaluation and CO2 Sequestration," *Northeastern Section (45th Annual) and Southeastern Section (59th Annual) Joint Meeting,* March 13-16, 2010.

Jacobi, Robert D., Stuart Loewenstein, Al Leaver, Gerald Smith, John Martin, and Thomas Mroz, "The Pennsylvania Salient: An Example of the Ragged Iapetan Rift Margin of Laurentia," *Northeastern Section (45th Annual) and Southeastern Section (59th Annual) Joint Meeting,* March 13-16, 2010.

Tamulonis, Kathryn, Teresa Jordan, Brian Slater, Robert D. Jacobi, and John P. Martin, "Regional Stratigraphy of the Queenston Formation in New York State and Its Implications for Geological Carbon Storage Potential," *Northeastern Section (45th Annual) and Southeastern Section (59th Annual) Joint Meeting,* March 13-16, 2010.

Zelazny, Melissa M., Beata Csatho, Robert D. Jacobi, and John P. Martin, Lineament Identification in New York State Using Remote Sensing techniques for Geological CO2 Sequestration, *Northeastern Section (45th Annual) and Southeastern Section (59th Annual) Joint Meeting,* March 13-16, 2010.

Martin, John P., "Oil and Gas Exploration in Northeastern North America: Is There a Common Thread?" *2010 Annual Spring Technical Meeting*, Geological Association of Canada, Newfoundland and Labrador Chapter, February 22-23, 2010.

Martin, John, Amanda D. Stevens, Robert Singer, George Rusk, F. Charles Dayter, and Rick Victor, "Advancing Carbon Capture and Geologic Sequestration in New York State," 2009 *Eastern Section Meeting, American Association of Petroleum Geologists*, Evansville, IN, September 20-22 2009.

Stolorow, Alexa, Brian Slater, Langhorne Smith, John P. Martin, Joel Sminchak, "Characterization of Possible Carbon Sequestration Targets in Cambrian Strata Near Jamestown, NY," *2009 Eastern Section Meeting, American Association of Petroleum Geologists*, Evansville, IN, September 20-22 2009.

Billman, Dan and John P. Martin, "Comparison of the Ordovician Utica Shale Reservoir Characteristics of Quebec, Canada and NY/PA, U.S.A.," *2009 Eastern Section Meeting, American Association of Petroleum Geologists*, Evansville, IN, September 20-22 2009.

Smith, Langhorne, James Leone, and John P. Martin, "Integrated Characterization of the Ordovician Utica/Trenton Organic-Rich Shale and Limestone Plays in New York State," *2009 Eastern Section Meeting, American Association of Petroleum Geologists*, Evansville, IN, September 20-22 2009

Martin, John P., "The Marcellus Shale and Other Tales: Developing Research, Technology and Policy to Meet the Coming Energy Revolution," *4th International Symposium on the Oil & Gas Resources of Western Newfoundland*, Steady Brook, Newfoundland, Canada, September 11-13, 2009.

Walker, Kirby, John Sink, Joel Le Calvez, Joe Frantz, John Martin, "Using Microseismic Monitoring to Better Understand Completion of the Medina - Whirlpool Formations: a NYSERDA - Sponsored Project," Society of Petroleum Engineers Paper SPE 125979, Society of Petroleum Engineers, Richardson, TX, 2009.

Martin, John, Amanda Stevens, F. Charles Dayter, Rick Victor and Robert Singer, "Advancing Carbon Capture and Geologic Sequestration in New York State," *Annual Convention of the American Association of Petroleum Geologists*, Denver, CO, June 7-10, 2009.

Martin, John, Richard Nyahay, James Leone, and Langhorne Smith, "The Utica Shale Play of Eastern New York," *2008 Eastern Section Meeting, American Association of Petroleum Geologists (in conjunction with the Society of Petroleum Engineers – Eastern Region)*, Pittsburgh, PA, October 11-15, 2008.

Martin, John and Amanda Stevens, "New York's Response to Climate Change on New York: Monitoring, Reducing and Sequestering Carbon Dioxide," *2008 Eastern Section Meeting, American Association of Petroleum Geologists (in conjunction with the Society of Petroleum Engineers – Eastern Region)*, Pittsburgh, PA, October 11-15, 2008.

Martin, John P., David G. Hill, Tracy E. Lombardi, Richard E. Nyahay, "A Primer on New York's Gas Shales," *New York State Geological Association: Field Trip Guidebook – 80th Annual Meeting*, Lake George, NY, September 26-28, 2008; NYSGA, 2008.

Martin, John P., "Shale Gas Development in Eastern North America," *3rd International Symposium on the Oil & Gas Resources of Western Newfoundland*, Steady Brook, Newfoundland, Canada, September 13-15, 2008.

Jacobi, Robert, Paul Agle, Mark Evans, Steve Coulter, Stuart Loewenstein, Tom Mroz, and John Martin, "Taconic Tectonics and the Trenton/Black River Carbonate Gas Play in the Northern Appalachian Basin of New York State: Evidence from Seismic Data and the First Oriented Horizontal Core in the Appalachian Basin T/BR," Back to Exploration - 2008 CSPG CSEG CWLS Conference, Calgary, AB, May 12-15, 2008

Martin, John and Amanda Stevens, "Identifying and Mitigating the Impacts of Climate Change on New York's Energy Infrastructure," *Annual Meeting of the American Association of Petroleum Geologists*, San Antonio, TX, April 20-23, 2008.

Martin, John, Richard Nyahay, James Leone, and Langhorne Smith, "Developing a New Gas Resource in the Heart of the Northeastern U.S. Market: New York's Utica Shale Play," *Annual Meeting of the American Association of Petroleum Geologists*, San Antonio, TX, April 20-23, 2008.

Nyahay, Richard E., and John P. Martin, "Delineating the Utica Formation From Outcrop to Subsurface," Geological Society of America Northeastern Section - *43rd Annual Meeting*, 27-29 March 2008.

Martin, John, "Carbon Sequestration in New York and its Potential Impact in Reducing CO2 Emissions," *Second Annual Energy and Resources Conference*, Metro New York Section, American Institute of Chemical Engineers, New York, NY, December 6, 2007.

Jacobi, Robert, Stuart Loewenstein, Gerald Smith, John Martin, and Thomas Mroz, "The Pennsylvania Salient: Seismic and Other Evidence for an Iapetan Arcuate Rift Influence and the Arcuate Map Pattern," 2007 Geological Society of America Annual Meeting (28–31 October 2007), *GSA Abstracts with Programs* Vol. 39, No. 6.

Martin, John and Amanda Stevens, "Climate Change and Carbon Sequestration Programs in New York," *Thirty-Sixth Meeting of the Eastern Section, American Association of Petroleum Geologists*, Lexington, KY, September 16-18, 2007.

Nyahay, Richard, James Leone, Langhorne Smith, John Martin, Dan Jarvie, "Update on Regional Assessment of Gas Potential in the Devonian Marcellus and Ordovician Utica Shales of New York," *Thirty-Sixth Meeting of the Eastern Section, American Association of Petroleum Geologists*, Lexington, KY, September 16-18, 2007, *Search and Discovery* Article #10136 (2007).

Martin, John P., "The Oil and Gas Industry in the Empire State: Past, Present and Future," History of the Earth Sciences Society 25th Anniversary Meeting, Rensselaer Center of Applied Geology, Troy, NY, June 24-26, 2007.

Martin, John, Richard Nyahay, James Leone, and Daniel Jarvie, "Shale Gas Potential in New York: Results from Recent NYSERDA-Sponsored Research," Annual Meeting of the American Association of Petroleum Geologists, Long Beach, CA, April 1-4, 2007 published in abstract in the *AAPG Bulletin* and *Search and Discovery* (2007).

Martin, John, "Development of the Ordovician hydrothermal dolomite play in the Appalachian Basin," *Quebec Exploration 2006*, Quebec City, Quebec, November 20-23, 2006.

Martin, John P., "The Middle Devonian Hamilton Group Shales in the Northern Appalachian Basin: Production and Potential," Thirty-Fifth Meeting of the Eastern Section, American Association of Petroleum Geologists, Buffalo, NY, October 8-11, 2006.

Martin, John P. "The Utica Shale: Evolution and the Potential for Natural Gas Production," Thirty-Fifth Meeting of the Eastern Section, American Association of Petroleum Geologists, Buffalo, NY, October 8-11, 2006.

Jacobi, Robert D., Stuart Loewenstein, Gerald Smith, John Martin, and Tom Mroz, "Separating the Spiderweb of Faults in the Northern Appalachian Basin of NYS and PA: Grenvillian to Present Fault Activity That Influenced Reservoir Development," Thirty-Fifth Meeting of the Eastern Section, American Association of Petroleum Geologists, Buffalo, NY, October 8-11, 2006.

Martin, J.P. and Jacobi, R.D., "Understanding hydrothermal alteration of the Ordovician carbonate platform of New York State: Implications for hydrocarbon exploration" Keynote Presentation, Joint Annual Meeting of the Canadian Association of Geologists and the Mineralogical Association of Canada, Montreal, Quebec, Canada, May 14-17, 2006, GAC-MAC Abstracts Volume 31, p. 97.

Martin, John P. and Robert D. Jacobi, "Developing the Ordovician Hydrothermal Dolomite Play in

New York and Implications for Western Newfoundland," First International Symposium on the Oil & Gas Resources of Western Newfoundland, Deer Lake, Newfoundland, Canada, October 25-26, 2005.

Martin, John, "Utica Shale Deposition in the Taconic Foreland Basin: Evolution and the Potential for Natural Gas Production," Northeastern Section of the Geological Society of America - 40th Annual Meeting, *GSA Abstracts with Programs* Vol. 37, No. 1, 2005.

Jacobi, Robert, Stuart Loewenstein, Gerald Smith and John Martin, "Ordovician Fault Systems in the Appalachian Basin of New York State," Northeastern Section of the Geological Society of America - 40th Annual Meeting, GSA Abstracts with Programs Vol. 37, No. 1, 2005.

Martin, John P., Robin Petrusak, Julio Manik and Donald Drazan, "Using a Risk-Based Data Characterization Approach to Efficiently Manage Potential Point-Source Emissions from New York's Oil and Gas Wells," *Environmental Quality Management*, Winter 2004, volume 14, issue 2 pages 89-95.

Jacobi, Robert D., Stuart Loewenstein, Gerald Smith, John Fountain, Courtney Lugert, Tom Mroz, and John Martin, "Fault Systems and the Trenton/Black River Play in New York State," Thirty-Third Meeting of the Eastern Section, American Association of Petroleum Geologists, Columbus, OH, October 3-6, 2004.

Martin, J.P., "The Utica Group Shales: The Next Fractured Shale Play?" Joint Annual Meeting of the Canadian Association of Geologists and the Mineralogical Association of Canada, St. Catharines, Ontario, Canada, May 12-14, 2004, GAC-MAC Abstracts Volume 29, p. 322.

Martin, John P., David G. Hill and Tracy E. Lombardi, "Fractured Shale Gas Potential in New York," *Northeastern Geology and Environmental Science*, 2004, vol. 26, no. 1&2, pp. 57-78.

Martin, John P., "New York's Utica Group Shales: The Next Fractured Shale Play?" Thirty-Second Meeting of the Eastern Section, American Association of Petroleum Geologists, Pittsburgh, PA, September 6-10, 2003.

Martin J. P., D. Drazan, R. Petrusak, and J. Manik, "Helping Evaluate New York's Marginal and Inactive Oil and Gas Wells – Assets or Liabilities?" Annual Meeting of the American Association of Petroleum Geologists, Salt Lake City, Utah, May 11-14, 2003 published in abstract in the *AAPG Bulletin.*

Martin, John and Langhorne Smith, "182 Years After the Hart Well, The Trenton / Black River Carbonates Re-ignite New York State's Natural Gas Industry," Northeastern Section of the Geological Society of America - 38th Annual Meeting, March 27–29, 2003, Halifax, Nova Scotia and published in GSA Abstracts with Programs Vol. 35, No. 3, February 2003.

Hill, David G., Tracy E. Lombardi and John P. Martin, "Fractured Shale Potential in New York," *Proceedings of the 2002 Ontario – New York Oil and Gas Conference*, Ontario Petroleum Institute, London, Ontario, v. 41, 2002.

Martin, John P., "Natural Gas Exploration in the Finger Lakes Region: a Tale of Science, Politics and Public Perception," Thirty-First Meeting of the Eastern Section, American Association of Petroleum Geologists, Champaign, IL, October 2-4, 2002.

Martin, John P., "Energy Innovation Using an Ancient Idea: The Madison Wind Power Project," *Pollution Prevention Review*, v. 11, n. 3, John Wiley & Sons, 2001.

Martin, John P., "Exploration and Drilling in Lake Erie: Opportunity and Challenges for New York," Thirtieth Meeting of the Eastern Section, American Association of Petroleum Geologists, Kalamazoo, MI, September 24-25, 2001 and published in abstract in the *AAPG Bulletin*, v 85, no. 8, 2001.

Martin, John P., "Reducing Methane Leakage at the Wellsite - Results of the Natural Gas STAR Well Demonstration Program," Twenty-Ninth Meeting of the Eastern Section, American Association of Petroleum Geologists, London, ON, September 23-27, 2000 and published in abstract in the *AAPG Bulletin*, v. 84, no. 9, 2000.

Martin, John P., Jennifer L. Harvey, and John L. McCarthy, "Windpower Comes to New York: Siting and Permitting the Madison Windpower Project," *Windpower 2000*, American Wind Energy Association, Palm Springs, CA, April 30- May 4, 2000.

Pekot, Lawrence J., David A. Wozniak, and John P. Martin, *Tight Sand Evaluation Applied to the Medina Group of Chautauqua County, NY*, Society of Petroleum Engineers Paper SPE 57440, Society of Petroleum Engineers, Richardson, TX, 1999.

Martin, John P., "Recent Exploration and Development Trends in New York State," *Proceedings of the 37th Annual Conference of the Ontario Petroleum Institute*, London, Ontario, November 4-6, 1998, v. 37, n. 12, 1998.

Loewenstein, Stuart, Robert Jacobi, and John Martin*, "Geologic Assessment of Core Data from the Stahl #1 and Correlation with the Rose Run of Ohio," Twenty-Seventh Meeting of the Eastern Section, American Association of Petroleum Geologists, Columbus, OH, October 7-10, 1998 and published in abstract in the *AAPG Bulletin*, v. 82, no. 9, 1998. (* Presented by John Martin.)

Martin, John P., "Developing Viable Industry-Government Partnerships," Twenty-Sixth Meeting of the Eastern Section, American Association of Petroleum Geologists, Lexington, KY, September 27-30, 1997 and published in abstract in the *AAPG Bulletin*, v. 81, n. 9, 1997.

Martin, J. P., "The Natural Gas Industry Potential in the Empire State - A Multi-Year Plan," Twenty-Fourth Meeting of the Eastern Section, American Association of Petroleum Geologists, Schenectady, NY, October 13-17, 1995.

The State of African American New Yorkers: A Statistical Profile 1991, John P. Martin, Project Director, New York African American Institute, Institute Document 91-12, 1991, 91 pages.

Other Presentations, Committees, Workshops and Articles

Presentations made to the Canadian Institute's *8th Annual Shale Gas & Oil Symposium* (2012), Hart Energy's *Developing Unconventional Gas (DUG) East* (2011), Hart Energy Webinar *Unlocking the Utica: The Next Big Northeast Shale Play?* (2011), the Canadian Institute's *Northeast Shale Gas Symposium* (2011), Canadian Institute's *Eastern Shale Gas Conference* (2011), Erie-Niagara Chapter New York State Society of Professional Engineers *Marcellus Shale Conference* (2010), Central New York Association of Professional Geologists (2010), Quebec Oil and Gas Association (2010), Energy

IQ's *Upstream Environmental Issues Summit* (2010), New York State Bar Association Environmental Law Section (2010), Oil and Gas IQ's *Shale Gas Drilling and Completions* (2010), Hart Publications *Developing Unconventional Gas* (DUG 2010), Air and Waste Management Association – Finger Lakes Chapter (2010), EUCI (2009), Cornell Cooperative Extension (2009), Hudson Mohawk Professional Geologist Association Marcellus Shale Symposium (2009), Air and Waste Management Association – Eastern New York Chapter (2009), Annual Meeting of the New York State Department of Environmental Conservation Division of Mineral Resources (2008), Stripper Well Consortium (2007), Interstate Oil and Gas Compact Commission Midyear Meeting (2007), Northern Appalachian Landman's Association (2006), Strategic Research Institute *Gas Shales Conference* (Denver and Houston, 2002, Denver 2004, Denver 2005), New York State Bar Association Committee on Public Utility Law (2004), National Wind Coordinating Committee New England Wind Power Siting Workshop (2001), American Association of Professional Landmen Education Seminar (2001, 2002), U.S. Environmental Protection Agency Natural Gas STAR Program Implementation Workshop (1998, 2000), Buffalo Association of Professional Geologists (2009, 2000), Hudson Mohawk Professional Geologist Association (2011, 2005, 2000) Appalachian Natural Gas Marketing Seminar (1998), NYS DEC, Independent Oil and Gas Association of New York Annual and Summer meetings (1996-2008).

Invited panelist for the *2nd United States-Indonesia Energy Investment Roundtable: "Unconventional Gas,"* under the auspices of the United States-Indonesia Energy Policy Dialogue, to be held February 6, 2012, in Jakarta, Indonesia.

Meeting Chairperson, IQPCs *3rd Marcellus Shale Gas Environmental Summit*, held in Pittsburgh, PA, October 24-26, 2011.

Served on the faculty of the ALI-ABA Continuing Legal Credit Audio Seminar *Drilling into Hydraulic Fracturing and Shale Gas Development: A 3-State Perspective (PA, TX and NY)*, October 18, 2011 and available for purchase from the ALI-ABA.

Presented the Keynote Address at the *83th Meeting of the New York State Geological Association*, Syracuse, NY, October 15-16, 2011.

Marketing Committee Chairperson, 2011 Eastern Section Meeting, American Association of Petroleum Geologists held in Washington, DC, September 25-27.

Meeting Technical Chairperson: 6th International Symposium on Oil & Gas Resources in Western Newfoundland, Steady Brook, Newfoundland and Labrador, August 23-25, 2010.

Symposium Organizer: "Fractures Developing: The Science, Policy and Perception of Shale Gas Development," *2011 AAAS Annual Meeting*, American Association for the Advancement of Science, Washington, DC, February 17-21, 2011.

Meeting Technical Chairperson: 5th International Symposium on Oil & Gas Resources in Western Newfoundland, Steady Brook, Newfoundland and Labrador, September 22-24, 2010.

Served on the faculty of the Institute for Energy Law's Short Course on the *Law of Shale Gas Plays*, Fort Worth, Texas, June 2-3, 2010.

Panelist for *Popular Science Magazine's* Future of Energy and the Environment Roundtable (2009, 2008).

Meeting Technical Chairperson: *4th International Symposium on Oil & Gas Resources in Western Newfoundland*, Steady Brook, Newfoundland and Labrador, September 11-13, 2009.

Presented the Keynote Address at the Hudson Mohawk Professional Geologist Association *Marcellus Shale Gas Symposium*, Albany, NY, April 29, 2009.

General Meeting Chairperson and Session Chair/Moderator: Geology Panel for the Society of Petroleum Engineers Regional Technology Workshop *Water Management*, March 31-April 1, 2009.

Presented the Keynote Address at the *80th Meeting of the New York State Geological Association*, Lake George, NY, September 26-28, 2008.

Developed the Shale Workshop for the *80th Meeting of the New York State Geological Association*, Lake George, NY, September 26-28, 2008.

Session Chair/Moderator: Geology Panel for the Society of Petroleum Engineers Regional Technology Workshop *Stimulating Shale Reservoirs* held March 18-19, 2008.

Meeting Technical Chairperson: *2nd International Symposium on Oil & Gas Resources in Western Newfoundland*, Corner Brook, Newfoundland and Labrador, June 5-8, 2007.

Moderator for the Finance Panel, *Clean Coal: Opportunities for Appalachia*, sponsored by the Appalachian Regional Commission and the Commonwealth of Kentucky, Lexington, KY, held April 24-25, 2007.

Co-chair of technical session entitled "Black Shales – What We Know and What We Need to Know" at the *Thirty-Fifth Meeting of the Eastern Section, American Association of Petroleum Geologists*, Buffalo, NY (2006).

Chair of special session entitled "Optimizing Industry Investments: New Trends in Shared Research" at the *Twenty-Sixth Meeting of the Eastern Section, American Association of Petroleum Geologists*, Lexington, KY (1997).

Space and Events Committee Chair, *Twenty-Fourth Meeting of the Eastern Section, American Association of Petroleum Geologists*, Schenectady, NY (1995).

Member of the USDOE Unconventional Resources Technical Advisory Committee (2010-2012), Cornell University Applied Research and Extension Program Council (2010-), National Petroleum Council's Operations & Environment Task Group (OETG) for the "Prudent Development of North American Natural Gas and Oil Resources" study (2010), Governor's Carbon Capture and Sequestration Working Group (2007-2009), Stripper Well Consortium's Executive Council (2001-), Gas Technology Institute's Underground Gas Storage Steering Committee (1998-2003), Gas Technology Institute's Natural Gas Supply Advisory Board (1998-2002), AAPG Division of Environmental Geosciences Environmental Issues Subcommittee (1998-2002). Also presented testimony to the USDOE's Office of Fossil Energy Oil and Natural Gas Technologies Programs Public Hearing, Pittsburgh, PA, August 13,

2001.

Invited participant at workshops and symposia including the International Energy Agency Working Party on Fossil Fuels (IEA WPFF) workshop on *Carbon Capture and Storage (CCS): Bridging the Commercial Gap (Activity Component of the IEA WPFF Strategic Plan in Support of the G8 CCS Recommendations, New York, 2009), Natural Gas STAR Program Implementation Workshop* (Houston, 2007), *Summit on Coal Technology and Policy*, Lenfest Center for Sustainable Energy, The Earth Institute at Columbia University (New York, 2006), *Natural Gas as a Climate Change Solution*, United States Environmental Protection Agency and International Petroleum Industry Environmental Conservation Association (Washington, DC, 2006), *Increasing the Pace of Technology Innovation and Application*, International Petroleum Industry Environmental Conservation Association (Washington, DC, 2006), *Unconventional Gas Technology Workshop*, United States Department of Energy and the Gas Technology Institute (Pittsburgh, PA, 2005), *New England Wind Power Siting Workshop*, National Wind Coordinating Committee (Boston, MA, 2001), USDOE Natural Gas Storage R&D Workshop (Pittsburgh, PA, 2001), *Workshop on Pipeline Safety Research and Development*, United States Department of Transportation (Washington, DC, 2001), East African Hydrocarbon Conference (Capetown, South Africa 1997).

CURRICULUM VITA

Dr. Robert D. Jacobi

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Getzville, NY 14068
[redacted] (cell)

Education

Columbia University, Ph.D. 1980
Dissertation Title: *Geology of part of the terrane north of Lukes Arm Fault, north-central Newfoundland (Part I); modern submarine sediment slides and their implications (Part II), 422 p.*
Columbia University, M. Phil, 1974 (geology)
Beloit College, B. A., 1970 (geology & music)

Employment History

Present-2007	Department of Geology, SUNY at Buffalo, Full Professor, part-time
Present-2012	Senior Geology Advsior, EQT, Pittsburgh, PA
2011-2007	Norse Energy Corporation, Director of Special Projects
2008-1994	Consultant to such corporations as Akzo Nobel Salt, Solvay (WY), Bath Petroleum Storage, AECB (Canada), Talisman, Ansbro (Anschutz), Quest, Norse Energy, various litigants
2008-1997	Department of Geology, University at Buffalo, Full Professor, full-time
2005	Interim Chair, Geology Department, University at Buffalo
1997-1986	Department of Geology, SUNY at Buffalo, (Buffalo, NY 14260), Associate Professor
1992-1986	Lamont-Doherty Geological Observatory of Columbia University, Adjunct Research Scientist
1990-1986	Senior Member, Undergraduate College at SUNY at Buffalo
1986-1981	Lamont-Doherty Geological Observatory of Columbia University, Visiting Research Associate
1985-1980	Department of Geological Sciences, SUNY at Buffalo, (Buffalo, NY 14226), Assistant Professor
1980	Lamont-Doherty Geological Observatory of Columbia University, Visiting Professor
1979	Lamont-Doherty Geological Observatory of Columbia University, Research Scientist
1970	Associated Colleges of the Midwest summer school at Colorado College (Colorado Springs, CO), Instructor
1968	Texas Gulf Sulfur, Lee Creek Mine (Aurora, North Carolina), Assistant Geologist

Professional Memberships & Activities

I) Memberships

American Association of Petroleum Geologists
Geological Society of America

II) Activities

A. Honors and awards

2011 Certificate of Appreciation for Leadership Role: AAPG Technology Workshop "Success in the Marcellus and Utica Shales: Case Studies and New Developments"
2009 Certificate of Merit (Eastern Section, AAPG)
2006 Eight Certificates of Merit (Eastern Section, AAPG)
2006 Outstanding Educator Award (Eastern Section, AAPG). The citation reads:
"To an educator whose contribution transcends the classroom. He brings the world to his students and prepares them as a gift to the world"
2002 UB Sustained Achievement Award
1986 Certificate of Award for Distinguished Achievement in the Development of the Undergraduate College (SUNY at Buffalo)

B. International/National panels and offices held

2009-2008 President, ES AAPG
2008-2007 Vice-President, Eastern Section, AAPG
2007-2006 President, NYSGA
2007-2006 Secretary, Eastern Section AAPG
2006 General Chair, Eastern Section AAPG Annual Meeting, Buffalo, NY
2006 General Chair, NYSGA Annual Meeting, Buffalo, NY
2006 Finance, Registration, Publicity/Marketing, Audio-Visual, Website, Hotel Liaison, Logo and Announcement, and Entertainment chairs, Eastern Section, AAPG Annual Meeting, Buffalo, NY
2006-2005 Treasurer, Eastern Section AAPG
2005 NYSERDA proposal review panel
2004 External Evaluator for Brooklyn College Geology Department's 5 year review
2002-2000 President Eastern Section, SEPM
2000-1999 President Geological Society of America, Northeastern Section
1999-1998 Vice-president, Geological Society of America, Northeastern Section
1999-1998 President-elect, Eastern Section, SEPM
1997-1996 Panel member, Atomic Energy Control Board (Canada): Review Panel for Seismic Hazard Assessment
1996 General Co-Chair & Symposia Director, Geol. Soc. Am., Northeast Section Annual Meeting, Buffalo, NY
1986-1979 Member of National Site Assessment Committee (for the subseabed disposal of high-level nuclear waste)

C. Symposia - invited participant (including topic presented)

1. International Workshop on the Geological History of the North Atlantic Border Lands (St. John's, Newfoundland, 1979) (abstract: "Transatlantic correlations of the geology & geophysical anomalies on Europe, Newfoundland, and adjacent continental shelves")

2. Penrose Conference on the Tectonics and Geophysics of the Appalachians (Georgia, 1980) (Trans-Atlantic geological & geophysical correlations)

3. International Colloquium on Quaternary Sedimentary Environments in North Atlantic (Bordeaux, France, 1981) (abstract: "Microphysiography of the southeastern North

Atlantic and its implications for the distribution of near-bottom processes and related sedimentary facies")

4. Melanges: Their Nature, Origin & Significance (Geol. Soc. Am., National Meeting, 1981, Cincinnati, Ohio) (abstract: "Modern submarine sediment slides and their implications for 'melange'")

5. Sub Seabed Disposal of Nuclear Wastes: Site Assessment (Am. Geophys. Un., Nat'l Fall Meeting, 1983, San Francisco, CA) (abstracts: "General geology/geophysics of three 1^{o} x 1^{o} candidate disposal sites for nuclear waste," "Evaluation of the North Pacific subseabed for disposal of high-level nuclear waste")

6. Mylonites and shear zones of the Northern Appalachians Geol. Soc. Am., Northeast Section, 1984, Providence RI) (abstract: "The Salt Harbour mylonite, north-central Newfoundland")

7. Penrose Conference on Melanges of the Appalachian (Newfoundland, 1984) (Modern submarine sediment slides; geologic history of the Dunnage melange)

8. New Developments in Appalachian-Caledonian Geology (GAC, MAC, CSPG Nat'l. Meeting, 1988, St. John's, Canada) (abstract: "Sedimentological, geochemical & structural analyses bearing on the origin of the Dunnage melange")

9. The Role of ODP Drilling in the Investigation of Global Changes in Sea Level (ODP + JO1 sponsored) (1988, El Paso, Texas)

10. Advances in the Geology of Vermont and Adjacent Regions: In Tribute to Norman L. Hatch, Jr. (Geol. Soc. Am., Northeast Section, 1993, Burlington, VT) (abstract: Geochemistry and structure of the Hawley Formation, northwestern Massachusetts)

11. Panel on the subsidence and room closure of the Retsof Salt Mine (Akzo-Nobel Salt Inc., Retsof, NY, (June 9 & 10, 1994) ("Fracture Systems in western New York & the Clarendon-Linden Fault System")

12. Lithotectonic Terranes in the Northern Appalachians (Geol. Soc. Am., Northeast Section, 1995, Cromwell, CT)(abstract: "Geochemical considerations for discrimination of potential terrains in northeastern Appalachians: Hawley Formation and other volcanic units")

13. Special Workshop on Structure and Seismicity in eastern Canada (Geological Survey of Canada and Atomic Energy Control Board, Ottawa, Canada, May 3, 1995) (Structural features on the bed of Lake Ontario and in related areas)

14. Atomic Energy Control Board Workshop on Seismic Hazard Assessment in Southern Ontario(AECB, Ottawa, Canada, June 19-21, 1995) (Abstracts: Clarendon-Linden Fault System)

15. GIS, Geologic Maps and Public Policy (Geol. Soc. Am., Northeast Section, 1996, Buffalo, NY) (Abstract: "Utilization of a GIS (ARC/INFO) for compilation of cultural and geological data in land use considerations: Allegany County, New York State")

16. Fracture and Fault Characterization: Innovative Techniques and Interpretation (Geol. Soc. Am., Northeast Section, 1996, Buffalo, NY) (Abstracts: "Digital Imaging and Analyses of Fractures: Evidence for Appalachian Style Tectonics in the Appalachian Plateau of Western New York"; "Formation of the Regional Systematic Joints in the Appalachian Plateau"; "Utilization of Remote Sensing for Fracture and Fault Characterization: A Case Example from the Clarendon-Linden Fault System in Allegany County, Southwestern New York"; "Detection of the Clarendon-Linden Fault System, Allegany County, New York Using Soil Gas Analyses")

17. Taconic Convergence: Orogen, Foreland Basin, and Cratonic Interactions (Geol. Soc. Am., Northeast Section, 1996, Buffalo, NY)(Abstracts: "The Dolgeville-Indian Castle Contact: The role of Local Tectonic Control on the development of a regional drowning surface"; "The Rowe-Hawley Belt during the Taconic Orogeny")

18. Neotectonics, Subsidence, and Slumping (Geol. Soc. Am., Northeast Section, 1996, Buffalo, NY) (Abstracts: "Character and reactivation history of the Clarendon-Linden Fault System: Evidence from New York State"; "Submersible observations of neotectonic structures and their implications for geologic hazards in the western Lake Ontario Area")

19. Geochemistry and Tectonics in the Northern Appalachians (Geol. Soc. Am., Northeast Section, 1996, Buffalo, NY) (Abstract: "A survey of Ordovician igneous geochemistry in the northeastern Appalachians")

20. Criteria for Differentiating Tectonic from Non-tectonic Faults (Am. Geophys. Un., 1997, Baltimore) (Abstract: "Discrimination of Tectonic & Non-tectonic Faults: A Case Study Involving 11 Integrated Techniques").

21. Penrose Conference on Tectonics of Continental Interiors (9/1998; Brian Head, Utah)

22. Fault Reactivations, Neotectonics, and seismicity in the Great Lakes Region (Nat't Geol. Soc. Am, 1998, Toronto) (Abstracts: "Multiple Reactivations of the Clarendon-Linden Fault System, Western New York"; "A Bedrock Pop-up Field Beneath Lake Ontario, South of Toronto, Ontario"; "Can Palynology be Used to date Seismically -induced Lake bottom Features?"

23. Extensional Basins in the Northeast Appalachians: Stratigraphy, Sedimentology, Tectonics, and Resource Potential (Northeast Section, Geol. Soc. Am., 1999, Providence, RI) (Abstracts: "Magnetics, Gravity, Landsat Lineaments, and Extensional Faults in New York State"; "Paleocurrent orientation and Fault Block Rotation During the Deposition of the Late Middle Ordovician Succession of the Mohawk Valley Region, New York")

24. Fracture Populations, Scaling Laws, and Mechanics of Fracturing (Northeastern Geol. Soc. Am., 2000, New Brunswick, NJ)

25. Appalachian Basin Stratigraphy: Sequences in an Active Tectonic Basin (Northeastern Geol. Soc. Am., 2000, New Brunswick, NJ)

26. NYSERDA 25th Anniversary Energy Technology Expo, (Albany NY 9/19/2000 (Jacobi and Fountain)

27. Basement Geology (Am Assoc. Petroleum Geologists 2000 Eastern Section Annual Mtg, London, ONT, Canada, 9/26/00)

28. IOGA Fall meeting ("Magnetic, gravity and Landsat lineaments in the Appalachian Basin, NYS: groundtruth, faults, and traps"; with an emphasis on the entire state), Buffalo, NY, 11/09/00

29. "Joints and other Discontinuities" (Nat'l Geol. Soc. Am. Mtg., Reno, NV, 11/16/2000)

30. "Rapid and rigorous outcrop fracture mapping and analyses", at Geological Society of Nevada, 2001 Spring Field Conference, Battle Mountain, NV, May 4, 2001

31. "Research Frontiers in Appalachian Geology and Tectonics: An EarthScope Perspective", (Invited participant in the NSF-sponsored workshop) Arlington, Virginia, September 10-11, 2004.

D. Miscellaneous

1980 Co-chief scientist on R/V VEMA cruise V3612 (Northwest Pacific)
1981-1988 Summer field work in Newfoundland (1.5 mos. per year)
1982 Seismic stratigrapher & sedimentologist on DSDP/IPOD leg 86 of GLOMAR CHALLENGER (Northwest Pacific)
1982 Registration Chairman AAPG Eastern Section & NYSGA
1982 Session Co-chairman AAPG Eastern Section
1983 Participating scientist, C.S.S. HUDSON cruise 83-017 (Sea MARC survey of Laurentian Fan)
1984 Participating scientist, C.S.S. HUDSON cruise 84-040 (Sea MARC survey of Laurentian Fan)
1985 Chief Scientist on N/O JEAN CHARCOT (Northwest Pacific)
1986 Session Presider, "Geophysical Measurement Techniques and Their Applications," Am. Geophys. Union, Fall mtg., San Francisco
1987 Session Co-Presider, "Structural Geology I" Geol. So. Am. NE Section, March, Pittsburgh, PA
1988 Session Co-Presider, "Sedimentology & Sedimentary Petrology I," Geol. Soc. Am. NE Section, March, Portland, ME
1988 Participating scientist, R/V W+HS EXPLORER (Lake Ontario)
1989 Participating scientist, CHARLES DARWIN (GLORIA cruise on Magdalena Fan/convergent margin, Colombia)
1994 Participating scientist, R/V EDWIN LINK and submersible CLELIA (submersible dives on anomalous, potentially neotectonic, structures in Lake Ontario)
1994 Team leader for submersible dives off the HMCS CORMORANT on Scotch Bonnet Rise, Lake Ontario
1996 Symposium co-organizer, "Fracture & Fault Characterization: Innovative Techniques and Interpretation": Geol. Soc. Am. NE Section, March, Buffalo, NY
1996 Symposium co-organizer, "Taconic Convergence: Orogen, Foreland Basin & Cratonic Interactions": Geol. Soc. Am. NE Section, March, Buffalo, NY
1996 Co-Instructor for Northeast GSA Short Course entitled: "Contaminant Hydrogeology in Fractured Bedrock"
1997 Team leader for submersible dives off the HMCS Cormorant
1998 Symposium lead co-organizer, "Fault Reactivations, Neotectonics, and Seismicity in the Great Lakes Region (Nat't Geol. Soc. Am, Toronto)

1999 Symposium co-organizer, "Extensional Basins in the Northeast Appalachians: Stratigraphy, Sedimentology, Tectonics, and Resource Potential (Northeast Section, Geol. Soc. Am., Providence, RI)

2000 Symposium and Theme sessions co-convenor, "Appalachian Basin Stratigraphy: Sequences in an Active Tectonic Basin (Northeastern Geol. Soc. Am., New Brunswick, NJ)

2000 Symposium co-organizer and co-convenor "Joints and other Discontinuities" (Nat'l Geol. Soc. Am. Mtg., Reno, NV, Nov. 16, 2000)

1997-2002 Co-editor of "Taconic Convergence, Orogen, Foreland Basin, and Craton" (with Dr. Mitchell), published by: Physics and Chemistry of the Earth, v. 27, n.1-3, 288 pp.

2000-2002 Co-editor of "Neotectonics in the Eastern Great Lakes Basin" (with Drs. Fakundiny and Lewis), to be published by Tectonophysics.

2002 Symposium co-organizer, "Fractures, lineaments, and Implications for Fluid Flow" (Northeast Section, Geol. Soc. Am., Springfield MA)

2004 (July) IOGA Panel Discussion Leader (one of three on the panel). Summer IOGA meeting Peek 'n Peak Resort (NY)

2006 Eastern Section AAPG Short Course (with Dr. Gerald Smith): "Tectonic Evolution of the Faulted Northern Appalachian Basin and its Influence on the Development of Clastic, Hydrothermal and Fracture Reservoirs" (Eastern Section AAPG Meeting, Buffalo, NY, October 11, 2006)

2006 Short Course: Plate Tectonics and the Tectonic Evolution of the Northern Appalachian Basin and its Influence on the Development of Clastic, Hydrothermal and Fracture Reservoirs" (Talisman Energy, Calgary, Canada, December 12, 2006) 2006 Short Course: Plate Tectonics and the Tectonic Evolution of the Northern Appalachian Basin and its Influence on the Development of Clastic, Hydrothermal and Fracture Reservoirs" (Talisman Energy, Calgary, Canada, December 12, 2006)

2006 Talisman, Calgary, Canada, All day seminar entitled "An Integrated Approach to the Geodynamics of the Appalachian Orogen and the Appalachian Basin"

2007 Talisman, Calgary, Canada, Half day seminar entitled "Part I: The Taconic Orogeny and Reservoir Development in the Northern Appalachian Basin", "Part II: Lineaments, aeromagnetics and CAI"

2010 AAPG Webinar: Marcellus and Utica in the Field: Looking at Faults, Fractures and Folds that Affect the Sedimentary Units of the Northern Appalachian Basin

2010-2011 Joint AAPG-UB week-long field seminar: Northern Appalachian Basin Faults, Fractures and Tectonics and Their Effects on the Utica, Geneseo and MarcellusBlack Shales:

F. Invited Lectures

1. Rutgers University (New Brunswick campus) (May, 1981)
2. Institute of Ocean Studies (Wormley, Great Britain, September, 1981)
3. Western New York Science Forum (November, 1981)
4. Lamont-Doherty Geological Observatory (November, 1981)
5. University of Rochester (March, 1983)
6. SUNY College at Fredonia (April, 1983)
7. University of Waterloo (Ontario) (February, 1984)
8. Rutgers University (Newark Campus) (March, 1984)
9. McMaster University (Ontario) (November, 1986)
10. Western New York Science Forum (November, 1986)
11. Northwestern University (Ill.) (May, 1987)
12. Allegany County Legislature (November, 1989)
13. NYS Low Level Waste Group (NYSLLWG) (April, 1990)

14. U.B. Council (May, 1990)
15. Buffalo Association of Professional Geologists (BAPG) (October, 1990)
16. National Center for Earthquake Engineering Research (NCEER) (Buffalo, NY) (April, 1991)
17. Alfred University (February, 1992)
18. University of Waterloo (Ontario) (February, 1992)
19. Middlebury College (March, 1993)
20. Buffalo Society of Natural Sciences (November, 1993)
21. Akzo-Nobel Salt Inc. (Retsof, NY) (January, 1995)
22. University of Pittsburgh (April, 1995)
23. Western New York Science Forum (November, 1995)
24. Science Alumni Association (February, 1997)
25. Independent Oil & Gas Association of New York (September, 1997)
26. Project Impact (Buffalo, NY; Jan., 1999)
27. Ohio Geological Society (Columbus, Ohio; April, 1999)
28. Regents Earth Science Teachers of Western New York (April, 1999)
29. Disaster Preparedness Advisory Board (Buffalo, May, 1999)
30. SUNY College at Geneseo (Geneseo, NY, November, 1999)
31. University of Cincinnati (Cincinnati, OH, April, 2001)
32. Wooster College (Wooster, OH; April 17, 2003)
33. SUNY College at Buffalo (Buffalo, NY; May 1, 2003
34. Upstate New York Business Continuity Planners (UNYBCP), (Buffalo, NY; Sept. 28, 2005): Seismicity and Faults
35. Library Foundation of Buffalo and Erie County (Central Buffalo Library): "Faults and Seismicity in New York" (part of the Map that Changed the World celebration)
36. Pittsburgh Association of Petroleum Geologists (Ramada Greentree, PA [Pittsburgh], November 17, 2005)
37. Central New York Earth Sciences Student Symposium (Syracuse, NY, April 28, 2006): keynote address
38. Cornell University (Ithaca, NY, November 1, 2006)
39. BAPG (Buffalo Association of Professional Geologists) (Buffalo, NY, November 15, 2006)
40. Talisman, Calgary, Canada, December, 2006. All day seminar entitled "An Integrated Approach to the Geodynamics of the Appalachian Orogen and the Appalachian Basin"
41. Talisman, Calgary, Canada, December, 2007. Half day seminar entitled "Part I: The Taconic Orogeny and Reservoir Development in the Northern Appalachian Basin", "Part II: Lineaments, aeromagnetics and CAI"
42. Colgate University , December 1, 2009
43. Western New York Science and Technology Forum, Horizons of the Sciences, December 1, 2010
44. Mohawk Hudson Valley Professional Geologists' Association: Faults in the Appalachian Basin of NYS and their Significance, Nov 16, 2011

University Service

Senior Member, Undergraduate College, SUNY at Buffalo (1986-1990)
Curriculum Committee, member (1986-1989)
Feminist and Minorities Viewpoint Committee, member (1986-1987)
Resources Committee, member (1986-1987)
Faculty Senate, alternate (1980-1981, 1984-1986, 1999)
Faculty Senate, member (1982-1984)

DUE Committee on Degree Requirements - member (1981-1982)
Rehabilitation Act Commission (Section 504) - Department Resource (1981-present)
Science & Engineering Library Director Search Committee, member, (1989)
CAS Dean Search Committee member (1997-1998)
Associate Provost Search Committee (2004-2005)
Faculty Senate Governance Committee (for the review of upper administration, 2005-present)

Faculty Service

FNSM Directors of Undergraduate Studies Committee (1983-1986, 1996)
Early Acceptance Committee, member (1988)
Computer Committee, member (1989)
SEL Advisory Committee (1995-2002)
CAS Divisional Committee (1998-2000, 2004-2006)
CAS Policy Committee (1999-present), Chair (2002-2004)
CAS Policy Steering Committee (1999-2006), Chair (2002-2004)
CAS Library Committee (2006-2007)
Beautification Committee (2004)

Departmental Service

Department Executive Committee (1983-1986)
Department Undergraduate Studies Committee, Member (1982-1983, 1987-1989, 1992-1994)
Department Undergraduate Studies Committee, Director (1983-1986, 1994-present)
Department Graduate Studies Committee, Member (1989-1992, 1996-1998, 2002-present)
Department Graduate Studies Committee, Chair (1998-2000, 2004-2005)
Friday-noon Seminars Organizer (1980-1985)
Ad Hoc Committee on Teaching Assessment and Improvement, Member (1984-1987)
Undergraduate Curriculum Review Ad Hoc Committee, Chairperson (1983-1987)
Department Awards Committee, member (1986-1992, 1999), Chairperson (1991-1992)
Department Liaison, SEL (1986-present)
Department 5-year Planning Committee (1986-1990)
Department Chairperson Search Committee, member (1989-1990)
Futures Committee, member (1991-1997)
Pegrum Seminar Series (chairperson, 1993, 1994, 1995, 1996, 1997, 1998)
Search Committees for both Structure and Geophysics personnel, chair
Ad hoc Committee on Undergraduate Involvement in Research, Member (1999-2000)
Search Committee for Remote Sensing personnel, chair
Director, Sloan Professional Science master's degree program in the Geological Sciences (2003-present)
Tenure Committee Chair for Matt Becker (2004)
Tenure Committee Member/advocate for Greg Baker (2004)
Search Committee member (2004-2005, 2005-2006, 2006-2007)
Interim Chair Jan-June, 2005

Courses Taught

SEMESTER LIST OF COURSES AND ENROLLMENTS

Semester	Course	Title	Credit Hours	Enrmt.
Spring 1980	GLY 208	Stratigraphy and Sedimentation	4	33
	GLY 539	Sedimentation	4	16
Fall 1980	GLY 524	Sedimentary Petrology	4	14

SEMESTER LIST OF COURSES AND ENROLLMENTS

Semester	Course	Title	Credit Hours	Enrmt.
	GLY 537	Advanced Stratigraphy	4	15
Spring 1981	GLY 208	Stratigraphy and Sedimentation	4	24
	GLY 590	Appalachian Geology Seminar	2	14
Summer 1981	GLY 407	Geologic Field Training (Shared Teaching)	6	45
Fall 1981	GLY 537	Advanced Stratigraphy	4	15
	GLY 539	Sedimentation	4	6
Spring 1982	GLY 208	Stratigraphy and Sedimentation	4	62
	GLY 590	Appalachian Geology Seminar	2	4
Fall 1982	GLY 537	Advanced Stratigraphy	4	13
	GLY 590	Advanced Geology Seminar	2	7
Spring 1983	GLY 318	Stratigraphy	4	63
	GLY 443/543	Marine Geology	4	6/7
Fall 1983	GLY 537	Advanced Stratigraphy	4	16
	GLY 590	Appalachian Geology Seminar	2	9
Spring 1984	GLY 318	Stratigraphy and Sedimentation	4	44
	GLY 443/543	Marine Geology	4	10/18
	GLY 596	Critical Issues Seminar	1	8
Summer 1984	GLY 407	Geologic Field Training (Shared Teaching)	6	57
Fall 1984	GLY 537	Principles of Stratigraphy	4	8
	GLY 442/542	Tectonics	3	4/5
	GLY 596	Critical Issues Seminar	1	8
Spring 1985	GLY 318	Stratigraphy & Sedimentation	4	30
	GLY 443/543	Marine Geology	4	5/7
	GLY 596	Critical Issues in Geology	1	12
Fall 1985	GLY 325	Structural Geology	4	20
	GLY 442/542	Tectonics	3	7/8
	GLY 596	Critical Issues in Geology	1	9
Spring 1986	GLY 318	Stratigraphy & Sedimentation	4	21
	GLY 443/543	Marine Geology	4	4/5
	GLY 596	Critical Issues in Geology	1	9
Fall 1986	Sabbatical			
Spring 1987	Sabbatical			
Fall 1987	GLY 199	Ribs of the Earth	3	20
	GLY 537	Principles of Stratigraphy	4	11
Spring 1988	GLY 318	Stratigraphy and Sedimentology	4	10
	GLY 443/543	Marine Geology	4	3/5
	GLY 596	Issues in Geology	1	6
Fall 1988	GLY 510	Advanced Field Geology	3	9
Spring 1989	GLY 318	Stratigraphy and Sedimentology	4	16
	GLY 443/543	Marine Geology	4	0/4
	GLY 480/580	Geol. Evol. of North America	4	4/7
	GLY 596	Critical Issues in Geology	1	6
Fall 1989	GLY 539	Sedimentology	4	6
Spring 1990	GLY 318	Stratigraphy & Sedimentology	4	23
	GLY 480/580	Geol. Evol. of North America	4	9/1
	GLY 537	Principles of Stratigraphy	4	5
Fall 1990	GLY 510	Advanced Field Geology with Fountain	3	5
	GLY 596	Critical Issues in Geology	1	4
Spring 1991	GLY 318	Stratigraphy & Sedimentology	4	13
Fall 1991	GLY 510	Advanced Field Geology with Fountain	3	7

SEMESTER LIST OF COURSES AND ENROLLMENTS

Semester	Course	Title	Credit Hours	Enrmt.
Spring 1992	GLY 318	Stratigraphy & Sedimentology	3	22
	GLY 480/580	Geol. Evol. of North America (JCF & CEM)	3	6/7
	GLY 597	Advanced Geology Sem. – Fault Systems	1-3	5
Fall 1992	GLY 597	Fault Systems Seminar	1	4
Spring 1993	GLY 318	Sedimentology	3	21
	GLY 480/580	Geologic Evolution of North America	3	6/4
Fall 1993	GLY 597	Fault Systems	1-4	5
	GLY 633	Graduate Research	1-12	1
	GLY 700	Thesis Guidance	1-12	3
Spring 1994	Sabbatical			
Fall 1994	GLY 597	Marine Depositional Systems	1-3	12
	GLY 633	Graduate Research	1-12	3
	GLY 700	Thesis Guidance	1-12	8
Spring 1995	GLY 318	Sedimentology	3	21
	GLY 480/580	Geologic Evolution of North America	3	14/4
	GLY 499	Independent Study	1	1
	GLY 633	Graduate Research	1-12	1
	GLY 700	Thesis Guidance	1-12	7
Fall 1995	GLY 539	Sedimentology	3	13
Spring 1996	GLY 318	Stratigraphy & Sedimentology	3	30
	GLY 480/580	Geol. Evol. N. A. (w/CEM)	3	7/1
Fall 1996	GLY 537	Stratigraphy	4	7
	GLY 700	Thesis Guidance	1-12	6
Spring 1997	GLY 318	Sedimentology	3	22
	GLY 480/580	Evolution of North America	3	14/4
	GLY 597	Fault Systems	1-3	4
	GLY 633	Graduate Research	1-12	1
	GLY 700	Thesis Guidance	1-12	4
Fall 1997	GLY 318	Sedimentology	3	15
	GLY 480/580	Geologic Evolution of North America	3	7/3
	GLY 499	Independent Study	3	1
	GLY 526	Geology for Graduate Students	1-3	2
	GLY 633	Graduate Research	1-12	1
Spring 1998	GLY 499	Independent Study	2-3	3
	GLY 539	Advanced Sedimentology	3	12
Fall 1998	GLY 215	Soft Rock I (2/3's of the term)	3	12
	GLY 215	Soft Rock I Lab (2/3's of the term)	1	12
	GLY 325	Struc/Geophys/Tectonics I(2/3's of the term)	3	10
	GLY 325	Str/Geo/Tec Lab (2/3's of the term)	1	10
	GLY 597	Fault Systems (seminar)	1	14
	GLY 499	Independent Study	1-3	1
Spring 1999	GLY 326	Struc/Geophys/Tectonics II (2/3's of the term)	3	7
	GLY 600	Fault Systems (seminar)	1	4
	GLY 499	Independent Study	1	1
Fall 2000	GLY 597	Advanced Geology Seminar	1	6
Spring 2001		**SABBATICAL**		
Fall 2001	GLY 215	Soft Rocks 1	3	20
Spring 2002	GLY480/580	Geologic Evolution of NA part I	3	2/13
Fall 2003	GLY478/578	Advanced Field Methods	3	4/2

SEMESTER LIST OF COURSES AND ENROLLMENTS

Semester	Course	Title	Credit Hours	Enrmt.
		(Structure/fractures)		
	GLY 596	Advanced Studies of fractures	1	7
Spring 2004	GLY 326	Structure-Geophysics-Tectonics II	3	21
	GLY480/580	Geologic Evolution of NA part I	3	5/6
	GLY 596	Advanced Studies of fractures	1	6
Fall 2004	GLY 215	Strat-sed-paleo I	3	26
	GLY478/578	Advance field methods (overload)	3	2/3
	GLY 596	Advanced Studs	1	7
Spring 2005	GLY 596	Advanced Studs	1	4
Fall 2006	GLY 215	Soft Rocks 1	3	26
	GLY 596	Advanced Studs	1	5
Spring 2006	GLY480/580	Evolution of NA (part I)	3	14
	GLY 596	Advanced Studs	1	2
Fall 2006	GLY 215	Soft Rocks 1	3	
	GLY 596	Advanced Studs	1	
Spring 2007		Medical leave		
Fall 2009	GLY 578	Advanced Field Methods	3	5
Fall 2011	GLY 596	Advanced Studs—Appal plate tectonics	1	3
Fall 2011	GLY 478/578	Advanced Field Methods	3	4/2
Fall 2011	GLY 499	Independent Study	1	1
Spring 2012	GLY 596	Advanced Studs—Appal fractures and faults	1	5

Research Supervision

I) Major Thesis Advisor

a) Completed Theses

Student, Defense Date	Thesis Title
Ritter (M.A.), 3/14/83	Anomalous deformation of the Dolgeville facies, central New York State
Oleynek (M.A.), 3/21/83	Cornulitids in the Hamilton Group of western New York
Wasowski (M.A.), 4/19/83	Sedimentary & tectonic history of the north-eastern portion of the Dunnage melange & surrounding units, Newfoundland
Vassallo (M.A.), 4/22/83	Bottom reflectivity, microphysiography and their implications for near-bottom sedimentation processes, western North Atlantic
Janish (M.A.), 5/6/83	Nature, origin, & significance of the Cheneyville Formation, north-central Newfoundland
Kloc (M.A.), 5/9/83	Stratigraphic distribution of Ammonoids from the Middle Devonian Ludlowville Formation in New York

Fargo (M.A.), 12/12/85	The stratigraphy, structure & tectonic significance of the Campbellton Sequence & associated rock units, north central Newfoundland
Talkiewicz (M.A.), 4/24/86	A petrographic analysis of the Martinsburg Formation, north central New Jersey - An insight into the tectonic setting
Koslosky (M.A.), 5/9/86	Analysis of folding in the middle Ordovician foredeep facies of central New York and eastern Pennsylvania
Kommeth (M.A.), 5/16/86	An examination of the fabric of modern submarine sediment slides using a scanning electron microscope
Wasowski (Ph.D.), 10/24/86	Geology and plate tectonic significance of rock units in the New Bay - Bay of Exploits area, north central Newfoundland
Arnold (M.A.), 12/2/86	Seafloor echo character and geologic history of survey site E_2, the type locality for deep sea red clay deposition, Northwest Pacific
Burkett (M.A.), 1987	Volcanic ash layers in the northwest Pacific: size analysis and explosive history
Erb (M.A.), 10/14/87	An investigation of DSDP Leg 86 ash layers bearing on stratigraphy and volcanic history of the Northwest Pacific
Ranger (M.A.), 4/21/88	Implications of a petrographic analysis of sandstone clasts within the Dunnage Formation, Newfoundland
Gutmann (M.A.), 4/21/89	Upper Devonian turbidites in the South Wales shale member of the Perrysburg Formation
Scheuing (M.A.), 2/1/90	Structural & geochemical studies in complexly deformed terranes, Notre Dame Bay, Newfoundland
Piechocki (M.A.), 4/30/90	The Nunda Sandstone Member of the West Falls Formation: A possible submarine sand lobe
Kim (Ph.D.), 9/8/95	Tectonic Evolution of the Hawley Formation, Northwestern Massachusetts
Zhao (Ph.D.), 5/25/97	Analyses of Multiple Faults Systems: An Example from the Appalachian Plateau of Western New York State
Smith (Ph.D.), 5/19/97	Stratigraphic analyses of Northern and Central Allegany County, New York: Evidence of Sea Level Change, depositional Environments and Faulting
Bechtel (MA), 2/1/98	Major Element Geochemical Correlation of Sandstones in the Devonian Catskill Delta Complex of Allegany County New York: A Test Case

Peters (MA), 4/22/98	Geologic Mapping of the Rawson 7.5' Quadrangle in New York State: Characterization of Multiple Fault Systems
Zack (MA), 7/30/98	Geologic Mapping of the Freedom 7 1/2' Topographical Quadrangle in Southwestern New York State
Xu (PhD), 8/6/98	Geometrical Characterization of fracture Networks: Core and Borehole Fracture Surveys, Density Calculation and Spatial Structural Analyses.
Reay (MA), 12/7/00	Geologic Mapping of the Pike 7.7' Quadrangle in Wyoming and Allegany Counties, New York: Evidence for the Southern Extension of the Clarendon-Linden Fault System
Harper (MA), 1/17/01	Fracture Analysis in Five 7.5' Quadrangles on the Southwest Shore of Lake Ontario: Implications for an Extension of the St. Lawrence rift System Through Lake Ontario.
Guidetti (Tober), 2/1/2002	Structural geology and fracture spacing trends in the Ashford Hollow 7.5' Quadrangle, New York State: Implications for the Bass Island trend and north-striking lineaments
Baudo (MA) May 2002	1-D fractal, geostatistical, and abutting analyses of fractures along a 4 km scanline
Witmer (MS), 4/29/04	Fractures, lineaments and faults: Structural geology of the Collins Center 7.5' Quadrangle, New York State
Cross (MS), 4/29/04	Fault-related fracturing and mineralization in the Mohawk Valley, eastern New York State
Lugert (MS), 3/22/2005	Fractures and their relation to other geological data sets along the southeastern shore of Seneca Lake, New York State: Implications for fault systems in the Appalachian Plateau
Cruz (MS), 5/6/2005	Satellite image enhancements, lineament identification and quantitative comparison with fracture data, central New York State
Terech (MS), 1/19/2006	Fracture Patterns, Lineaments and Seismic Reflection Data: Integration for Fault Mapping in the Appalachian Basin of East-Central New York State."
Blood (MS), 12/8/06	The Burial, Thermal maturation, and Fracture History of the Upper Devonian Rhinestreet Shale, Western New York State

Ahmed (MS), 1/19/07	Geologic Controls and reservoir Characterization of Bradley Brook Field; Madison County, New York
McGuire (MS), 4/30/07	Fracture, Lineament, and Seismic Data: Indication of Fault Patterns in the Appalachian Basin in East-central New York State
Agle (PhD)	Faulting in eastern NYS (Mohawk Valley)
Hansen (MS) 2010	Structure and vein isotopic signatures of a Cambro-Ordovician 360M core from Saratoga Springs region, New York State: Implications for tectonics, gas exploration, and CO2 sequestration
Zelazny (MS) 5/10/2011	Lineament mapping in central New York State using remote sensing techniques for CO2 sequestration (joint with Dr. Csatho)

b) <u>In Progress Theses</u>

Jodi Seever (MS)	Fracturing, lineaments, and CO2 sequestration in eastern NYS
Mike LaGamba	Marcellus fractures
Alex OHara	Utica fractures

II) Thesis Committee Member

a) <u>Completed Ph.D. Theses</u>

1) SUNYAB

1984 DeRito	"Geothermal influences on the long-term thickness of the mechanical lithosphere during flexure"
1986 Lowell	"Late Wisconsin stratigraphy, Ice flow and deglaciation; northwestern Maine"
1990 Waddell	"Petrogenesis of the Virginia Dale Complex, Colorado - Wyoming"
1992 Wiles	"Holocene glaciation of the southern Kenai Mountains, Alaska"
1997 Lee	"Use of Surfactant for Remediation of Organic Pollutants in the Unsaturated Zone"
1998 Barclay	"Tree-Ring and Glacial Records of Holocene Climate Change, Northern Gulf of Alaska Region"
2001 Joy	"Chronostratigraphy and the sequence hierarchy of the Late Turonian through early Edenian (Ordovician) Taconic foreland in New York and central Pennsylvania: Implications for active margin basin evolution"

2001 Bergslien "Effect of Changes in wettability on non-aqueous phase liquid (NAPL) flow in single natural fractures"

2003 Jordan "Amplitude and Phase variation with offset (APVO) analysis of ground penetrating radar data"

2) Columbia University

1984 Farre "The importance of mass wasting processes on the continental slope" (replacement for Prof. Hollister, Dean; Woods Hole Oceanographic Institute)

c) Completed M.A. Theses

1980

Lorenz "A petrological & geochemical study of the South Lake Igneous Complex, Newfoundland"

1981

Al-habash "A reconnaissance analysis of organic material, uranium, thorium and other source elements in black shale of western New York"

Datondji "The mechanical evolution of the Williston Basin"

1982

Diringer "Subsurface configuration of the Bottle Lake Complex & Center Pond pluton, east-central Maine"

Hendry "Gravity study of subsurface geologic basement & crustal structures in the central Appalachian Rome Trough region, West Virginia"

Klein "Attachment and epizones of Cystiphylloides sp. in the Spinatrypa spinosa bed of the Windom shale of western New York"

Lemmon "Gravity, magnetics, & structure of the central Appalachian plateau region, northern West Virginia"

Molnar "Correlation of thermal conductivity with physical properties obtained from geological well logs"

1983

Barnum "1-D synthetic seismogram analysis of seismic anomalies in the Lockport Formation, Allegany County, New York"

Becker "Late Wisconsin stratigraphy, upper St. John River, northwestern Maine"

DeRito "The significance & thermal dependence of the thickness of the mechanical lithosphere during flexure"

Studley	"The distribution of heat producing elements in the Mt. Waldo pluton, south-central Maine"
1984	
Awosika	"Geophysical interpretation of magnetic data from the northeastern United States and adjoining part of Canada"
DeVincenzo	"Gravitational & stratigraphic analysis of Orange Dome, Texas"
Eckert	"Spatial domain filtering of the Bouguer gravity of northeastern North America"
Lamb	"Geomorphology of the Upper Kurupa River Valley System, Brooks Range, Alaska"
1985	
Dull	"Evaluation of acid treatments and paraffin control techniques in Bass Island Trend oil reservoirs"
Hetherly	"Joint orientations and their relationships to structures and lithologies of the rocks between Fine & Edwards, New York"
1986	
Borkland	"Mechanisms of Emplacement of Middle Mountain Laccolithic Complex, La Sal Mountains, Utah"
Brady	"Porosity and diagenetic sequence of the whirlpool sandstone"
Campbell	"The effect of organic fluids on fabric and behavior of clays"
Williams	"Environmental and reservoir mapping trends of the lower Silurian Medina Group, northwestern Warren County, Pennsylvania"
1990	
Hasiotis	"Paleontology, Ichnology, and Paleoecology of the Upper Triassic Chinle Formation of the Canyonlands, Southeastern Utah"
Smith	"Glacial Stratigraphy of Niagara County, New York"
1991	
Schaper	"The Hydrogeology and the Mineralogy of the Unconsolidated Sediments Surrounding the CID Landfill"
Whitford	"A Survey of Periglacial and Glacial Landforms, Kigluaik Mountains Area, Alaska"
1992	
Goldman	"Taxonomy, Evolution, and Biostratigraphy of the Orthograptus Quadrimucronatus"
Peck	"Relative Dating and Morphometry of Moraines and Cirques in the Kigluaik Mountains, Seward Peninsula, Alaska"

Tollerton	"Comparative Ontogeny of Eurypterus Remipes Dekay, 1825 and Eurypterus Lacustris Harlan, 1934"
1995	
Luttinger	"Seismic Investigations of the Upper Minnelusa Formation, Powder River Basin, Wyoming"
1996 Kurbatov	"Investigation of the May 18, 1980, Blast Surge Deposit at Mount St. Helens Volcano, USA"
1997	
Hegarty	"The Use of Soil Gas for the Study of Subsidence in the Cuylerville, NY Area"
Cohen	"Measurement and Analysis of Aperture Distributions in Fractures"
Park	"The Effect of Mechanical Interaction on the Scaling of Fracture Aperture"
1998	
Pefley	"Borehole Stratigraphy of the Middle Reach, Preglacial Allegheny River Trough, Southwestern New York"
Paquette	"The use of Soil Gas Analyses for the Evaluation of Potential Gas Leakage from a Petroleum Storage Facility"
2001	
Hart	"Characterization of Aquifer vulnerability using Drastic and GIS for the Olean Creek watershed, Cattaraugus County, New York"
Budny	"An innovative method for ascertaining tortuosities in dry and moist porous media and the delineation of tectonic structures using soil gas in southern Seneca and northern Schuyler counties, New York"
Nelson	"The use of soil gas surveys to delineate deep structure: cross-strike discontinuity locations for Cherry Creek, Perrysburg, Gowanda, and Collins Center quadrangles, Bass Island Trend, western New York State"
2002	
Evenick	
Gates	"Analysis of graptolite population structure preserved within the Indian Castle Shale (Middle-Upper Ordovician): western Mohawk Valley, New York State"
Healy	"Analysis of fracture frequency in bedrock core and its relation to the conceptual hydrogeologic model at Hooker Hyde Park National Priority Site (Hyde Park Landfill), Niagara County, New York State"
2003	
Saunders	"Integrating multiple geophysical methods to characterize depth to bedrock and subsurface stratigraphy in a buried glacial valley: Ischua Valley, Cattaraugus County, New York"

Mayer	"Azimuthal resistivity analysis using a capacitively-coupled resistivity meter for the determination of hydrologic parameters
2005	
Talley	"Imaging channelized flow in fractured bedrock using surface ground penetrating radar"
Dosen	"Mineralogical analysis of Upper Devonian Black shales in western New York"

III) Undergraduate research advisor (independent study)

		Semester Hours
Fall 1980	Walsh	3
Fall 1981	Kamber	3
Spring 1982	Kamber	3
Fall 1983	Burkett	3
	Herrenkohl	1
Spring 1984	Arnold	3
	Burkett	3
	Dorsch	2
	Herrenkohl	3
	Klenk	2
	Pockalny	3
Fall 1984	Giese	3
	Klenk	3
	Scheuing	3
Spring 1985	Frappa	3
	Giese	3
	Klenk	3
	Scheuing	2
Fall 1985	Klenk	3
Spring 1986	Razik	2
	Schaper	2
Fall 1999	Lugert	2

RESEARCH/INSTRUCTIONAL GRANTS

1) SUNY at Buffalo

Title	Year	Granting Agency	Principal Investigator	Amount
Sediment Laboratory	1981	SUNYAB Institutional Funds	Jacobi	$3,600
Northwest Pacific	1981-82	Columbia University	Jacobi	$1,000
Newfoundland	1981-82	SUNY Research Foundation	Jacobi	$6,250
Geologic Hazards	1982	Columbia University	Jacobi	$8,668

Northwest Pacific	1982	Scripps Inst. of Oceanography	Jacobi	$5,764
Instr. Innovation Award "Marine Geology"	1982	SUNYAB Institutional Funds	Jacobi	$1,850
Volcanic Ash in the NW Pacific	1982-83	SUNY Research Foundation	Jacobi	$5,904
Scaly Cleavage	1983-85	ACS Petroleum. Res. Fund	Jacobi	$15,000
Laurentian Fan	1984	Columbia University	Jacobi	$3,249
Sea MARC study	1985	Sandia National Laboratories	Jacobi	$43,501
NW Pacific seabed echo character - Site E_2	1986-88		Jacobi	$147,446
Ancient Seamounts in Newfoundland	1986	SUNY Research Foundation	Jacobi	$5,750
Geochemistry of the Hawley Fm., W. Mass.	1987-88	SUNY Research Foundation Fountain, co-PI	Jacobi, P. D.	$2,700
Clarendon-Linden Fault System	1989	NCEER	Jacobi, P.D.& Fountain, co-PI	$3,285
Clarendon-Linden Fault System	1989	Allegany Co. Soil & Water Conservation District	Jacobi, P.D.& Fountain, co-PI	$8,832
Turbidite Deposition	1989-92	NSF	Jacobi	$60,260
The Rowe-Hawley Belt	1990	SUNY Research Foundation	Jacobi, P.D.& Fountain, co-PI	$3,660
Clarendon-Linden Fault System	1991-96	NYSERDA	Jacobi, P.D.& Fountain, co-PI	$842,000
Pilot Project, Akzo Salt	1994-95	Akzo Salt	Jacobi & Fountain	$8,500
Surface Bedrock Structure & Stratigraphic Survey	1994-96	Akzo-Nobel Salt	Jacobi	$49,678
Surface Bedrock Structure Survey of the New Mine Site	1994-96	Akzo-Nobel Salt	Jacobi	$28,936.
Structure & Lineament Analysis in the Cuylerville Region	1994-96	Akzo-Nobel Salt	Jacobi	$68,239
Fracture Analyses of Video Images from Wells	1995-96	Akzo-Nobel Salt	Jacobi	$20,995

1996 EDMAP Element of the National Cooperative Geologic Mapping Program	1996-97	US Dept. of the Interior	Jacobi	$20,000
Maps of Multiple Fault Systems	1997-98	USGS	Jacobi	$12,000
Angelica Quadrangle	1997-98	USGS & NYSGS	Jacobi	$10,705
Sequence Stratigraphy	1997-98	ACS Petroleum Res. Fund	Mitchell, PD & Jacobi co-PI	$47,606
Integrating High Resolution Hyperspectral Remote Sensing Data	1998	NYSERDA	Jacobi, PD & Fountain, co-PI.	$49,998
Demonstration of An Exploration Technique	1998-99	NYSERDA	Jacobi, PD. & Fountain, co-PI	$49,896
7.5 Quad: Collins Center	1998-99	USGS	Jacobi	$8,000
7.5 Quad: Gowanda	1998-99	USGS	Jacobi	$8,000
Farmersville Faults	1998	NY Planning	Jacobi	$2,750
Federation Finger Lakes Prospects	1998-99	NYSERDA	Jacobi	$75,000
Ashford Hollow Quad	1999-00	USGS	Jacobi	$13,000
Millenium Project	1999	NYSERDA+Millenium	Jacobi	$30,956
Cayuga Prospect	2000-01	NYSERDA	Jacobi	$75,000
West Valley Quad	2000-01	USGS+NYSGS	Jacobi	$16,000
Fault Demonstration	2000-02	DOE	Jacobi, PD+	$827,505
Trenton/Black River, WNYS	2001-02	NYSERDA	Jacobi, PD+ Fountain, coPI	$99,999
Sequence Strat Analysis	2001-2002	NYSERDA	Smith, PD+ Jacobi, co PI	$25,015
Seismographs	2002-04	FEMA	Jacobi, PD+ Fountain, CoPI	$80,000
Lineaments/Faults in WNY	2002-03	NYSERDA	Jacobi	$25,000
Delevan Quad faults	2002-03	NYSGS	Jacobi	$16,000

Satellite Hyperspectral Data	2002	NYSERDA	Jacobi	$15,000
Chenango County	2002-03	NYSERDA	Jacobi	$199,998
Ellicottville Quad faults	2003	NYSGS (USGS)	Jacobi	$17,119
Little Falls Quad faults	2004	NYSGS (USGS)	Jacobi	$18,000
Mohawk Vlly fracs and veins	04	NYSERDA	Jacobi	$50,000
Devonian Sand Architecture	05-06	NYSERDA	Smith (PD)+ Jacobi(coPI)	$59,824
Technology Transfer	06	NYSERDA	Jacobi	$40,436
Innovative Methodology Phase II additional funds:	06	DOE	Jacobi	$84,000
CO2 Sequestration	08-11	NYSERDA & Industrial Associates	Jacobi	$708,795
CO2 fractures	11-12	NYSERDA/DOE	Jacobi	$100,000

2) Lamont-Doherty Geological Observatory of Columbia University

1. "Analysis of Geological and Geophysical Data in Selected Areas of the North Pacific and Site Surveys Aboard R/V VEMA in the PAC 1 Area", Oct. 1, 1979 – Sept. 30, 1980
   Funding Agency: SANDIA Laboratories, Albuquerque, NM
   Total Amount of Award: $419,027

   Relationship to Contract: one of four (5 months salary, investigating sea pay, computer scientists costs & trips to Guam, Japan, Hawaii & west coast) = $19,700; about $250,000 was for shiptime of which R. D. Jacobi was co-chief scientist

2. "Analysis of Geological and Geophysical Data in Selected Areas of the North Pacific and Site Surveys Aboard R/V VEMA in the PAC 1 Area", Oct. 1, 1980 –Sept. 30, 1981
   Funding Agency: SANDIA Laboratories, Albuquerque, NM
   Total Amount of Award: $134,988

   Relationship to Contract: one of four (3 months salary, investigating computer charges, scientists trips to WHOI & west coast =$11,637)

3. "Synthesis of Marine Geophysical and Geological Data: OMD Geographic Area XI Morocco Continental Margin", Oct. 1, 1980 –Sept. 30, 1982
   Funding Agency: Joint Oceanographic Institutions, Inc.
   Total Amount of Award: $217,889 (including $68,034 supplement)

   Relationship to Contract: one of six co- (1 month salary, investigators computer charges, In original trip to work at proposal WHOI = $5,000)

4. "Analysis of Geological and Geophysical Data in Selected Areas of the North Pacific and Site Surveys Aboard R/V VEMA in the PAC 1 Area", Oct. 1, 1981 – Sept. 30, 1982
Funding Agency: SANDIA Laboratories, Albuquerque, NM
Total Amount of Award: $95,988

Relationship to Contract: one of four (2 mos. salary, investigators computer charges, Xerox/photo reproduction charges, trip to west coast & WHOI =$9,400)

5. "Analysis and Publication of Geological and Geophysical Site Characterization Data in Selected Areas of the North Pacific", Oct. 1, 1982 – Sept. 30, 1983
Funding Agency: SANDIA Laboratories, Albuquerque, NM
Total Amount of Award: $85,000

Relationship to Award: one of three(0.5 month salary, investigators trip to WHOI & misc. expenses =$3,000)

PUBLICATIONS (ARTICLES)

I) Refereed Journals

(J1) Jacobi, R. D., Rabinowitz, P. D., and Embley, R. W., 1975, Sediment waves on the Moroccan continental rise: Marine Geology, v. 19, p. M61-M67.

(J2) Jacobi, R. D. and Kristoffersen, Y., 1976, Geophysical and geological trends on the continental shelf off northeastern Newfoundland: Can. J. Earth Sci., v. 13, p. 1039-1051.

(J3) Jacobi, R. D., 1976, Sediment slides on the northwestern continental margin of Africa: Marine Geology, V. 22, p. 157-173.

(J4) Embley, R. W. and Jacobi, R. D., 1977, Exotic middle Miocene sediment from Cape Verde Rise and its relation to piercement structures: Am. Assoc. Petrol. Geol., v. 61, p. 2004-2009.

(J5) Embley, R. W. and Jacobi, R. D., 1977, Distribution, morphology and sedimentological setting of large submarine sediment slides and slumps on the Atlantic continental margins: Marine Geotechnology, v. 2, p. 205-227.

(J6) Embley, R. W., Rabinowitz, P. D., and Jacobi, R. D., 1978, Hyperbolic echo zones in the eastern Atlantic and the structure of the southern Madeira Rise: Earth and Planet. Sci. Letters, v. 41, p. 419-433.

(J7) Jacobi, R. D., and Mrozowski, C., 1979, Sediment slides and sediment waves in the Bonin Trough, western Pacific: Marine Geology, v. 29, M1-M9.

(J8) Jacobi, R. D., 1979, Comment and reply on geophysical evidence from an east-dipping Appalachian subduction zone beneath Newfoundland, Comment: Geology, v. 7, p. 470-471.

(J9) Jacobi, R. D., 1981, Peripheral Bulge-A mechanism for the Lower-Middle Ordovician unconformity along the western margin of the Northern Appalachians: Earth and Planet. Sci. Letters, v. 56, p. 245-251.

(J10) Jacobi, R. D., 1982, Microphysiography of the southeastern North Atlantic and its implications for the distribution of near-bottom processes and related sedimentary facies: Bull. Inst. Geol. Bassin d'Aquitaine (Bordeaux) n. 31, pp. 31-46.

(J11) Heath, G. R., Burckle, L. H., et al., 1982, Glomar Challenger at the Cretaceous-Tertiary boundary: Nature, v. 299, p. 208.

(J12) Damuth, J. E., Jacobi, R. D. and Hayes, D. E., 1983, Sedimentation processes in the northwest Pacific Basin revealed by echo character mapping studies: Bull. Geol. Soc. Am., v. 94, pp. 381-395.

(J13) Jacobi, R. D. and Wasowski, J. J., 1985, Geochemistry and plate tectonic significance of the volcanic rocks of the Summerford Group, north-central Newfoundland: Geology, v. 13, p. 126-130.

(J14) Wasowski, J. J. and Jacobi, R. D., 1985, Geochemistry and tectonic significance of the mafic volcanic blocks in the Dunnage melange, north-central Newfoundland: Can. J. Earth Sci., v. 22, p. 1248-1256.

(J15) Piper, D. J. W., Shor, A. N., Farre, J. A., O'Connell, S. and Jacobi, R., 1985, Sediment slides and turbidity currents on the Laurentian Fan: Sidescan sonar investigations near the epicenter of the 1929 Grand Banks earthquake: Geology, v.13, p. 538-541.

(J16) Wasowski, J. J. and Jacobi, R. D., 1986, The tectonic and depositional history of Ordovician and Silurian rocks in Notre Dame Bay, Newfoundland: Discussion: Can. J. Earth Sci., v. 23, p. 583- 585.

(J17) Jacobi, R. D. and Hayes, D. E., 1989, Sedimentary and paleoceanographic effects of the interplay between the Kuroshio Extension and Pacific Plate motion: Geol. Soc. Am. Bull., v. 101, p. 549-560.

(J18) Jacobi, R. D. and Fountain, J. C., 1993, The Southern Extension & Reactivations of the Clarendon-Linden Fault System: Geographie Physique et Quaternaire, v.47, n.3, p.285-302.

(J19) Kim, J. and Jacobi, R. D., 1996, Geochemistry and tectonic implications of Hawley Formation meta-igneous units: NW Massachusetts: Am. J. Sci., v.296, p.1126-1174.

(J20) Zhao, M. and Jacobi, R. D., 1997, Formation of the regional cross-fold joints in the Appalachian Plateau: J. Struc. Geol., v. 19, n. 6, p. 817-834.

(J21) Smith, G. J. and Jacobi, R. D., 1998, Fault induced transgressive incised shoreface model for the Canadaway Group, Catskill Delta Complex: Journal of Sedimentary Research, v. 68, n. 4, p.668-683

(J22) Baird, G. C., and Jacobi, R., 1999, "Nunda Sandstone" Creek Black Shale, South Wales-Varysburg area, New York: New York Geological Assoc.(Fredonia, NY), Field Trip Guidebook, p. Sun B1-Sun B7.

(J23) Jacobi, R. D., and Smith, G, 1999, Structure and Upper Devonian stratigraphy in the Appalachian Plateau of Allegany County, New York State, including the Clarendon-

Linden Fault System: New York Geological Assoc. (Fredonia, NY), Field Trip Guidebook, p. Sat. C1-Sat C44.

(J24) Smith, G.J., and Jacobi, R. D., 2000, Re-evaluating the Canadaway Group: A Revised Stratigraphic Correlation Chart for the Upper Devonian of southwestern New York State: Northeastern Geology and Environmental Sciences; v. 2, p.173-201.

(J25) Smith, G.J., and Jacobi, R. D., 2001, Tectonic and eustatic signals in the sequence stratigraphy of the Upper Devonian Canadaway Group, New York State: American Association of Petroleum Geologists Bulletin, v. 85, no. 2, p. 325-357.

(J26) Fountain, J. C., Jacobi, R. D. and Fountain, M.J., 1999, Detection of fracture intensification domains using hyperspectral remote sensing data: A case study in Allegany County, New York: Proceedings of the 1999 Independent Oil and Gas Association Conference, Hamilton, Ontario, 10p.

(J27) Xu, jiandong, Qu Guosheng, Jacobi, Robert D., 1999, fractal and multifractal properties of the spatial distribution of natual fractures: analyses and applications; Acta Geologica Sinica (English Edition), v. 73, n. 4, p. 477-487.

(J28) Fountain, J. C. and Jacobi, R. D., 2000, Detection of buried faults and fractures using soil gas analyses: Journal of Environmental and Engineering Geosciences, v. VI, p. 201-208.

(J29) Smith, G.J., and Jacobi, R. D., 2002, Tectonic and Eustatic Signals in the Sequence Stratigraphy of the Upper Devonian Canadaway Group, New York State Reply: American Association of Petroleum Geologists Bulletin, v. 86, no. 4, p. 696-697.

(J30) Xu, J. D., Lin, C., and Jacobi, R. D., 2002, Characterizing fracture spatial patterns by using semivariograms: Acta Geologica Sinica-English Edition, v. 76 (1), p. p. 89-99 .

(J31) Xu, J. D., and Jacobi, R. D., 2003, Estimation of 2-D and 3-D fracture densities from 1-D data - Experimental and field results: Acta Geologica Sinica-English Edition, v. 77 (4): p. 491-503.

(J32) Everett, John R., Staskowski, Ronald J., and Jacobi, Robert D., 2003, Fracture and satellite hyperspectral analysis for petroleum exploration: World Oil, Nov 2003, p. 44-47.

(J33) Evenick, Jonathan C., Jacobi, Robert D., Baker, Gregory S., and Mitchell, Charles E., 2005, Subsurface evidence for faults in the Appalachian Basin, western New York State: Northeastern Geology and Environmental Sciences, v. 27, n. 1 p. 1-17.

II) Refereed contributions to books

(B1) McDowell, S., Kumar, N., Jacobi, R. D., Johnson, D. A., and Bunce, E. T., 1977, Regional setting of site 357, north flank of Rio Grande Rise, in Initial Reports, Deep Sea Drilling Project, v. 39, P. R. Supko, K. Perch-Nielson, K., et al (eds.): U. S. Gov't Printing Office, Washington, D. C., p. 955-969.

(B2) Jacobi, R. D., and Kristoffersen, Y., 1981, Transatlantic correlation of geology and geophysical anomalies on Europe, Newfoundland and adjacent continental shelves, in Geology of the North Atlantic Borderlands, J. Wm. Kerr and A. J. Fergusson (eds.): Can. Soc. Pet. Geol., Mem. 7, p. 197-229.

(B3) Jacobi, R. D. and Hayes, D. E., 1982, Bathymetry, microphysiography and reflectivity characteristics of the West African margin between Sierra Leone and Mauritania, in Geology of the Northwest African Continental Margin, U. von Rad, K. Hinz, M. Sarnthein and E. Seibold (eds.): Springer-Verlag, Berlin, pp. 182-212.

(B4) Haworth, R. T. and Jacobi, R. D., 1983, Geophysical correlation between the geological zonation of Newfoundland and the British Isles, in Contributions to the Tectonics and Geophysics of Mountain Chains, Robert D. Hatcher, Jr., Harold Williams and Isodore Zietz (eds.): Geol. Soc. Am., Mem. 158, pp. 25-32, + 3 fig. in pocket of back cover.

(B5) Jacobi, R. D., Vassallo, K., and Shor, A., 1983, Echo character, microphysiography and geologic hazards, in OMD, Regional Data Synthesis Series Atlas 4 (Eastern North American Continental Margin and Adjacent Ocean Floor, 34° to 41° N and 68° to 78° W), J. I. Ewing and P. H. Rabinowitzr (eds.): JOI, Inc., Washington, map #31.

(B6) Vassallo, K., Jacobi, R. D., and Shor, A., 1983, Echo character, microphysiography and geological hazards, in OMD, Regional Data Synthesis Series Atlas 5 (Eastern North American Continental Margin and Adjacent Ocean Floor, 28° to 36° N and 70° to 82° W), G. M. Bryan and J. R. Heirtzler (eds.): J01, Inc. Washington, map #40.

(B7) Jacobi, R. D., 1984, Modern submarine sediment slides, melange, and the Dunnage Formation in north-central Newfoundland, in Melanges: Their Nature, Origin, and Significance, L. Raymond (ed.): Geol. Soc. Am., Sp. Paper 198, p. 81-102.

(B8) Jacobi, R. D., Hayes, D. E. and Damuth, J. E., 1985, High resolution seismic studies and site survey results near DSDP sites 576 & 578, NW Pacific, in Initial Reports, Deep Sea Drilling Project, v. 86, G. R. Heath and L. H. Burckle, et al (eds.): U. S. Gov't Printing Office, Washington, D. C., p. 23-50.

(B9) Fountain, J. C., Jacobi, R. D. and Fahey, T. J., 1985, Petrology & geochemistry of basalts from DSDP leg 86, site 581, in Initial Reports, Deep Sea Drilling Project, v. 86, R. Heath and L. H. Burckle et al (eds.): U. S. Gov't Printing Office, Washington, D. C., p. 691-700.

(B10) Jacobi, R. D. and Hayes, D. E., 1984, Echo character, microphysiography & geologic hazards, in OMD, Regional Data Synthesis Series Atlas 12 (Northwest African Continental Margin and Adjacent Ocean Floor off Morocco), D. E. Hayes, P. D. Rabinowitz and K. Hinz (eds.): JOI, Inc. Washington, p.14 (oversize).

(B11) Jacobi, R. D., and Hayes, D. E., 1984, Echo character and geologic hazards of the Morocco continental margin hazards, in OMD, Regional Data Synthesis Series Atlas 12 (Northwest African Continental Margin and Adjacent Ocean Floor Off Morocco), D. E. Hayes, P. D. Rabinowitz and K. Hinz (eds.): JOI, Inc. Washington, p. 14a (oversize).

(B12) Embley, R. W. and Jacobi, R. D., 1986, Mass wasting in the western North Atlantic, in The western North Atlantic Region P. R. Vogt and B. E. Tucholke, (eds.): Geol. Soc. Am., DNAG v. M, p. 479-490.

(B13) Laine; E., Damuth, J. E., and Jacobi, R. D., 1986, Western North Atlantic echo-character, in The western North Atlantic Region, P. R. Vogt and B. E. Tucholke (eds.): Geol. Soc. Am., DNAG v. M, p. 427- 436.

(B14) Haworth, R. T., Hipkin, R., Jacobi, R. D., Kane, M., Lefort, J. P., Max, M. D., Miller, H. G., & Wolff, F., 1988, Geophysical framework and the Appalachian-Caledonide connection, in The Caledonian- Appalachian Orogen, A. L. Harris & D. J. Fettes (eds): Geol. Soc., sp. pub. 38, p. 3-20.

(B15) Fie, S. M., Fountain, J., Hunt, E. D., Zubrow, E., Jacobi, R., Bartolotta, K., Brennan, J., Allen, K., Bush, P., 1990, The analysis of encrustations in Iroquois ceramic vessels: implications for the delineation of food resource areas, in Organic Contents of Ancient Vessels, W.R. Biers and P. E. McGovern (eds.): Philadelphia, v.7, p. 11-23, MASCA, U. Pennsylvania.

(B16) Jacobi, R., Gutmann, M., Piechocki, A., O'Connell, S., Singer, J., Mitchell, C., Frank S., Scheuing, D., and Hasiotis, S., 1990, Upper Devonian turbidites in WNY: Characteristics and implications for submarine fan deposition models, in Field Trip Guidebook, Western New York and Ontario, G. G. Lash (ed.): NYSGA, p. Sat. E1- Sat. E25.

(B17) Jacobi, R. D., and Hayes, D. E., "1989-1990," Echo character and microphysiography of the northwest African margin off Morocco, in G. B. Udintsev, ed., The Int'l. Geological/ Geophysical Atlas of the Atlantic Ocean (GAPA): Intergovernmental Oceanographic Commission (of UNESCO), Min. Geol. USSR, Ac. Sci. USSR, Moscow, p.72.

(B18) Jacobi, R. and Hayes, D., 1992, Northwest African continental rise: Effects of near-bottom processes inferred from high-resolution seismic data, IN C. Wylie Poag and Pierre C. de Graciansky, eds., Evolution of Continental Rises: Van Nostrand Reinhold, New York, p. 293-326 + pocket folded figure.

(B19) Fountain, J. C. & Jacobi, R. D., 1994, Hydrogeologic concerns at the West Valley, NY, site: implications for site characterizations in Toxic Substances and Hydrologic Sciences, Alan R. Dutton, ed.: American Institute of Hydrology, Minneapolis, MN, p. 466-477.

(B20) Jacobi, R., Gutmann, M., Piechocki, A., Singer, J., O'Connell, S., and Mitchell, C., 1994, Lobe & lobe fringe sands in the Upper Devonian of western New York, in Studies in Paleontology & Stratigraphy in Honor of Donald W. Fisher, E. Landing, (ed.,): New York Geol. Surv. Bull. 481, p. 101-115.

(B21) Armstrong, D. K., Lewis, C. F. M., Bowlby, J. R., Jacobi, R. D., and Mohajer, A. A., 1996, Submersible investigation of linear bedrock features on the floor of western Lake Ontario: a progress report, in Summary of Field Work and Other Activities, C. L. Baker, P. C. Thurston, M. C. Gerow, C. A. Kasycki, D. G. Laderoute, G. Merlino, J. W. Newsome, L. Owsiacki, G. Spiers, and J. A. Fyon, (eds.): Ontario Geological Survey, Misc. paper 166, p. 108-109.

(B22) Jacobi, Robert D. and Smith, Gerald, 1999, Structure and Upper Devonian stratigraphy in the Appalachian Plateau of Allegany County, New York State, including the Clarendon-Linden Fault System, in Field Trip Guidebook, Gordon C. Baird and Gary G. Lash, (eds.): New York Geol. Assoc., 71 annual meeting (Fredonia, NY), p. SAT C1-C44.

(B23) Baird, Gordon C. and Jacobi, Robert , 1999, "Nunda Sandstone" depositional event in the Pipe Creek Black Shale, South Wales-Varysburg area, New York, in Field Trip

Guidebook, Gordon C. Baird and Gary G. Lash, (eds.): New York Geol. Assoc., 71 annual meeting (Fredonia, NY), p. SUN B1-B21.

(B24) Jacobi, Robert D., 2001, Part 2: Rapid and rigorous outcrop fracture mapping and analyses, in Regional Tectonics and Structural Control of Ore: in The Major Gold Trends of Northern Nevada, David R. Shaddrick, Elizabeth Zbinden, David C. Mathewson, and Camille Prenn (eds.): Geological Society of Nevada, Special Publication n. 33, p.225-242.

(B25) Jacobi, R. D. and Mitchell, C. E., 2002, Geodynamical interpretation of a major unconformity in the Taconic Foredeep: Slide scar or onlap unconformity?, *In*: Taconic Convergence, Orogen, Foreland Basin, and Craton, Mitchell and Jacobi (eds.): Physics and Chemistry of the Earth, v. 27, n.1-3, p.169-201.

(B26) Kim , J., and Jacobi R. D., 2002, Boninites: characteristics and tectonic constraints, northeastern Appalachians, *In*: Taconic Convergence, Orogen, Foreland Basin, and Craton, Mitchell and Jacobi, Des: Physics and Chemistry of the Earth, v. 27, n.1-3, p.109-147.

(B27) Mitchell, Charles E. and Jacobi, Robert D., 2002, Preface, In "Taconic Convergence: Orogen, Foreland Basin, and Craton", C. E. Mitchell and R. D. Jacobi, (eds.): Physics and Chemistry of the Earth, v. 27, p. 3-4.

(B28) Jacobi, Robert D., and Mitchell, Charles E., 2002, Geodynamical interpretation of a major unconformity in the Taconic Foredeep: slides scar or onlap unconformity?, In "Taconic Convergence: Orogen, Foreland Basin, and Craton", C. E. Mitchell and R. D. Jacobi, (eds.): Physics and Chemistry of the Earth, v. 27, p. 169-201.

(B29) Jacobi, Robert D., Eastler, Thomas E., and Xu, Jiandong, 2002, Methodology for remote characterization of fracture systems in enemy bedrock underground facilities, *in* The Environmental Legacy of Military Operations, Russell Harmon and J. Ehlen (eds.): Geol. Soc. Am. Engineering Geology Division, v. 14, p. 27-60.

(B30) Jacobi, Robert D. and Fountain, John C, 2002, The character and reactivation history of the of the southern extension of the seismically active Clarendon-Linden Fault System, western New York State, *in* Neotectonics and Seismicity in the Eastern Great Lakes Basin, R. H. Fakundiny, R. D. Jacobi, and C. F. M. Lewis (eds.): Tectonophysics, v. 353, p.215-262.

(B31) Jacobi, Robert D., 2002, Basement faults and seismicity in the Appalachian Basin of New York State, *in* Neotectonics and Seismicity in the Eastern Great Lakes Basin, R. H. Fakundiny, R. D. Jacobi, and C. F. M. Lewis (eds.): Tectonophysics, v. 353, p.75-113.

(B32) Fakundiny, Robert H. Lewis, C.F. Michael, and Jacobi, Robert D., 2002, Neotectonics and seismicity in the eastern Great Lakes basin: introduction, *in* Neotectonics and Seismicity in the Eastern Great Lakes Basin, R. H. Fakundiny, R. D. Jacobi, and C. F. M. Lewis (eds.): Tectonophysics, v. 353, p.1-2.

(B33) Smith, G.J., and Jacobi, R. D., 2002, Anomalous paleoflow orientations: A potential methodology for determining recurrence rates and magnitudes in paleoseismic studies of syndepositional faults: *in* Ancient Seismites, F. R. Ettensohn, N. Rast, and C. E. Brett (eds.): Geol. Soc. Am., Special Paper 359, p. 145-164.

(B34) Agle, Paul, Jacobi, Robert, Mitchell, Charles, Nyahay, Rich, Slater, Brian, and Smith, Langhorne, 2006, Faulting and Mineralization in the Cambro-Ordovician Section of the Mohawk Valley, IN, NYSGA Field Trips, Robert Jacobi (Ed): New York State Geological Association, 78th Annual Meeting (Buffalo, NY), p. 1-53.

(B35) Smith, Gerald, and Jacobi, Robert, 2006, Depositional and tectonic models for Upper Devonian sandstones in western New York, IN, NYSGA Field Trips, Robert Jacobi (Ed): New York State Geological Association, 78th Annual Meeting (Buffalo, NY), p. 54-115.

(B36) Brett, Carlton E., Mclaughlin, Patrick I., and Jacobi, Robert, 2006, Silurian sequence stratigraphy, events, and paleoenvironments along the cratonic margin of the Appalachian Foreland, IN, NYSGA Field Trips, Robert Jacobi (Ed): New York State Geological Association, 78th Annual Meeting (Buffalo, NY), p. 290-353.

(B37) Jacobi, Robert D., Kim, Jon, Agle, Paul A., Gale, Marjorie, Becker, Laurence, Mitchell, Charles and Smith, Gerald, 2006, Generation of Lower Paleozoic carbonate reservoirs in the Appalachian Basin of New York State: faults, timing, and the plate tectonic connection: Ontario-New York Oil and Gas Conference, Forty-Fifth Annual Conference (Ontario Petroleum Institute, London, Ontario), Session No, 6, No. 21 p. 1-36.

(B38) Jacobi, Robert D., Lewis, C.F. Michael, Armstrong, Derek K., and Blasco, Stephan M., 2007, Popup field in Lake Ontario south of Toronto, Canada: Indicators of late glacial and post-glacial strain: in Continental Intraplate Earthquakes: Science, Hazard, and Policy Issues, Seth Stein and Stéphane Mazzotti (eds.): Geol. Soc. Am., Special Paper 425, p. 129-147.

(B39) Jacobi, Robert, and Loewenstein, Stuart, in press, Ordovician structural styles and carbonate reservoirs in the Appalachian Basin of New York State: NYS Museum, special issue.

(III) <u>Conference Proceedings (published abstracts)</u>

(A1) Jacobi, R., 1975, Structure and stratigraphy of the eastern part of the terrane north of Lukes Arm Fault, north-central Newfoundland: Geol. Soc. Am., Abstracts with Programs, v. 7, n. 1, p. 79.

(A2) Damuth, J. E., Embley, R. W., Hayes, D. E., Hoose, P. J. and Jacobi, R. D., 1975, Regional mapping and interpretation of deep sea sedimentation processes using 3.5 kHz precision depth recordings: Geol. Soc. Am., Abstracts with Programs, v. 7, n. 7, p. 1044.

(A3) Jacobi, R. D., and Schweickert, R. A., 1976, Implications of new data on stratigraphic and structural relations of Ordovician rocks on New World Island, north-central Newfoundland: Geol. Soc. Am., Abstracts with Programs, v. 8, n. 2, p. 20.

(A4) Jacobi, R. D., and Kristoffersen, Y., 1979, Transatlantic correlations of the geology and geophysical anomalies on Europe, Newfoundland and adjacent continental shelves: Int'l Workshop, C.S.P. G. and P. E. S. G. P., p. 43. (invited presentation)

(A5) Jacobi, R. D., Damuth, J. E., Hayes, D. E., 1980, Evaluation of the north Pacific subseabed for disposal of high level nuclear waste: II, Analysis of geologic data in the Pac 1 area, northwest Pacific to locate potential candidate disposal sites: Trans. Am. Geophys. Un., v. 61, p. 988.

(A6) Damuth, J. E., Jacobi, R. D., Flood, R. D., and Hayes, D. E., 1980, Evaluation of the north Pacific subseabed for disposal of high level nuclear waste: III, Preliminary results of geological/geophysical surveys of three 1^{o} x 1^{o} candidate disposal sites: Trans. Am. Geophys. Un., v. 61, p. 989.

(A7) Jacobi, R. D., 1981, The Herring Neck Group in north-central Newfoundland: An Ordovician interarc basin?: Geol. Soc. Am., Abstracts with Programs, v. 13, n. 3, p. 139.

(A8) Jacobi, R. D. 1981, Microphysiography of the southeastern North Atlantic and its implications for the distribution of near-bottom processes and related sedimentary facies: International colloquium on Quaternary Sedimentary Environments in North Atlantic (Bordeaux, France), p. 28-29. (invited presentation)

(A9) Jacobi, R. D., 1981, Modern submarine sediment slides and their implications for "melange": Geol. Soc. Am., Abstracts with Programs, v. 13, n. 7, p. 479. (invited presentation)

(A10) Janish, J. K. and Jacobi, R. D., 1982, Nature, origin and significance of the Cheneyville Formation, south coast of New World Island, Newfoundland: Geol. Soc. Am., Abstracts with Programs, v. 14, p. 29.

(A11) Wasowski, J. J., and Jacobi, R. D., 1982, Nature and significance of igneous-clast breccias and adjacent units in the Dunnage melange, north-central Newfoundland: Geol. Soc. Am., Abstracts with Programs, v. 14, p. 94.

(A12) Heath, G. R., Pisias, N., Damuth, J. E., Jacobi, R. D., Hayes, D. E. and Barton, C. E., 1982, Site assessment in the North Pacific for the subseabed disposal of nuclear waste: Joint Oceanographic Assembly, Poster Abstract, v. 1, p. 46. (Halifax, Nova Scotia)

(A13) Vassallo, K. L., and Jacobi, R. D., 1983, Echo character of the western North Atlantic: Geol. Soc. Am., Abstracts with Programs, v. 15, n. 3, pp. 190-191.

(A14) Wasowski J. J., and Jacobi, R. D., 1983, Geochemistry and tectonic significance of mafic volcanic blocks in the Dunnage melange, north- central Newfoundland: Geol. Soc. Am., Abstracts with Programs, v. 15, n. 3, p. 189.

(A15) Jacobi, R. D., Hayes, D. E., Damuth, J. E., and Flood, R. D., 1983, General geology/ geophysics of three 1^{o} x 1^{o} candidate disposal sites for nuclear waste: Trans. Am. Geophys. Un., v. 64, n. 45, p. 741. (invited presentation)

(A16) Damuth, J. E., Hayes, D. E., and Jacobi, R. D., 1983, Evaluation of the North Pacific subseabed for disposal of high-level nuclear waste: Trans. Am. Geophys. Un., v. 64, n. 45, p. 741. (invited presentation)

(A17) Shor, A., Farre, J., O'Connell, S., Piper, D., and Jacobi, R., 1983, Sand waves and mass failures generated by the 1929 Grand Banks earthquake: A Sea MARC I survey: Trans. Am. Geophys. Un., v. 64, n. 45, p. 729.

(A18) Jacobi, R. D., 1984, The Salt Harbour mylonite, north-central Newfoundland: Geol. Soc. Am., Abstracts with Programs, v. 16, n. 1, p. 26. (invited presentation)

(A19) Wasowski, J. J. and Jacobi, R. D., 1984, Geochemistry and tectonic setting of the Lawrence Head Volcanics, north-central Newfoundland: Geol. Soc. Am., Abstracts with Programs, v. 16, n. 1, p. 69.

(A20) Haworth, R. T., Hipkin, R., Jacobi, R. D., Kane, M., LeFort, J-P, Max, M. D., Miller, H. D., & Wolff, F., 1984, Geophysical framework and the Appalachian-Caledonide connection: Int'l. Geol. Correlation Program, Project 27, Programme of Final Symposium (Glasgow, Scotland), p. (invited presentation)

(A21) Jacobi, R. D., and Hayes, D. E., 1986, SeaBeam survey and preliminary sediment isopach maps at potential candidate site E_2 (NW Pacific) for subseabed disposal of high level nuclear waste: Trans. Am. Geophys. Un., v. 67, p. 1001.

(A22) Arnold, E. M., and Jacobi, R. D., 1986, Seafloor echo character of a red clay province, NW Pacific, at potential candidate site E_2 for subseabed disposal of high level nuclear waste: Trans. Am. Geophys. Un., v. 67, p. 1001.

(A23) Jacobi, R. D. and Scheuing, D., 1987, Dunnage melange revisited: a detailed structural/stratigraphic section across its northeastern termination: Geol. Soc. Am., Abstracts with Programs, v. 19, n. 1, p. 21.

(A24) Gutmann, M. P. and Jacobi, R. D., 1988, The Devonian South Wales Member: A suprafan lobe?: Geol. Soc. Am., Abstracts with Programs, v. 20, n. 1, p. 24.

(A25) Scheuing, D. F., Jacobi, R. D., and Fountain, J. C., 1988, Geochemistry of argillaceous rocks from the Dunnage melange: Implications for depositional setting: Geol. Soc. Am., Abstracts with Programs, v. 20, n. 1, p. 67.

(A26) Jacobi, R. D. and Fountain, J. C., 1988, Structural and geochemical transect across the Rowe-Hawley zone, central Massachusetts: Geol. Soc. Am., Abstracts with Programs, v. 20, n. 1, p. 29.

(A27) Jacobi, R. D., Scheuing, D., and Ranger, J., 1988, Sedimentological, stratigraphical, and structural analyses bearing on the origin of the Dunnage melange: Geol. Assoc. Canada, Program with Abstracts, v. 13, p. A60. (invited presentation)

(A28) Scheuing, D.F., and Jacobi, R. D., 1989, Significance of geochemical abundances in the matrix of melanges in central Newfoundland: 29th Intl. Geol. Congress (Washington), v. 3, p. 3·45.

(A29) Pirmez, C., Breen, N. A., Flood, R., Jacobi, R., Ladd, J.W., O'Connell, S. & Westbrook, G., 1989, Interaction of plate convergence & deep-sea fan sedimentation: preliminary interpretations of a GLORIA mosaic of the northern Colombian continental margin: Trans., Am. Geophys. Un., v. 70, n. 43, p. 1345.

(A30) Jacobi, R. D., Fountain, J.C., Gill, G., Hunt, E. D., 1990, Evidence for the continuation of the Clarendon-Linden Fault System into central Allegany County, New York: Geol. Soc. Am., Abstracts with Programs, v.22, n.2, p.25-26.

(A31) Fountain, J.C., Jacobi, R. D., Gill, G., 1990, Detection of bedrock faults in covered areas through the use of soil-gas surveys: a case study on the Clarendon-Linden Fault: Geol. Soc. Am., abstracts with Programs, v.22, n.2, p.17.

(A32) Piechocki, A. L., Jacobi, R. D., Hasiotis, S.T., 1990, The Nunda Sandstone: a Devonian non-channelized sand lobe of a submarine fan: Geol. Soc. Am., Abstracts with Programs, v.22, n.2, p.62.

(A33) Scheuing, D.F., & Jacobi, R. D., 1990, Implications of geochemistry of sedimentary rocks in eastern Notre Dame Bay, Newfoundland: Geol. Soc. Am., Abstracts with Programs, v.22, n.2, p.68.

(A34) Pirmez, C., Breen, N. A., Flood, R. D., O'Connell, S., Jacobi, R. D., Ladd, J. W., Westbrook, G., Franco, J. V., Garzon, M., Arias-Isaza, F. A., 1990, Gloria mosaic of the Magdalena deep-sea fan, northern Colombian convergent margin: Am. Assoc. Pet. Geol., 1990 Annual Convention, Official Program, p.153.

(A35) Jacobi, R. D., 1990, The Clarendon-Linden Fault and the Saguenay Earthquake: MAGNEC (Multi-Agency Group for Neotectonics in eastern Canada)/AMNEC, AECB file 34-5-4-0, Minutes of Meeting, p.27-28 (invited presentation)

(A36) Jacobi, Robert D., and Fountain, John C., 1991, Evidence for the continuation of the Clarendon-Linden Fault System into central Allegany County, New York: GAC/MAC/SEG Joint Annual Meeting, Program with Abstracts, v.16, p.A60 (invited presentation)

(A37) Jacobi, R. D., and Fountain, J.C., 1991, Evidence for the southern extension and reactivation of the Clarendon-Linden Fault System: EOS, Transactions, Am. Geophys. Union, v. 72, p.196.

(A38) Wawrzynski, A. L. and Jacobi, R. D., 1992, Remote sensing on the Clarendon-Linden Fault System in Allegany County, New York: Geol. Soc. Am., Abstracts with Programs, v.24, n.3, p.83.

(A39) Kim, J. and Jacobi, R., 1993, Geochemistry and structure of the Hawley Formation, northwestern Massachusetts: Geol. Soc. Am., Abstracts with Programs, V. 24, n. 2, p. 29. (invited presentation)

(A40) Wawrzynski, A. L., Jacobi, R. D., and Fountain, J.C., 1993, Remote sensing study on the Clarendon-Linden Fault System in Allegany County, New York: Geol. Soc. Am., Abstracts with Programs, v.24, n.3, p.88.

(A41) Zhao, M. and Jacobi, R. D., 1993, Fractal and more conventional analyses on fracture systems in the Appalachian Plateau, Allegany County, New York: Geol. Soc. Am., Abstracts w/ Programs, v. 25, n. 2, p. 91.

(A42) Kim, J. & Jacobi, R. D., 1994, Geochemistry of Hawley Formation meta-igneous units & their comparison to modern Pacific convergent igneous units: implications for New England tectonic models: Geol. Soc. Am., Abstracts with Programs, v. 26, n. 3, p. 28.

(A43) Zhao, M. & Jacobi, R. D., 1994, Further fractal & more conventional analyses of fracture systems in the Appalachian Plateau, Allegany County, New York: Geol. Soc. Am., Abstracts with Programs, v. 26, n. 3, p. 82.

(A44) Zhao, M., Jacobi, R. D., & Xu, J., 1994, Fractal features of extension fracture sets: insights from generated fracture patterns: Geol. Soc. Am., Abstracts with Programs, v. 26, n. 3, p. 82.

(A45) Kim J. and Jacobi, R. D., 1995, Geochemical Considerations for discrimination of potential terrains in northeastern Appalachians: Hawley Formation and other volcanic units. Geol. Soc. Am., Abstracts with Programs, v. 27, n. 1, p.60. (invited presentation)

(A46) Jacobi, R. D., and Fountain, J. C., 1995, Character and reactivation history of the Clarendon-Linden Fault System: Evidence from southwestern New York State: AECB Workshop on Seismic Hazard in Southern Ontario (AECB, Ottawa, Canada), p. C1-4 (invited presentation)

(A47) Jacobi, R. D., and Fountain, J. C., 1995, Character and reactivation history of the Clarendon-Linden fault system: Evidence from southwestern New York State: Report: AECB Workshop on Seismic Hazard Assessment in Southern Ontario--Recorded Proceedings (AECB, Ottawa, Canada), p. 8

(A48) Bechtel, R., Jacobi, R. D., Fountain, J. C., 3-89 (invited presentation) and Smith, G., 1996, Geochemical correlation of sandstones in the Devonian Catskill delta of Allegany County, New York: Geol. Soc. Am., Abstracts with Programs, v. 28, n. 3, p. 38.

(A49) Bowlby, J. R., Thomas, R. L., Jacobi, R. D., McMillan, R. K., and Lewis, C. F. M., 1996, Submersible observations of neotectonic structures and their implications for geologic hazards in the western Lake Ontario area: Geol. Soc. Am., Abstracts with Programs, v. 28, n. 3, p. 41 (invited presentation)

(A50) Fountain, J. C., Jacobi, R. D., and Joy, M. P., 1996, Detection of the Clarendon-Linden Fault System, Allegany County, New York using soil gas analyses: Geol. Soc. Am., Abstracts with Programs, v. 28, n. 3, p. 55 (invited presentation)

(A51) Jacobi, R. D., Fountain, J. C., Burley, J., Korff, S., Kracker, L., and Zent, C., 1996, Utilization of a GIS (ARC/INFO) for compilation of cultural and geological data in land use considerations: Allegany County, New York State: Geol. Soc. Am., Abstracts with Programs, v. 28, n. 3, p. 67 (invited presentation)

(A52) Jacobi, R. D., and Zhao, M., 1996, Digital imaging and analyses of fractures: Evidence for Appalachian style tectonic in the Appalachian Plateau of western New York: Geol. Soc. Am., Abstracts with Programs, v. 28, n. 3, p. 67 (invited presentation)

(A53) Jacobi, R. D., Mitchell, C. E., and Joy, M. P., 1996, The Dolgeville-Indian Castle contact: The role of local tectonic control on the development of a regional drowning surface: Geol. Soc. Am., Abstracts with Programs, v. 28, n. 3, p. 67 (invited presentation)

(A54) Jacobi, R. D., Fountain, J. C., Zhao, M., Smith, G., and Peters, T., 1996, Character and reactivation history of the Clarendon- Linden Fault System: Evidence from the New York State: Geol. Soc. Am., Abstracts with Programs, v. 28, n. 3, p. 67 (invited presentation)

(A55) Kim, J., and Jacobi, R. D., 1996, A survey of Ordovician igneous geochemistry in the northeastern Appalachians: Geol. Soc. Am., Abstracts with Programs, v. 28, n. 3, p. 71 (invited presentation)

(A56) Kim, J., Armstrong, T., Jacobi, R. D., and Ratcliffe, N. M., 1996, The Rowe-Hawley Belt during the Taconic Orogeny: Geol. Soc. Am., Abstracts with Programs, v. 28, n. 3, p. 71 (invited presentation)

(A57) Smith, G. J., and Jacobi, R. D., 1996, Transgressive surfaces of erosion in the Upper Devonian Catskill Delta Complex: Evidence for the support of the incised shoreface model: Geol. Soc. Am., Abstracts with Programs, v. 28, n. 3, p. 100.

(A58) Wawrzynski, A. L., Jacobi, R. D., and Zhao, M., 1996, Utilization of remote sensing for fracture and fault characterization: A case example from the Clarendon-Linden Fault System in Allegany County, southwestern New York: Geol. Soc. Am., Abstracts with Programs, v. 28, n. 3, p. 109 (invited presentation)

(A59) Zhao, M., and Jacobi, R. D., 1996, Formation of the regional systematic joints in the Appalachian Plateau: Geol. Soc. Am., Abstracts with Programs, v. 28, n. 3, p. 112 (invited presentation)

(A60) Mitchell, C. E., Jacobi, R. D., Joy, M. P., and Goldman, D., 1997, Tectonic control on stratigraphic sequences deposited in the Taconic Foredeep: Am. Assoc. Petrol. Geol., Annual Convention (abs.), v. 6, p. A83.

(A61) Xu, Jiandong and Jacobi, Robert D., 1997, Fracture analysis techniques for data from cores and downhole video images: Geol. Soc. Am., Abstracts w/Programs, v.29, n. 1, p.91.

(A62) Bergslien, Elisa T., Fountain, John C, Jacobi, Robert D., and Renshaw, Carl E., 1997, Experimental investigation of two-phase flow in rough-walled fractures: Geol. Soc. Am., Abstracts w/Programs, v.29, n. 6, p.187.

(A63) Zack, Dino and Jacobi, Robert D., 1997, Geologic mapping of the Freedom Quadrangle in Allegany and Cattaraugus counties, New York: Evidence for multiple fault systems in the Appalachian Plateau: Geol. Soc. Am., Abstracts w/Programs, v. 29, n. 1, p. 91.

(A64) Peters, Todd and Jacobi, Robert D., 1997, Geology of the Rawson 7.5 minute quadrangle in New York State: Upper Devonian tempesites and multiple fault systems: Geol. Soc. Am., Abstracts w/Programs, v. 29, n. 1, p. 72.

(A65) Jacobi, Robert D., 1997, Discrimination of tectonic and non-tectonic faults: A case study involving 11 integrated techniques: American Geophysical Union 1997 Spring Meeting, v. 78, n. 17, p. S316 (invited presentation).

(A66) Jacobi, Robert D. and Fountain John C., 1998, Characteristics of the basement-controlled faults of the Clarendon-Linden Fault System: Evidence from seismic reflection profiles for local multiple Phanerozoic reactions during far-field orogenies: Geol. Soc. Am., Abstracts w/Programs: v. 30, n. 1,p. 27.

(A67) Loewenstein, Stuart, Jacobi, Robert, Martin, John, 1998, Geologic assessment of core data from the Stahl and correlation with the Rise Run of Ohio: Am. Assoc. Petroleum Geologists Bulletin, v. 82, n.9, p.1770.

(A68) Paquette, Lisa M., Fountain, John C., and Jacobi, Robert D., 1998, Characterization of fractures in the Bath and Savona, New York area: Soil gas surveys and structural data: Geol. Soc. Am., Abstracts w/Programs: v. 30, n. 1, p. 65.

(A69) Peters, Todd W. and Jacobi, Robert D., 1998, Analysis of systematic structural domains and their close relation to topographic lineaments in Rawson 7.5 quadrangle western New York: Geol. Soc. Am., Abstracts w/Programs: v. 30, n. 1, p. 66.

(A70) Smith, Gerald J., Jacobi, Robert D., Peters, Todd W., Reay, Michelle L., Zack, Dino L., and Zhao, Meng, 1998, Stratigraphic and structural analyses of 7 1/2' topographic quadrangles in western New York State: Geol. Soc. Am., Abstracts w/Programs: v. 30, n. 1, p. 85.

(A71) Xu, Jiandong and Jacobi Robert D., 1998, Relationship between frequency and density of fracture networks: Experimental and field results: Geol. Soc. Am., Abstracts w/Programs: v. 30, n. 1, p. 85.

(A72) Young, Richard A. and Jacobi, Robert D., 1998, Bedrock-till deformation structure along the Clarendon-Linden Fault Zone near Linden, NY: Tectonic or glacial origin?: Geol. Soc. Am., Abstracts w/Programs: v. 30, n. 1, p. 85.

(A73) Armstrong, Derek K., Lewis, C.F.M., Jacobi, R. D., Bowlby, J. R., and Mohajer, A. A., 1998, A bedrock pop-up field beneath Lake Ontario, south of Toronto, Ontario: Geol. Soc. Am., Abstract w/ Programs, v. 30, n. 7, p. A-295.

(A74) Eastler, Thomas E. and Jacobi, Robert D., 1998, Methodology for remote characterization of fracture systems in enemy bedrock underground facilities (UGF): Geol. Soc. Am., Abstract w/ Programs, v. 30, n. 7, p. A-49.

(A75) Fountain, John, and Jacobi, Robert, 1998, The relationship between fracture characteristics and soil gas anomalies: Geol. Soc. Am., Abstract w/ Programs, v. 30, n. 7, p. A-324.

(A76) Jacobi, Robert, and Fountain, John, 1998, Multiple reactivations of the Clarendon-Linden Fault System, western New York: Geol. Soc. Am., Abstract w/ Programs, v. 30, n. 7, p. A-249.

(A77) Jacobi, Robert D. and Xu, Jiandong, 1998, Fracture intensification domains as fault indicators: Geol. Soc. Am., Abstract w/ Programs, v. 30, n. 7, p. A-63.

(A78) Loewenstein, Stuart, Jacobi, Robert, and Martin, John, 1998, Geologic assessment of core data from the Stahl #1 and correlation with the Rose Run of Ohio: Am. Assoc. Petrol. Geol., v. 82, p. 1770.

(A79) Smith, Gerry, and Jacobi, Robert D., 1998, Anomalous paleoflow orientations: a potential methodology for determining recurrence rates and magnitudes in paleoseismic studies of syndepositional faults: Geol. Soc. Am., Abstracts w/ Programs, v. 30, n. 7, p. A-399.

(A80) Sunderland, B. P., McCarthy, F.M.G., Lewis, C.F.M., Jacobi, R., Armstrong, D., and Bowlby, J., 1998, Can palynology be used to date seismically-induced lake bottom features?: Geol. Soc. Am., Abstract w/ Programs, v. 30, n. 7, p. A-295.

(A81) Xu, Jiandong, and Jacobi, Robert D., 1998, Characterizing natural fracture networks: density calculation and spatial structure analyses: Geol. Soc. Am., Abstract w/ Programs, v. 30, n. 7, p. A-224.

(A82) Baudo, Andrew I, and Jacobi, Robert D., 1999, Fracture patterns along a 2.3 km scanline in the Appalachian Plateau, Cattaraugus County, western NY: statistical analysis and implications for fault activity: Geol. Soc. Am., Abstract w/ Programs, v. 31, n. 2, p. A-3.

(A83) Jacobi, Robert D., and Baudo, Andrew, 1999, Faults exposed in Zoar Valley, western New York, and their possible relation to geophysical anomalies, Landsat lineaments and seismicity: Geol. Soc. Am., Abstract w/ Programs, v. 31, n. 2, p. A-25.

(A84) Jacobi, Robert D., Loewenstein, Stuart, Mitchell, Chuck, and Forsyth, David, 1999, magnetics, gravity, Landsat lineaments, and extensional faults in New York State: Geol. Soc. Am., Abstract w/ Programs, v. 31, n. 2, p. A-25.

(A85) Marsh, Todd L., Mitchell, Charles E., and Jacobi, Robert D., 1999, Paleocurrent orientation and fault block rotation during deposition of the Late Middle Ordovician succession of the Mohawk Valley Region, New York State: Geol. Soc. Am., Abstracts w/ Programs, v. 31, n. 2, p. A-32.

(A86) Reay, Michelle L., and Jacobi, Robert D., 1999, Geologic mapping of the Pike quadrangle in western New York: Evidence for faults at the surface in the Appalachian Plateau: Geol. Soc. Am., Abstract w/ Programs, v. 31, n. 2, p. A-62.

(A87) Smith, Gerald J., and Jacobi, Robert D., 1999, Syndepositional fault-controlled reservoir formation: Lowstand shoreface deposits in southwestern New York State: 1999 Am. Assoc. Petrol. Geol. Annual Convention Official Program, v. 8, p. A131.

(A88) Baudo, A., and Jacobi, R. D., 2000, Fractal and geostatistical analyses of fractures along a 4 km scanline in the Appalachian Plateau, SW New York State: Geol. Soc. Am., Abstracts w/ Programs, v. 32, n.1, p. A4

(A89) Harper, A., and Jacobi, R. D., 2000, Fracture analysis along the southwest shores of Lake Ontario: implications for extension of the St. Lawrence rift system through Lake Ontario: Geol. Soc. Am., Abstracts w/ Programs, v. 32, n.1, p. A23

(A90) Jacobi, R. D., and Baudo, A, 2000, Fractal and geostatistical analyses of fracture and lineament patterns in the Appalachian Plateau: Geol. Soc. Am., Abstracts w/ Programs, v. 32, n.1, p. A26

(A91) Marsh, T. L., Jacobi, R. D., and Mitchell, E., 2000, Preferential accumulation of sediments of the Dolgeville Formation (Late Middle Ordovician) caused by tectonically induced topography: Geol. Soc. Am., Abstracts w/ Programs, v. 32, n.1, p. A57

(A92) Reay, M., and Jacobi, R. D., 2000, Detailed geologic mapping of the Pike 7.5' quadrangle in western New York: structural and stratigraphic analyses: Geol. Soc. Am., Abstracts w/Programs, v. 32, n.1, p. A68

(A93) Smith, G. and Jacobi, R. D., 2000, Reactivation of intracontinental faults in foreland basins and the effects on local sequence stratigraphy and the apparent relative sea level signal. Geol. Soc. Am., Abstracts w/ Programs, v. 32,n.1, p. A75

(A94) Fakundiny, Robert H., Wallach, Joseph L., and Jacobi Robert D., 2000, Neotectonics of the eastern Great Lakes basin cities: Will we experience a major earthquake: EOS Transactions, Am. Geophys. Un, v. 81 n. 19, p. S10.

(A95) Smith, G. J. and Jacobi, R. D., 2000, Reactivation of intracontinental faults in foreland basins and the effects on local sequence stratigraphy and the apparent relative sea level signal: Am. Assoc. Petrol. Geol. Annual Convention, Official Program, v. 9, p. A139.

(A96) Tober, B. K., and Jacobi, R. D., 2000, Fracture trends and spacing in the Appalachian Plateau of western New York: implications for the Bass Island trend and north-striking lineaments: Geol. Soc. Am., Abstracts w/ Programs, v. 32, n.1, p. A79

(A97) Jacobi, Robert D., Fountain, John, Smith, Gerald, Tober, Beth, Loewenstein, Stuart, 2000, FIDs in the Appalachian Plateau of NYS: Indicators of faults and their motion histories, seismicity and hydrocarbon potential: Geol. Soc. Am., Annual Meeting Program, p. P-158

(A98) Jacobi, Robert D., and Fountain, John C., 2001, The implications of fracture intensification domains (FIDs) for fluid flow: Part I, recognition and characteristics of FIDs and their relation to faults, in Session 5 of Conference Proceedings, B. H. Kueper, K. S. Novakowski, and D. A. Reynolds (eds.): Queens University (website and CD), 4p.

(A99) Fountain, John C, Jacobi, Robert D., and Nelson, Travis A., 2001, The implications of fracture intensification domains (FIDs) for fluid flow: Part II, recognition of fracture sets with vertical continuity, in Session 5 of Conference Proceedings, B. H. Kueper, K. S. Novakowski, and D. A. Reynolds (Eds.): Queens University (website and CD), 5p.

(A100) Lugert, Courtney M., Jacobi, Robert D., When, Karen, S., and Fountain, John, 2001, Tracing deep structure: Fractures analysis in the Finger Lakes region of the Appalachian Plateau, NYS: Geol. Soc. Am., Annual Meeting Program, v. 33, n. 6, A-394.

(A101) Kim, Jonathan, and Jacobi, Robert D., 2001, Implications of boninites for the Cambro-Ordovician arc development in the NE Appalachians: Geol. Soc. Am., Annual Meeting Program, v. 33, n. 6, A-261 (Invited presentation).

(A102) Nelson, Travis, Fountain, John, Budney, Lucas, and Jacobi, Robert, 2001, Tracing deep structure: soil gas analyses in the Finger Lakes region of the Appalachian Plateau, NYS: Geol. Soc. Am., Annual Meeting Program, v. 33, n. 6, A-236.

(A103) Lugert, Courtney M., Jacobi, Robert D., Wehn, Karen S., Fountain, John C., and Zybala, Jon G., 2002, Coincidence of fracture intensification domains with Trenton-Black River faulting in the Finger Lakes region, New York State: Part 1, Seneca Lake: Geol. Soc. Am., Northeastern Section Annual Meeting (Springfield, MA) Abstracts, v. 34, n. 1, p. A-3.

(A104) Wehn, Karen S., Lugert, Courtney M., Jacobi, Robert D., Fountain, John C., and Zybala, Jon G., 2002, Coincidence of fracture intensification domains with Trenton-Black River faulting in the Finger Lakes region, New York State: Part II, Cayuga Lake: Geol. Soc. Am., Northeastern Section Annual Meeting (Springfield, MA) Abstracts, v. 34, n. 1, p. A-3.

(A105) Witmer, Todd C., Jacobi, Robert D., and Zybala, Jon G., 2002, Fractures in the Collins Center 7.5' quadrangle, western New York State: Implications for faulting: Geol. Soc. Am., Northeastern Section Annual Meeting (Springfield, MA) Abstracts, v. 34, n. 1, p. A-3.

(A106) Nelson, Travis, Fountain, John, Jacobi, Robert, Witmer, Todd C., and Bieber, Richard, 2002, The use of soil gas surveys to delineate subsurface structure: cross-strike discontinuity locations for the Bass Island Trend in western New York: Geol. Soc. Am., Northeastern Section Annual Meeting (Springfield, MA) Abstracts, v. 34, n. 1, p. A-3.

(A107) Jacobi, Robert D., Fountain, John C., Lugert, Courtney M., Wehn, Karen S., Nelson, Travis, Budney, Lucas, and Zybala, Jon G., 2002, Fracture Intensification Domains, fracture flow, and Trenton-Black River faults in the Finger Lakes region, NYS: Geol. Soc. Am., Northeastern Section Annual Meeting (Springfield, MA) Abstracts, v. 34, n. 1, p. A-11.

(A108) Jacobi, Robert D., Mitchell, Charles, Brett, Carlton, and Baird, Gordon, 2002, Soft-sediment deformation and the Prospect Fault, Taconic convergence, Mohawk Valley, central New York State: Geol. Soc. Am., Northeastern Section Annual Meeting (Springfield, MA) Abstracts, v. 34, n. 1, p. A-73.

(A109) Jacobi, Robert D., Fountain, John C., Nelson, Travis, and Lugert, Courtney M., 2002, Reactivated Precambrian faults in the Appalachian Basin of NYS: Geol. Soc. Am., Abstracts with programs, v. 34, n. 6, p. 79.

(A110) Blasco, Steve M., Lewis, Michael C. F., Jacobi, Robert D., Covill, Robert D., Keyes, Darren, Armstrong, Derek, and Harmes, Robert A., 2003, Bedrock pop-ups western Lakes Ontario, eastern Lake Erie and eastern Lake Huron: Evidence of neotectonic

activity on the lakebed of the southern Great Lakes: Geological Society of America, Abstracts with Programs, v. 35, n. 3, p.76-77.

(A111) Lewis, C. F. M., Blasco, S. M., Forsyth, D. A., Mayer, L. A., Dijkstra, S. J., Jacobi, R. D., Todd, B. J., Parrott, D. R., and Coakley, J. P., 2003, Do Quaternary sediments register paleoseismicity or neotectonic rejuvenation of ancient faults beneath Lake Ontario: Geological Society of America, Abstracts with Programs, v. 35, n. 3, p.77.

(A112) Cross, Gareth E., Smith, Langhorne, Lupulescu, Marian, Nyahay, Richard, and Jacobi, Robert D., 2003, Normal fault-related dolomitization and fracturing, Mohawk Valley, east-central New York State: Geological Society of America, Abstracts with Programs, v. 35, n. 3, p.14.

(A113) Jacobi, Robert D. , Fountain, John, Lugert, Courtney, Nelson, Travis, Smith, Gerald, and Industrial Associates, 2003, Characteristics of Trenton/Black River structures in the Finger Lakes: Progress Report": Central New York Association of Professional Geologists 2003 Spring Symposium; Syracuse, NY; p. (rdj) 1-23.

(A114) Jacobi, Robert D., Fountain, John, Lugert, Courtney, Nelson, Travis, Smith, Gerald, Mroz, Thomas, and Martin, John, 2003, Identifying Trenton/Black River targets in the northern Appalachian Basin (NYS): Demonstration of integrated exploration tools: American Assoc. Petrol. Geol. Annual Meeting program, v. 12, p. A44

(A115) Staskowski, R. J., Jacobi, R. D., and Everett, J. R., 2003, Fracture analysis for petroleum exploration of Ordovician to Devonian fractured reservoirs in New York State using satellite imagery: American Assoc. Petrol. Geol. Annual Meeting Program, v. 12, p. A162.

(A116) Smith, G.J., and Jacobi, R.D., 2003, Clastic Depositional Environments and Sequence Stratigraphy in the Acadian Foreland Basin in Western New York State; American Assoc. Petrol. Geol. Annual Meeting Program, Salt Lake City, v.12, p. A159.

(A117) Jacobi, Robert D., Fountain, John, Lugert, Courtney, Nelson, Travis, Smith, Gerald, and Industrial Associates, 2003, Characteristics of Trenton/Black River structures in the Finger Lakes: Progress Report: Silver Jubilee Anniversary Symposium (Dr. Gerald Friedman, organizer), Northeastern Science Foundation (Troy NY): p. 23-24.

(A118) Jacobi, Robert D., Loewenstein, Stuart, Smith, Gerald, Fountain, John, and Nelson, Travis, 2004, Faults and hydrocarbon resources in the Appalachian Basin of New York State: Geological Society of America, Abstracts with Programs, v. 36, n. 2, p.146.

(A119) Jacobi, R. D. and Smith, G.J., 2004, Geologic mapping in the Appalachian Basin of western New York State; Geological Society of America, Abstracts with Programs, v. 36, n. 2, p. 58.

(A120) Nelson, Travis A., Fountain, John C., Jacobi, Robert, Smith, Gerry, Cross, Gareth, Witmer, Todd, and Bieber, Richard, 2004, The relationship of state-wide soil gas surveys to fracture data and lineaments: delineation of subsurface structures related to

hydrocarbons: Geological Society of America, Abstracts with Programs, v. 36, n. 2, p. 146.

(A121) Drechsel, Cheri A., Jacobi, Robert D., Everett, John R., and Staskowski, Ronald J., 2004, ASTER lineaments, faults, and reservoirs in the Appalachian Basin of New York State: Geological Society of America, Abstracts with Programs, v. 36, n. 2, p. 146.

(A122) Cross, Gareth E., Jacobi, Robert D., Smith, Langhorne, Nyahay, Richard, and Lupulescu, Marian, 2004, Taconic faults and mineralization: outcrop analog for Ordovician hydrocarbon plays in the Appalachian Basin: Geological Society of America, Abstracts with Programs, v. 36, n. 2, p. 146.

(A123) Smith, G.J. and Jacobi, R. D., 2004, Upper Devonian Sands in New York State: Examples of Storm-Generated Offshore Sand-Ridges; American Assoc. Petrol. Geol. Annual Meeting Program, v. 13, p. A130.

(A124) Jacobi, Robert D., Smith, Gerald, Fountain, John, Fagan, JP, and Industrial Associates, 2004, Fault systems in New York State and carbonate reservoirs: Trenton/Black River and younger plays: American Assoc. Petrol. Geol. Annual Meeting Program, v. 13, p. A70.

(A125) Everett, John. R., Staskowski, Ronald J., and Jacobi, Robert D., 2004, Geochemical indications of fractured carbonate reservoirs in New York from ASTER data: American Assoc. Petrol. Geol. Annual Meeting Program, v. 12, p. A43.

(A126) Jacobi, Robert D., and Lewis, C. F. Michael, 2004, Pop-Up Field in Lake Ontario Southeast of Toronto, Canada: Indicators of Late Glacial and Post-Glacial Strain: Eos, Transactions, American Geophysical Union, v. 85 (17), Joint Assembly Supplement Abstract # S21A-03.

(A127) Jacobi, Robert D., Loewenstein, Stuart, Smith, Gerald, Fountain, John, Lugert, Courtney, and Martin, John, 2004, Iapetan Opening/Rome Trough-Related Faults and Their Reactivation History in New York State: AAPG Eastern Section Meeting Abstracts, http://www.searchanddiscovery.com/documents/abstracts/2004eastern/jacobi02.htm Accessed January 3, 2005.

(A128) Jacobi, Robert D., Loewenstein, Stuart, Smith, Gerald, Fountain, John, Lugert, Courtney, Mroz. Tom, and Martin, John, 2004, Fault Systems and the Trenton/Black River Play in New York State: AAPG Eastern Section Meeting Abstracts, http://www.searchanddiscovery.com/documents/abstracts/2004eastern/jacobi01.htm Accessed February 10, 2005.

(A129) Lugert, Courtney M., and Jacobi, Robert D., 2005, Tracing deep structure: Fracture analysis in the Finger Lakes region of the Appalachian Plateau, New York State: Geological Society of America, Abstracts with Programs, v. 37, n. 1, p. 4.

(A130) Cruz, Cheri, Jacobi, Robert D., Everett, John R., and Staskowski, Ronald J., 2005, ASTER and Landsat lineaments in central NYS: Image processing and groundtruthing for fractures: Geological Society of America, Abstracts with Programs, Geological Society of America, Abstracts with Programs, v. 37, n. 1, p. 58.

(A131) Jacobi, Robert, Loewenstein, Stuart, Smith, Gerald, and Martin, John, 2005, Ordovician fault systems in the Appalachian Basin of New York State: Geological Society of America, Abstracts with Programs, v. 37, n. 1, p. 5.

(A132) Agle, Paul, Jacobi, Robert D., Cross, Gareth E., and Mitchell, Charles E., 2005, Fractures and veins related to Taconic-aged faults in the Mohawk Valley: Geological Society of America, Abstracts with Programs, v. 37, n. 1, p. 3.

(A133) Terech, Nicholas, Jacobi, Robert D., McGuire Kelly, and Agle, Paul, 2005, Fracture patterns, lineaments, and seismic reflection data: integration for fault mapping in the Appalachian basin of east-central New York State: Geological Society of America, Abstracts with Programs, v. 37, n. 1, p. 83.

(A134) Jacobi, R. D., Loewenstein, S., and Smith, G. 2005: Seismic Data Bearing on Iapetan Opening/Rome Trough-Related Faults, Their Reactivation History and Effect on Deposition in the Appalachian basin of New York State: AAPG National Meeting Abstracts,
http://www.searchanddiscovery.com/documents/abstracts/2005annual_calgary/abstracts/jacobi.htm
Accessed May 4, 2006

(A135) Smith, G. J., and Jacobi, R. D., 2005, The Influence of Basement Structures on Upper Devonian Deposition in New York State: AAPG National Meeting Abstracts,
http://www.searchanddiscovery.com/documents/abstracts/2005annual_calgary/abstracts/smith03.htm
Accessed May 4, 2006.

(A136) Jacobi, Robert D. Loewenstein, Stuart, and Smith, Gerald, 2006, Seismic Evidence for Iapetan Fault Control of the Arcuate Map Pattern of the Pennsylvania Salient: Geological Society of America, Abstracts with Programs, v. 41, n. 2, p. 84.

(A137) Agle, Paul, Jacobi, Robert, and Mitchell, Charles, 2006, Fault-Related Fractures, Veins, And Fluid Migration; Mohawk Valley, NYS: Geological Society of America, Abstracts with Programs, v. 41, n. 2, p. 85.

(A138) Ahmed, Khurrum, Loewenstein, Stuart, and Jacobi, Robert, 2006, Characteristics Of The Bradley Brook Field; The Eastern-Most Economically Productive Gas Field In The Appalachian Basin In New York State: Geological Society of America, Abstracts with Programs, v. 41, n. 2, p: 66.

(A139) McGuire, Kelly M., Jacobi, Robert D., Terech, Nicholas, and Agle, Paul, 2006, Integration Of Fracture Patterns And Lineaments For Fault Mapping In The Appalachian

Basin Of Central New York State: Geological Society of America, Abstracts with Programs, v. 41, n. 2, p. 69.

(A140) Stroup, Joshua T., Jacobi, Robert, and Nelson, Travis, 2006, Fracture Intensification Domains, Lineaments And Faults In The Skaneateles Lake Region Of The Alleghanian Plateau Of New York State: Geological Society of America, Abstracts with Programs, v. 41, n. 2, p. 69.

(A141) Martin, J.P. and Jacobi, R.D., 2006, Understanding hydrothermal alteration of the Ordovician carbonate platform of New York State: Implications for hydrocarbon exploration (abstract): Geological Association of Canada-Mineralogical Association of Canada, GAC-MAC Abstracts Volume, v. 31, p. 97.

(A142) Agle, Paul A., Jacobi, Robert D., and Mitchell, Charles E., 2006, Mohawk Valley Exposures as Outcrop Analogs for the T/Br Finger Lakes Play, New York State: AAPG Eastern Section Meeting Abstracts (Buffalo, NY), http://www.searchanddiscovery.com/documents/2006/06091eastern/abstracts/agle.htm, Accessed January 29, 2007

(A143) Jacobi, Robert D., Kim, Jon, Agle, Paul A., Gale, Marjorie, Cross, Gareth, Becker, Laurence, Mitchell, Charles, and Smith, Gerald, 2006, Generation of Lower Paleozoic Carbonate Reservoirs in the Appalachian Basin of NYS: the Plate Tectonic Connection: AAPG Eastern Section Meeting Abstracts (Buffalo, NY), http://www.searchanddiscovery.com/documents/2006/06091eastern/abstracts/jacobi02.htm, Accessed January 29, 2007

(A144) Jacobi, Robert D., Loewenstein, Stuart, Smith, Gerald, Martin, John Martin, and Mroz, Tom, 2006, Separating the Spiderweb of Faults in the Northern Appalachian Basin of NYS and PA: Grenvillian to Present Fault Activity That Influenced Reservoir Development: AAPG Eastern Section Meeting Abstracts (Buffalo, NY), http://www.searchanddiscovery.com/documents/2006/06091eastern/abstracts/jacobi.htm, Accessed January 29, 2007

(A145) McGuire, Kelly M., Jacobi, Robert D., Terech, Nicholas, and Agle, Paul, 2006, Integration of Fracture Patterns and Lineaments for Fault Mapping in Southwestern Chenango County, New York: AAPG Eastern Section Meeting Abstracts (Buffalo, NY), http://www.searchanddiscovery.com/documents/2006/06091eastern/abstracts/mcguire.htmAccessed January 29, 2007

(A146) Stroup, Joshua T., Jacobi, Robert D., and Nelson, Travis, 2006, Fracture Intensification Domains, Lineaments and Faults in the Skaneateles Lake Region of the Alleghanian Plateau of New York State: AAPG Eastern Section Meeting Abstracts (Buffalo, NY), http://www.searchanddiscovery.com/documents/2006/06091eastern/abstracts/stroup.htm, Accessed January 29, 2007

(A147) Mitchell, Charles E., Jacobi, Robert D., Carey, Adam C., Samson, Scott D., Sell, Bryan K., Leslie, Stephen A., and Ganis, G. Robert, 2006, Regional Age and Facies Relations in the Black River, Trenton, and Utica Groups of the Central and Northern Appalachian

Basin: Potential for Testing Models of Tectonic Control on Fractured Reservoir Genesis: AAPG Eastern Section Meeting Abstracts (Buffalo, NY), http://www.searchanddiscovery.com/documents/2006/06091eastern/abstracts/mitchell.htmAccessed January 29, 2007

(A148) Jacobi, Robert D., Kim, Jon, Agle, Paul A., Gale, Marjorie, Becker, Laurence, Mitchell, Charles, and Smith, Gerald, 2006, Generation of Lower Paleozoic Carbonate Reservoirs in the Appalachian Basin of New York State: Faults, Timing, and the Plate Tectonic Connection: IOGA/OPI Annual Meeting (Niagara Falls, Ontario, November 3, 2006)

(A149) Smith, Gerald J. and Jacobi, Robert D., 2007, Upper Devonian sequence stratigraphy of the Acadian Foreland Basin: field observations on trace fossils and the development of the Catskill Delta Complex, IN: James A. MacEachern, Murray K. Gingras, Kerrie L. Bann and George Pemberton, Eds., Ichnological Applications to Sedimentological and Sequence Stratigraphic Problems: SEPM Research Conference (Price, Utah, May 20-26, 2007), p. 123-125.

(A150) Jacobi, Robert D., Loewenstein, Stuart, Smith, Gerald, Martin, John, and Mroz, Thomas, 2007, The Pennsylvania salient: seismic and other evidence for an Iapetan arcuate rift influence on the arcuate map pattern: Geological Society of America 2007 national convention.
http://gsa.confex.com/gsa/2007AM/finalprogram/abstract_130259.htm
Accessed May 22, 2008

(A151) Jacobi, Robert D., Kim, Jon, Agle, Paul A., Gale, Marjorie, Becker, Laurence, Mitchell, Charles, and Smith, Gerald, 2007, Generation of Lower Paleozoic Carbonate Reservoirs in the Appalachian Basin of NYS: The Plate Tectonic Connection: IOGA Annual Meeting (Buffalo, NY, November 6, 2007)

(A152) Jacobi, Robert, Agle, Paul, Loewenstein, Stuart, Smith, Gerald, Kim, Jon, Gale, Marjorie, and Becker, Larry, 2008, What can the craton tell us about Appalachian tectonics from Iapetan Opening through the Taconic Orogeny?: Geological Society of America, Abstracts with Programs, v. 4xx, n. xx, p. xxx.
http://gsa.confex.com/gsa/2008NE/finalprogram/abstract_134660.htm
Accessed May 22, 2008

(A153) Agle, Paul, Jacobi, Robert D., and Coulter, Stephen, 2008, Horizontal T/BR core from NYS: Connection to regional tectonics and exploration implications: Geological Society of America, Abstracts with Programs, v. 4xx, n. xx, p. xxx.
http://gsa.confex.com/gsa/2008NE/finalprogram/abstract_134996.htm
Accessed May 22, 2008

(A154) Brett, Carlton E. McLaughlin, Patrick, and Jacobi, Robert D., 2008, Widespread soft-sediment deformation intervals in Silurian strata of the Appalachian Basin: seismically induced event horizons: Geological Society of America, Abstracts with Programs, v. 4xx, n. xx, p. xxx.
http://gsa.confex.com/gsa/2008NC/finalprogram/abstract_137984.htm
Accessed May 22, 2008

(A155) Jacobi, Robert, Agle, Paul, Evans, Mark, Coulter, Steve, Loewenstein, Stuart, Mroz, Tom, and Martin, John, 2008, Taconic Tectonics and the Trenton/Black River Carbonate Gas Play in the Northern Appalachian Basin of New York State: Evidence from Seismic Data and the First Oriented Horizontal Core in the Appalachian Basin T/BR: CSPG 2008 C3Geo Convention, Core Conference Abstracts (Calgary, Alberta, Canada) http://www.geoconvention.org/2008abstracts/268.pdf Accessed May 22, 2008

(A156) Marner, Paula, Packard, Jeffrey, Coulter, Steve, Jacobi, Robert, and Agle, Paul, 2008, Cores from the Trenton-Black River (Ordovician) HTD Play in the Quackenbush Hill Field, Chemung County, New York: CSPG 2008 C3Geo Convention, Core Conference Abstracts (Calgary, Alberta, Canada), p.35-53

(A157) Jacobi, Robert, Agle, Paul, Smith, Gerald, Lugert, Courtney, Seever, Jodi, Cross, Gareth, and Loewenstein, 2008, Faulting and fracture heterogeneity in black shales of the Appalachian Basin of New York State: Geological Society of America, Abstracts with Programs, v. 40, n.6 (2008 Joint Annual Meeting, Houston, TX), p. 233.

(A158) Smith, G.J., Jacobi, R.D., Seever, J.L., and Loewenstein, S., 2008, Fault controls on Devonian black shales in the northern Appalachian foreland basin; Geological Society of America Annual Meeting Abstracts with Programs, v 40, p. 233.

(A159) Jacobi, Robert, Agle, Paul, Fisher, Jodi, Loewenstein, Stu, Smith, Gerald J., 2009, Structural anomalies in black shales of the Northern Appalachian Basin in New York State: AAPG National Convention, Denver CO: http://aapg09.mapyourshow.com/2_1/sessions/session.cfm?ScheduledSessionID=1499&CFID=16152370&CFTOKEN=3b543333e4ce88c0-36743E0A-BC23-81A0-83A1E92588CB683E (accessed 4/24/10).

(A160) Smith, G.J., and Jacobi, R.D., Seever, J.L., and Loewenstein, S., 2009, The influence of basement structures on Devonian black shale thicknesses in the northern Appalachian foreland basin; 2009 AAPG Annual Meeting Official Program, Denver, v. 18, p. 198.

(A161) Fisher, Jodi., Jacobi, Robert., Martin, John., 2010, Compilation of structural features in the northern Appalachian Basin of New York State to assist in site evaluation and CO2 sequestration: Geol. Soc. . Am. Abstracts with Programs, Vol. 42, No 1, p. 121

(A162) Hanson, S.L., Jacobi, R.D., Mitchell, C.E., and Roloson, M., 2010, Detailed structure study of the Utica, Schenectady, and Trenton- Black River in core 75-NY-2 in the Mohawk Valley, NY: Geol. Soc. Am. Abstracts with Programs, v. 42, No 1, p. 171.

(A163) Zelazny, M.M., Csatho, B., Jacobi, R.D., 2010, Lineament identification in New York State using remote sensing techniques for geological CO2 sequestration: Geol. Soc. Am. Abstracts with Programs, v. 42., no. 1, p. 121.

(A164) Tamulonis, Kathryn, Jordan, Theresa, Slater, Brian, Jacobi, Robert D., and Martin, John P., 2010, regional stratigraphy of the Queenston Formation in New York State and its

implications for geologic carbon storage potential: Geol. Soc. Am. Abstracts with Programs, v. 42, No 1, p. 62.

(A165) Jacobi, Robert D., Loewenstein, Stuart, Leaver, Al, Smith, Gerald, Martin, John, and Mroz, Thomas, 2010, The Pennsylvania Salient: An example of the ragged Iapetan rifted margin of Laurentia: Geol. Soc. Am. Abstracts with Programs, v. 42, No 1, p. 58.

(A166) Hanson, Stacey L., Jacobi, Robert D., and Mitchell, Charles E., 2010, Structure and Geochemistry of a Cambro-Ordovician 360m Core from Saratoga Springs Region, New York State: Implications for Tectonics, Gas Exploration, and CO_2 Sequestration: Eastern Section AAPG, 2010 Annual meeting (Kalamazoo, MI) http://www.searchanddiscovery.com/abstracts/pdf/2010/eastern/abstracts/ndx_hanson.pdf accessed 9/20/2011

(A167) Jacobi, Robert D., Leaver, Al, Loewenstein, Stu, Fisher, Jodi, and Smith, Gerald, 2010, Structural Anomalies in Black Shales of the Northern Appalachian Basin of New York State: Eastern Section AAPG, 2010 Annual meeting (Kalamazoo, MI) http://www.searchanddiscovery.com/abstracts/pdf/2010/eastern/abstracts/ndx_jacobi.pdf accessed 9/20/2011

(A168) Mitchell, Charles E., Jacobi, Robert D., Roloson, Melissa, and Hanson, Stacey, 2010, Characteristics of the Utica Black Shale in NY and PA: Black Shale Blanket or Complex Facies Mosaic?: Eastern Section AAPG, 2010 Annual meeting (Kalamazoo, MI) http://www.searchanddiscovery.com/abstracts/pdf/2010/eastern/abstracts/ndx_mitchell.pdf, accessed 9/20/2011

(A169) Jacobi, Robert D., Jordan, Teresa, Becker, Matthew, Csatho, Beata, Derry, Louis A., Frappa, Rick, Phipps Morgan, Jason, Brown, Larry, Tamulonis, Kathryn, and Castagna, Marta, 2011, CO2 Sequestration in Central New York State: Geol. Soc. Am. Abstracts with Programs, http://gsa.confex.com/gsa/2011NE/finalprogram/abstract_186263.htm accessed 9/15/2011

(A170) Jacobi, Robert D., Smith, Gerald, and Fisher, Jodi L, 2011, Post-Depositional Fault Effects In Black Shales of the Appalachian Basin of New York State: Fracture/Fault Heterogeneity and Thermal Maturity: Geol. Soc. Am. Abstracts with Programs, http://gsa.confex.com/gsa/2011NE/finalprogram/abstract_186071.htm, accessed 9/15/2011

(A171) Jacobi, Robert D., 2011, Faults in the Appalachian Basin of NYS: Geol. Soc. Am. Abstracts with Programs, http://gsa.confex.com/gsa/2011NE/finalprogram/abstract_185588.htm, accessed 9/15/2011

(A172) Smith, Gerald, Jacobi, Robert D., and Fisher, Jodi L, 2011, The Influence of Basement Structures on Ordovician and Devonian Black Shale Deposition and Post-Deposition in the Northern Appalachian Basin: Geol. Soc. Am. Abstracts with Programs, http://gsa.confex.com/gsa/2011NE/finalprogram/abstract_185580.htm, accessed 9/15/2011

(A173) Hanson, Stacey, Jacobi, Robert D., and Mitchell, Charles, E., 2011, Structure and Vein Isotopes of a Cambro-Ordovician 360m Core From the Saratoga Springs Region, New York State: Implications For Tectonics and Utica Gas Exploration: Geol. Soc. Am. Abstracts with Programs, http://gsa.confex.com/gsa/2011NE/finalprogram/abstract_185523.htm, accessed 9/15/2011

(A174) Jacobi, Robert, 2011, Faults in the Appalachian Basin of New York State: AAPG Geosciences Technology Workshop, Success in the Marcellus and Utica Shales: Case Studies and New Developments: Baltimore MD, p. 3.

(A175) Jacobi, Robert, 2011, Post-depositional fault effects in black shales of the Appalachian Basin of New York State: fracture/fault heterogeneity and thermal maturity: AAPG Geosciences Technology Workshop, Success in the Marcellus and Utica Shales: Case Studies and New Developments: Baltimore MD, p. 3.

(A176) Jacobi, Robert D., Cruz, Cheri, Leaver, Al, and Fisher, Jodi, 2011, Seismic Signatures of Faults in the Appalachian Basin of NYS, and the Effect of These Faults on Devonian Black Shales: An Update: Eastern Section AAPG, 2011 Annual meeting (Washington, DC)
http://www.searchanddiscovery.com/abstracts/pdf/2011/eastern/abstracts/ndx_jacobi.pdf
Accessed 9/29/2011

(A177) Jacobi, Robert D., Jordan, Teresa, Becker, Matthew, Csatho, Beata, Derry, Louis A., Frappa, Rick, Phipps Morgan, Jason, Brown, Larry, Tamulonis, Kathryn, Castagna, Marta, Fisher, Jodi, Zelazny, Melissa, and Martin, John, 2011, CO_2 Sequestration in Central New York State: Update: Eastern Section AAPG, 2011 Annual meeting (Washington, DC)
http://www.searchanddiscovery.com/abstracts/pdf/2011/eastern/abstracts/ndx_jacobi02.pdf
Accessed 9/29/2011

(A178) Jones, Kyle, Mitchell, Charles E., Smith, Langhorne "Taury", Smith, Gerald, and Jacobi, Robert D., 2011, Testing Depositional Models and Basin Geometry for the Utica Shale, Mohawk Valley, New York State: Eastern Section AAPG, 2011 Annual meeting (Washington, DC)
http://www.searchanddiscovery.com/abstracts/pdf/2011/eastern/abstracts/ndx_jones02.pdf
Accessed 9/29/2011

(A179) LaGamba, Michael J., Jacobi, Robert D., O'hara, Alex P., and Hrywnak, Anna, 2012, Fracture Patterns in Marcellus Black Shale Across the Appalachian Basin of New York. State: NE Geol. Soc. Am. Abstracts with Programs, http://gsa.confex.com/gsa/2012NE/finalprogram/abstract_200105.htm, accessed 4/15/2012

(A180) Jacobi, Robert D., 2012, Taconic Convergence Faults in the Mohawk Valley of New York State: NE Geol. Soc. Am. Abstracts with Programs,

http://gsa.confex.com/gsa/2012NE/finalprogram/abstract_200756.htm, accessed 4/15/2012

(A181) Jones, Kyle W., Mitchell, Charles E., Jacobi, Robert D., and Smith, Gerald, 2012, Determining water depth of the Utica Shale, Mohawk Valley, New York State: NC Geol. Soc. Am. Abstracts with Programs, http://gsa.confex.com/gsa/2012NC/finalprogram/abstract_202964.htm, accessed 5/13/2012

(IV) Technical and Other Miscellaneous Reports

Jacobi, Robert and Fountain, John, 1992, Determination of the Seismic Potential of the Clarendon-Linden Fault System in Allegany County, Interim Progress Report: Presented 12/29/92 to NYSERDA, 309 pp.

Jacobi, Robert, and Fountain, John, 1994, Remote Sensing Akzo Pilot Project and Reconnaissance Structural Analyses: Results: Presented 6/5/94 to Akzo-Nobel Salt Inc., Retsof, NY, 17 pp.

Jacobi, Robert, 1994, Final Report for the Surface Bedrock Structure Survey of the Proposed New Mine Site: Presented 10/11/94 to Akzo-Nobel Salt Inc., Retsof, NY, 91 pp.

Jacobi, Robert and Fountain, John, 1995, Determination of the Seismic Potential of the Clarendon-Linden Fault System in Allegany County, Draft Final Report: Presented 4/1/95 to NYSERDA, 1734 pp.

Jacobi, Robert, 1995, Valley Anticline Report: Presented 7/12/95 to Akzo-Nobel Salt Inc., Retsof, NY, 8 pp.

Jacobi, Robert, 1995, Annotated Bibliography for Valley Effects, Horizontal Stress in Western New York and Other Structural Considerations: Presented 8/3/95 to Akzo-Nobel Salt Inc., Retsof, NY, 40 pp.

Jacobi, Robert, 1996, Preliminary Fracture Analyses of Video Images from Well 9414: Presented 4/14/96 to Akzo-Nobel Salt Inc., Retsof, NY, 90 pp.

Jacobi, Robert and Zhao, Meng, 1996, Rapid and rigorous outcrop fracture trace mapping and analyses, In Contaminant Hydrogeology in Fractured Bedrock (J. Fountain, Ed.): Geol. Soc. Am. (Northeast Section, Buffalo meeting) short course notes, p. 1-19.

Jacobi, Robert and Fountain, John, 1996, Determination of the Seismic Potential of the Clarendon-Linden Fault System in Allegany County, Final Report: Presented 6/10/96 to NYSERDA, 2106 pp. & 31 oversized maps.

Jacobi, Robert, Loewenstein, Stuart, and Romans, Brian, 1999, The Basal Sandstone in the Stahl #1 well, Wyoming County, New York; Is It a Correlative of the Rose Run Sandstone? Final Report: Presented 5/6/99 to NYSERDA, 16 pp.

Jacobi, Robert, Zack, Dino, Peters, Todd, and Kliese, Trish, 1999, Geological mapping in the Farmersville Township. New York State: preliminary report on fracture intensification domains and faults: New York Planning Federation (New York), 40p.

Jacobi, Robert, and Smith, Gerald, 2000, Part I, Core and cutting analyses, surface structure, faults and lineaments, and stratigraphic cross-sections based on previous investigations, *in*: Geologic Investigation of the Gas Potential in the Otsego County Region, Eastern New York State, Final Phase One Report to Millennium Natural Resources Development, L.L.C., (Robert Jacobi, Ed.): Final Report: presented to NYSERDA (Albany NY) on 9/8/00, 85 p.

Jacobi, Robert, Fountain, John, and Loewenstein, Stuart 2001, Demonstration of an exploration technique integrating Earthsat's Landsat lineaments, soil gas anomalies, and fracture intensification domains for the determination of subsurface structure in the Bass Island Trend, New York State, Draft Final Report: presented to NYSERDA (Albany NY) on 2/23/01, 181 p.

Robert Jacobi (Ed.), 2002, Geologic Investigation of the Gas Potential in the Otsego County Region, Eastern New York State, Final Phase One Report to Millennium Natural Resources Development, L.L.C.,: presented to NYSERDA (Albany NY) on 9/8/00, 131 p.

Jacobi, Robert, Fountain, John, deRidder, Edward, and Loewenstein, Stuart, 2001, Innovative methodology for the detection of fracture-controlled sweet spots in the northern Appalachian Basin, Semi-annual Technical Progress Report: DOE, Morgantown, WV, 161p.

Jacobi, R. D., Smith, G.J., and Zhao, M., submitted 2001. Geologic Map of Angelica 7 ½' Quadrangle: N.Y.S. Geological Survey Report.

Smith, G. J., Jacobi, R. D., and Baudo, A. I., submitted 2002, Geologic Map of the West Valley 7.5' Quadrangle: N.Y.S. Geological Survey Report.

Jacobi, R. D., Smith, G. J., and Guidetti, B. K., submitted 2002, Geologic Map of Ashford Hollow 7.5' Quadrangle: N.Y.S. Geological Survey Report.

Jacobi, R. D., Fountain, J., and Loewenstein, S., 2002, Demonstration of an exploration technique integrating Earthsat's Landsat lineaments, soil gas anomalies, and fracture intensification domains for the determination of subsurface structure in the Bass Island Trend, New York State, Final Report: presented to NYSERDA (Albany NY) on 7/22/02, 188 p.

Jacobi, Robert D., Fountain, John C., Nelson, Travis, Lugert, Courtney, and Smith, Gerald, 2002, Fractures, lineaments, and reservoirs: interim results of the NYSERDA/DOE Finger Lakes Project: IOGA 22nd Annual Summer Mtg, Peek 'n Peak, Clymer, NY (presentation)

Jacobi, Robert and Loewenstein, Stuart, 2003, Definition of Trenton/Black River Prospects in the Finger Lakes Region, New York State: Final Report: presented to NYSERDA (Albany, NY) on April 23, 2003, 103 p.

Jacobi, Robert and Smith, Gerald, 2004, Faults and the Farmersville Site: presented 4/12/04 to Arnold and Porter (NYC), 22 pp + 28 figs.

Jacobi, Robert D., 2003, Semi-Annual Technical Progress Report (December 31, 2002-May 31,

. 2003): Innovative Methodology for Detection of Fracture-Controlled Sweet Spots in the Northern Appalachian Basin: Department of Energy (NETL), Morgantown, WV, 30 pp. + 81 figures.

Jacobi, Robert D., 2004, Semi-Annual Technical Progress Report (June 1, 2003-December 31, 2004): Innovative Methodology for Detection of Fracture-Controlled Sweet Spots in the Northern Appalachian Basin: Department of Energy (NETL), Morgantown, WV, 32 pp. + 31 figures.

Smith, G. J. and Jacobi, R. D., 2003, Preliminary Geologic Map of the Delevan 7.5' Quadrangle: NYS Geological Survey, open file report.

Jacobi, Robert D., 2006, Semi-Annual Technical Progress Report (January 1, 2006-June 30, 2006): Innovative Methodology for Detection of Fracture-Controlled Sweet Spots in the Northern Appalachian Basin: Department of Energy (NETL), Morgantown, WV, 19 pp.

Jacobi, Robert D., 2007, Final Technical Report (May 31, 2000-May 15, 2007): Innovative Methodology for Detection of Fracture-Controlled Sweet Spots in the Northern Appalachian Basin: Department of Energy/NETL, Morgantown, WV, 453 pp.

Jacobi, Robert D., 2007, Natural gas exploration in Chenango County, New York State: Economic development of stacked reservoirs: NYSERDA (Albany NY) Final report, 62 pp, 94 figures, and 30 tables.

Jacobi, Robert, Jordan, Terry, Frappa, Rick, Becker, Matt, Brown, Larry, Csatho, Bea, Derry, Lou, Phipps Morgan, Jason, 2009, CO_2 sequestration: capacity, security, & enhanced gas recovery in central New York State: NYSERDA (Albany NY), Quarterly Progress Report, 225 pp.

Jacobi, Robert, Jordan, Terry, Frappa, Rick, Becker, Matt, Brown, Larry, Csatho, Bea, Derry, Lou, Phipps Morgan, Jason, 2009, CO_2 sequestration: capacity, security, & enhanced gas recovery in central New York State: NYSERDA (Albany NY), Quarterly Progress Report, 131 pp.

Jordan, Teresa and Tamulonis, Kathryn, 2010, Task 4: Target Horizon Geology and Physical-Chemical Characteristics, *in* Robert Jacobi (Ed.), CO2 Sequestration: Capacity, Security, & Enhanced Gas Recovery in Central New York State: NYSERDA (Albany NY), Final Report Part 1, 84 pp.

Marta Castagna, Matthew Becker, Richard Frappa, P.G., 2010, Subtask 5.1 Modeling Fluid Behavior, *in* Robert Jacobi (Ed.), CO2 Sequestration: Capacity, Security, & Enhanced Gas Recovery in Central New York State: NYSERDA (Albany NY), Final Report Part 2, 94 pp.

Jacobi, Robert, 2010, Geophysical and geological evidence for arcuate Iapetan opening rift faults in the Pennsylvania Salient and New York recess: implications for the ragged Laurentian margin: NYSERDA (Albany NY) Final Draft Report, 42 pp.

Jacobi, Robert D., 2011, Fracture and geochemical characteristics of fluid flow in Cambro-Ordovician Units, New York State: NYSERDA (Albany NY) Final report, 64 pp.

Jacobi, Robert D., 2011, Integration of remotely-sensed and geophysical data with ground-truth structure: evidence for fault systems in part of Cayuga County: NYSERDA (Albany NY) Final report, 88 pp.

Jacobi, Robert D., Zelazny, Melissa, and Csatho, Bea, 2011, Tasks 6.2/6.3/6.6/6.7, Task 6: Faults and fractures in the focus areas, Subtask 6.2: Lineaments for focus areas from new fused Landsat and ASTER images, Subtask 6.3: Lineaments for focus areas from a DEM, Subtask 6.6: Groundtruthing lineaments, and Subtask 6.7: Estimates of fracture character in the target reservoirs, *in* CO_2 sequestration: capacity, security, & enhanced gas recovery in central New York State (R. D. Jacobi, Ed): NYSERDA (Albany NY): Final Report, 127 pp.

Jacobi, Robert D., and Fisher, Jodi, 2012, Tasks 6.1/6.5, Task 6, Faults and fractures in the focus areas, Subtask 6.1 Collection of historical data, Subtask 6.5 Maps for the focus areas of lineaments along prominent aeromagnetic anomalies, *in* CO_2 sequestration: capacity, security, & enhanced gas recovery in central New York State (R. D. Jacobi, Ed): NYSERDA (Albany NY): Final Report, 241 pp.

Phipps Morgan, Jason, and Kirkpatrick, 2012, Sub-Task 5.3: Behavior of H_2O-NaCl-CO_2 fluids in reservoirs, coupled hydrodynamic-geochemical modeling, *in* CO_2 sequestration: capacity, security, & enhanced gas recovery in central New York State (R. D. Jacobi, Ed): NYSERDA (Albany NY): Final Report, 40 pp.

Derry, Lou,Task 5: Behavior of H_20-NaCl-CO_2 fluids in reservoirs, Sub-Task 5.2: Geochemical modeling -evaluation of the Geochemist's Workbench© software for reactive transport modeling with H_2O-NaCl-CO_2 fluids and sedimentary basin mineral assemblages, *in* CO_2 sequestration: capacity, security, & enhanced gas recovery in central New York State (R. D. Jacobi, Ed): NYSERDA (Albany NY): Final Report, 41 pp.

Attachment-E

Funding Breakdown for

The Shale Resources & Society Institute

Shale Resources and Society Institute (SRSI) Summary of Annual Funding

Amount Purpose

$60,000	John Martin – Research Professor (in-house title: Director of the Shale Resources and Society Institute). This is a paid appointment @ .25 FTE from the Arts and Sciences General Fund UBF. The department listed on the UBF form is the College of Arts and Sciences. His appointment term in 12/15/11 - 12/14/14.
$4,914	Fringe Benefit costs on above (approx.)
$12,000	Travel support for John Martin @ $1,000 flat rate per month. This is added to his bi-weekly paycheck from UBF. Travel is paid from the Arts and Sciences General Fund UBF account.
$41,928	Robert Jacobi – Professor of Geology (Co-Director of SRSI). This is a paid appointment @ .40 FTE in the Department of Geology funded from Geology's state operating account. His appointment term is 1/12/12 – 1/8/14.
$10,000	Robert Jacobi – Summer salary. He will receive $10,000 in each of Summers 2012 and 2013. This appointment will be paid from CAS Dean's Office state operating account.
$20,000	Operating support for the Institute funded from CAS Indirect Cost Recovery Revenue (RF).
$20,000	Staff support for the Institute @ .50 FTE. This has not yet been provided, but the funding source will be CAS Indirect Cost Recovery Revenue (RF). We have not yet received a request for this funding, but I am of the understanding that part of the funding will be used to increase the FTE of a current part-time RF employee in the Department of Geology.
$8,600	Fringe Benefit costs on above (approx.)
$177,442	Total Annual Funding for SRSI

Other Information:

- In addition to the paid appointment above, John Martin has a volunteer appointment in the Department of Geology. His title is Research Professor and the term of his volunteer appointment is 1/1/12 – 12/31/14.
- UBF account was also set up by Development for the Institute. However, there is no funding in the account.

Source: UB College of Arts and Sciences, Office of the Dean

Attachment – F

SRSI Report Issued 5/15/12

"Environmental Impacts: During Marcellus

Shale Gas Drilling: Causes, Impacts and Remedies"

Environmental Impacts

DURING MARCELLUS SHALE GAS DRILLING: CAUSES, IMPACTS, AND REMEDIES

TIMOTHY CONSIDINE CENTER FOR ENERGY ECONOMICS AND PUBLIC POLICY
SCHOOL OF ENERGY RESOURCES | THE UNIVERSITY OF WYOMING
ROBERT WATSON THE PENNSYLVANIA STATE UNIVERSITY
NICHOLAS CONSIDINE CENTER FOR ENERGY ECONOMICS AND PUBLIC POLICY
JOHN MARTIN SHALE RESOURCES AND SOCIETY INSTITUTE
UNIVERSITY AT BUFFALO - THE STATE UNIVERSITY OF NEW YORK

ERRATA: CHANGES FROM PREVIOUS VERSION

June 6, 2012

This version of the report corrects and/or clarifies portions of the report dated May 15, 2012. The information contained in this errata document supersedes the affected portions that report. We have corrected the following typographical errors, which do not affect the conclusions of the report:

Page 3, paragraph 1:	The units shown should have been trillion cubic feet (TCF) rather than billion cubic feet (BCF).
Original version:	The Barnett shale in Texas was the first to be developed and produced 1.936 *billion cubic feet (BCF)* of natural gas during 2011.[2] The Haynesville shale now appears to be the largest shale gas-producing field, according to the Energy Information Administration.[3] The third-largest producing field is the Marcellus in Pennsylvania and West Virginia, with estimated production of 1.2 *BCF* during 2011 (Considine, et al. 2011b).
Revision in this report:	The Barnett shale in Texas was the first to be developed and produced 1.936 *trillion cubic feet (TCF)* of natural gas during 2011.2 The Haynesville shale now appears to be the largest shale gas-producing field, according to the Energy Information Administration.3 The third-largest producing field is the Marcellus in Pennsylvania and West Virginia, with estimated production of 1.2 *TCF* during 2011 (Considine, et al. 2011b).
Page 30, fourth bullet:	The third word "number" should read "rate."
Original version:	Both the *number* of environmental violations and subsequent environmental events that caused some physical impact on the environment steadily declined over the past four years, in conjunction with action by state regulators.
Revision in this report:	Both the *rate* of environmental violations and subsequent environmental events that caused some physical impact on the environment steadily declined over the past four years, in conjunction with action by state regulators.

ENVIRONMENTAL IMPACTS

DURING MARCELLUS SHALE GAS DRILLING: CAUSES, IMPACTS, AND REMEDIES

REPORT 2012 - 1

TIMOTHY CONSIDINE
CENTER FOR ENERGY ECONOMICS AND PUBLIC POLICY
SCHOOL OF ENERGY RESOURCES | THE UNIVERSITY OF WYOMING

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THE PENNSYLVANIA STATE UNIVERSITY

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* The authors gratefully acknowledge comments from Scott Anderson of the Environmental Defense Fund, Andrew Hunter of Cornell University, Robert Jacobi of the University at Buffalo - The State University of New York, Brigham McCown of United Transportation Advisors, LLC, and George Rusk of Ecology and Environment, Inc. with the usual disclaimer that the authors accept full responsibility for any remaining errors and omissions.

Executive Summary

The development of shale gas through hydraulic fracturing has awakened what some have described as an American energy renaissance. Shale gas formations thought to be economically unrecoverable as recently as a decade ago now provide nearly 25 percent of our nation's total natural gas supply. According to the Energy Information Administration's reference case forecast of April 2011, natural gas production from shale formations will comprise 46.5 percent of total U.S. dry gas production in 2035.

The investments under way for developing these shale resources are generating tens of thousands of jobs, billions in state and local tax revenues, and hundreds of billions in direct economic activity. Indirect benefits to oil and gas suppliers, to U.S. manufacturers that utilize natural gas as a feedstock, and to consumers enjoying lower electricity and heating bills multiply the already substantial direct economic gains. In short, the incentives for states to encourage and facilitate development are substantial.

But surprisingly little comprehensive analysis exists to quantify the success or failure of states in effectively and safely managing natural gas development. Without such information, it is very difficult for regulators, elected officials, and citizens to engage in productive dialogue around natural gas development and the process of hydraulic fracturing. Whether considering regulatory changes in a state where development is already under way, or debating the permitting of natural gas development where it has not yet occurred, quantifying measurements of success are necessary for building consensus and making sound decisions.

To address this question, this study provides a detailed analysis of notices of violations (NOVs) from the Pennsylvania Department of Environmental Protection (PA DEP) from January 2008 through August 2011, categorizing each violation. Of the 2,988 violations, 1,844, or 62 percent, were for administrative or preventative reasons. The remaining 38 percent, or 1,144 NOVs, were for environmental violations. The number of these environmental violations, however, is a misleading metric because an individual event may be associated with multiple environmental violations. As such, the 845 unique environmental events considered in this study were associated with 1,144 NOVs.

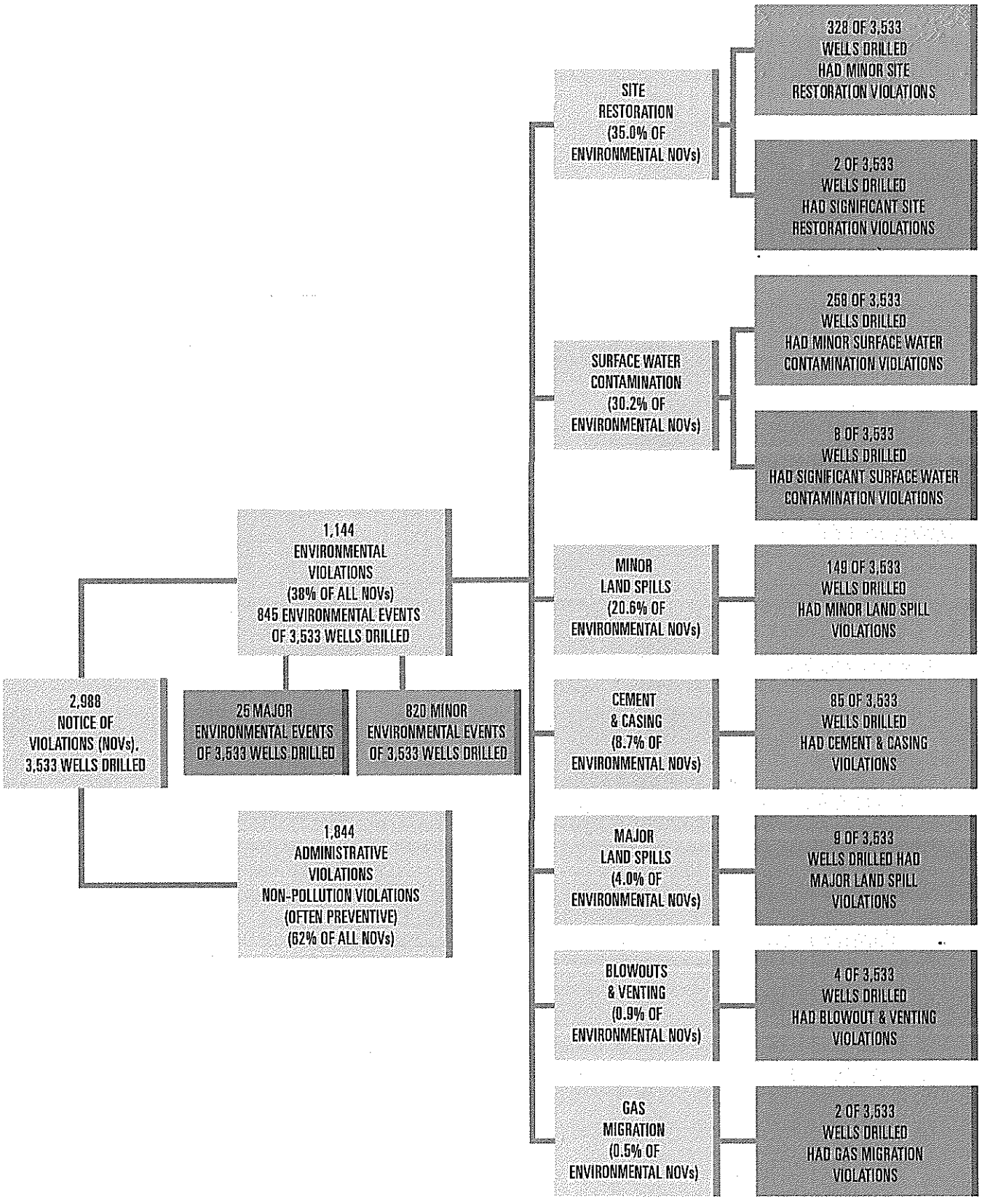
[The incidence of polluting environmental events [in Pennsylvania] declined 60 percent between 2008 and August 2011 ...]

To produce an accurate accounting of the environmental impacts of these 845 unique events, this study defines major and non-major environmental events through a detailed examination of NOV records.

Major environmental events are defined in this study to include major site restoration failures, serious contamination of local water supplies, major land spills, blowouts and venting, and gas migration. Our evaluation of NOV records identified 25 such events. In all but six cases, the resulting environmental impacts from major events have been mitigated.

Non-major environmental events concern site restoration, water contamination, land spills, and cement and casing events that do not involve what is classified as having major environmental impact. Many of the NOVs in this category, while resulting in measurable pollution, were rather

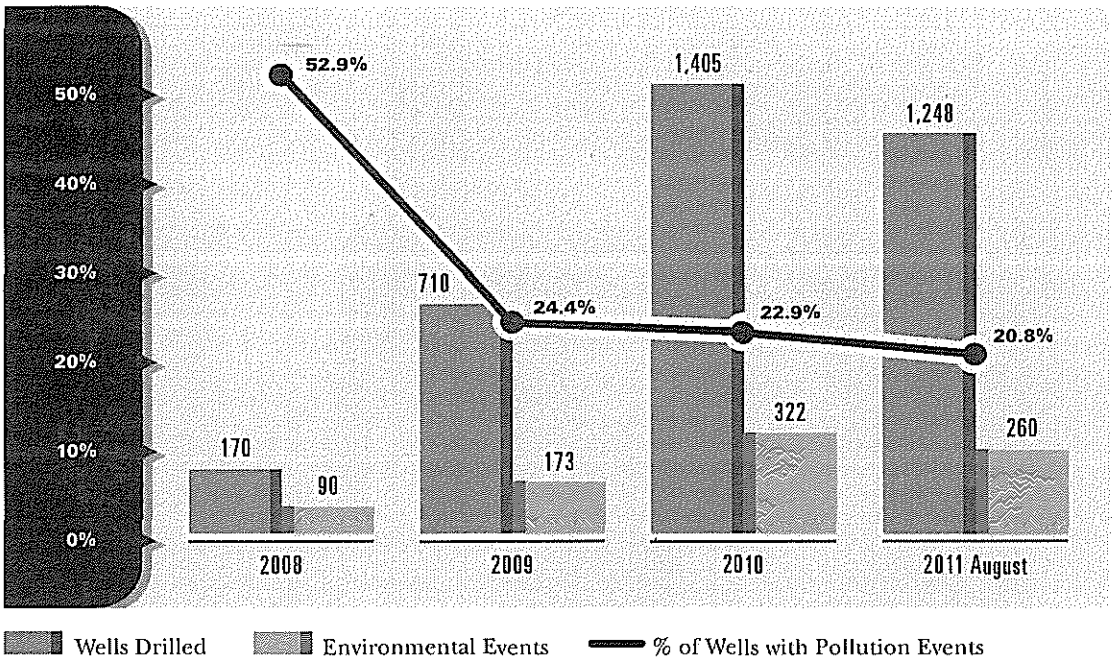
FIGURE ES1: ENVIRONMENTAL VIOLATIONS AND EVENTS IN PENNSYLVANIA MARCELLUS



minor, involving, for example, a gallon of diesel fuel or antifreeze spilled on the ground. The 820 non-major events identified, comprise the overwhelming majority of environmental NOV's issued by the PA DEP, as shown in figure ES 1.

Significantly, the incidence of polluting environmental events declined 60 percent between 2008 and August 2011, from 52.9 percent of all wells drilled in 2008 to 20.8 percent through August 2011 (Figure ES2). On this basis, the Marcellus industry has cut its incidence of environmental violations by more than half in three years, a rather notable indicator of improvement by the industry and oversight by the regulators.

FIGURE ES2:
WELLS DRILLED AND ENVIRONMENTAL EVENTS IN PENNSYLVANIA MARCELLUS



In conclusion, this study demonstrates that the odds of non-major environmental events and the much smaller odds of major environmental events are being reduced even further by enhanced regulation and improved industry practice. Moreover, the environmental impacts of most of these events have been almost completely mitigated by remedial actions taken by the companies.

The observed impacts of development in Pennsylvania captured within the paper provide a metric to gauge the regulatory proposal, known as the *Supplemental Generic Environmental Impact Statement* or SGEIS, currently under review in New York State. The last part of this study compares each of the 25 major incidents that occurred in Pennsylvania against New York's proposed SGEIS guidelines. Findings indicate that each of the underlying causes associated with these specific events could have been either entirely avoided or mitigated under New York State's proposed regulatory framework. This suggests that regulators are not only responding effectively within their states, but are learning and acting on the experiences of other states as well – a positive sign for the continued successful state regulation of natural gas development through hydraulic fracturing.

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1. Introduction

There are a growing number of states that are reviewing their regulations regarding shale energy development. This study examines New York as a representative example, since it has just completed a three-month public comment period addressing proposed environmental regulations governing shale gas development. A majority of citizens of New York may be supportive of oil and natural gas resource development if the environmental impacts appear manageable in light of the anticipated economic benefits. There is, however, a void of factual information concerning the environmental impacts, inadequate data on assessing the risks from development, and an incomplete articulation of strategies on how regulation may mitigate these impacts and risks.

Existing research previously conducted by Considine, et al. (2011a) provides a categorization of incidents in the Pennsylvania Marcellus Shale, parsing administrative failures from physical environmental events. There is, however, a noticeable lack of digestible research classifying physical incidents, and specific explanations of the causes and impacts associated with each category of physical incident. Offering this information is an important precursor to understanding the safeguards New York has adopted, and in communicating how regulation can prevent future incidents and protect local residents.

This study provides an extension of the research by Considine, et al. (2011a) with a more detailed analysis of notice of environmental violations (NOV) from the Pennsylvania Marcellus Shale industry. Not all environmental violations result in environmental pollution because many violations are citations for administrative failures or are issued to prevent pollution from occurring. Accordingly, this study makes the critical distinction between environmental violations and events, providing a complete enumeration and classification of environmental violations and the corresponding subset of events that resulted in actual, measurable pollution during drilling and completion operations in the Pennsylvania Marcellus. The categories for violations and events include drilling or well construction failures, surface handling and treatment of fluids, and failures in the drilling and completion process itself. Based upon this analysis, this study then examines how New York's proposed regulatory regime addresses these different categories of concern.

Coupling known risk with existing responses will both: 1) help the public differentiate between largely unrealized threats, such as migration of fracturing fluids out of a formation, and existing issues of concerns, such as improper surface disposal or wellhead and well casing failures, and 2) enable regulators to demonstrate strengths and potentially identify areas where state rules should be strengthened.

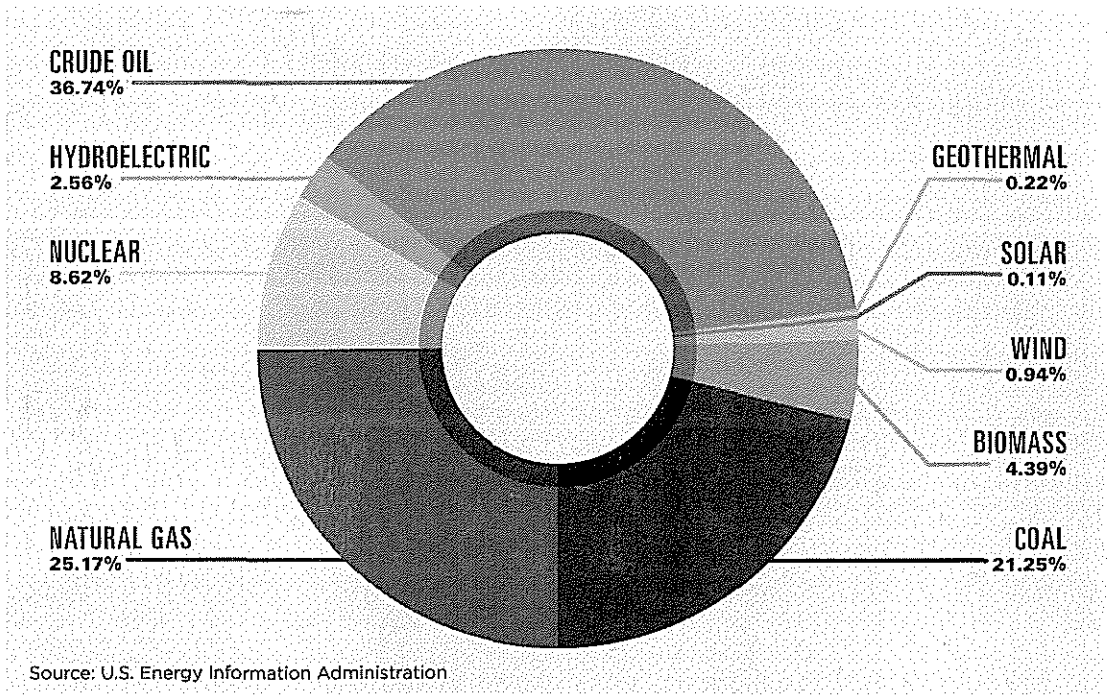
To quantify these risks and assess their impacts, this study provides a detailed analysis of environmental violations incurred during the drilling of natural gas wells in the Pennsylvania Marcellus from 2008 through 2011. The analysis of environmental violations estimates their probability of occurrence and severity, and identifies their causes, describing the response of natural gas production companies, available technologies to remedy these problems, and the implications for regulation.

The structure of this study is as follows. The next section provides an overview of the emergence of the shale energy industry. The study then provides a primer on the economic impacts from developing and producing energy from shale formations. What follows next is an overview of shale energy development, which is then followed by a discussion of complications associated with shale energy drilling and completion operations. The next three sections of the report provide the core analysis of the environmental violations and environmental events. A detailed discussion of 25 major environmental events appears in Appendix B. The implications for New York State regulatory policy are presented in section eight. The study concludes with a summary of the main findings and recommendations.

2. Emergence of Shale Energy

The U.S. economy is powered by fossil fuels, with slightly more than 83 percent of domestic energy consumption supplied by oil, natural gas, and coal. Oil leads with a share of 36.7 percent, natural gas is second with 25.2 percent, and coal provides 21.3 percent of total energy consumption (see Figure 1). Nuclear energy supplies 8.62 percent of total consumption, with biomass and hydroelectricity providing 4.39 percent and 2.56 percent, respectively. Wind energy provided 0.94 percent of total energy consumption during 2010, up from 0.76 percent in 2009. Geothermal energy furnished 0.22 percent of total consumption during 2010. Finally, solar photovoltaic provided 0.11 percent during 2010 (see Figure 1).

FIGURE 1: SHARES OF TOTAL ENERGY CONSUMPTION BY SOURCE, 2010



Source: U.S. Energy Information Administration

The contribution from natural gas in total energy consumption has been rising in recent years, expanding from 22.3 percent in 2006 to 25.2 percent in 2010. Much of this increase has been due to greater use of natural gas in electric power generation. Since 2005, natural gas use in electricity production has increased 25 percent. In 2010, more than a third of U.S. end-use natural gas consumption occurred in electric power generation. The electricity industry is now the single largest user of natural gas, and will likely expand consumption significantly in future years to meet higher demand for electricity and to replace aging coal-fired power plants. Since natural gas electric power generation has only 41 percent of the carbon dioxide emissions of coal-fired power generation, such a transition could significantly reduce greenhouse gas emissions.[1]

1 According to data from the U.S. Energy Information Administration, net electricity generation from coal and natural gas in 2009 was 1,755,904 and 920,929 thousand megawatt hours, respectively, while emissions of carbon dioxide were 1,742.2 and 372.6 million metric tons from coal and natural gas, respectively.

These additional demands for natural gas have been increasingly supplied by shale gas production. There are three major shale gas plays in the United States. The Barnett shale in Texas was the first to be developed and produced 1.936 trillion cubic feet (TCF) of natural gas during 2011.[2] The Haynesville shale now appears to be the largest shale gas-producing field, according to the Energy Information Administration.[3] The third-largest producing field is the Marcellus in Pennsylvania and West Virginia, with estimated production of 1.2 TCF during 2011 (Considine, et al. 2011b). As conventional natural gas deposits deplete, the role of shale gas in the U.S. natural gas supply is likely to continue to increase. Indeed, the Energy Information Administration projects that the share of shale gas in total U.S. dry gas production will rise from 24.8 percent in 2011 to 46.5 percent in 2035.[4]

Shale resources also contain crude oil and petroleum liquids. The Marcellus Shale in Appalachia is emerging as a major producer of natural gas liquids such as propane and butane. These fuels are a critical input in petrochemical industries. Production of crude oil from the Bakken shale play in North Dakota is also increasing rapidly. For example, crude oil production from North Dakota rose from an average of 123,620 barrels per day during 2007 to 418,923 barrels per day during 2011 (North Dakota, 2011). From negligible amounts in 2007, the Eagle Ford shale play in south Texas produced 83,434 barrels per day during 2011 (Texas Railroad Commission, 2011). The Niobrara plays in eastern Colorado and Wyoming are also promising. Production from these new oil-producing areas and the deep waters of the Gulf of Mexico are reversing the long-term decline in U.S. oil production that began in the early 1970s.

This large reserve base suggests that it will take decades to fully develop the shale energy potential.

According to the Energy Information Administration (2011), there are nearly 24 billion barrels of technically recoverable oil and 862 trillion cubic feet of natural gas from shale resources. The Potential Gas Committee (2011) estimated that the total natural gas resource base for the United States is even larger at 1,898 trillion cubic feet. This large reserve base suggests that it will take decades to fully develop the shale energy potential.

2 http://www.rrc.state.tx.us/barnettshale/index.php
3 http://205.254.135.7/todayinenergy/detail.cfm?id=570
4 http://205.254.135.7/analysis/projection-data.cfm#annualproj

3. Economic Impacts of Shale Energy Development

Shale gas production is different from conventional natural gas production from shallow fields because the production decline curve is much steeper, with output declining roughly 50 percent during the first few years of production before leveling out. This high rate of output early during the production period often implies very high rates of return, even at low prices. These high rates of return provide the incentive to continue drilling, which allows shale energy-producing companies to maintain or increase production as they bring new wells on stream to offset the steep production decline of older wells. Accordingly, shale energy development resembles continuous energy manufacturing, unlike conventional natural gas development with an intensive three- to seven-year period of well and pipeline infrastructure development, and relatively little labor and resource use afterward.

The continuity of drilling effort and the economic activity that it generates set shale resource development apart from other energy development activities. Developing coal mines, wind turbines, hydroelectric resources, and solar energy involves significant job creation during construction. Once the facilities are in place, however, their operation requires relatively few workers. In contrast, the labor-intensive aspects of shale gas development accelerate over time and can persist for decades, if the reserves in place are large enough, and market prices for natural gas justify continued investment.

Shale energy resources during 2010 alone supported more than 600,000 jobs, increased gross domestic product or value added by $76 billion ...

Transportation costs are high for key materials used in the exploration, drilling, and construction of gas-processing plants and pipelines. Therefore, support industries, including well support, steel, sand and gravel, concrete, trucking, and scientific and engineering services, often arise locally. Most of these support activities are not easily outsourced to foreign suppliers. And in regions with private mineral rights, shale gas development requires lease and bonus payments to landowners, who in turn pay taxes and spend this income on local goods and services. While the footprint of a shale well site is small, the shale deposits occupy an extensive geographical area, necessitating the leasing of large tracts of land.

Economic-impact studies have been conducted for the Barnett, Fayetteville, Haynesville, and Marcellus Shale gas plays. These studies employ input-output models to estimate the direct, indirect, and induced impacts on regional value added (the regional equivalent of contribution to the nation's gross domestic product), employment, and tax revenues. "Direct impacts" constitute the purchases by natural gas companies from other sectors of the economy. "Indirect impacts" refer to the supply chain. For example, a natural gas company contracts with a drilling supply company, which then hires workers and other companies to supply it with materials, equipment, and services. "Induced impacts" constitute the rounds of transactions throughout the economy set off by the spending of workers, hired directly or indirectly, on goods and services. "Induced impacts" also result from landowners' spending of lease, bonus, and royalty payments.

The development of these shale energy resources during 2010 alone supported more than 600,000 jobs, increased gross domestic product or value added by $76 billion, and generated more than $18.6 billion in tax revenues at the local, state, and federal levels (IHS, 2011). Similarly, the study by Considine, et al. (2011) finds that development of the Marcellus Shale in Pennsylvania

supported nearly 140,000 jobs and generated $11.6 billion and $1.1 billion in value added and state and local taxes, respectively.

If shale gas development was allowed in New York State, Considine (2010, 2011a) estimates that the accumulated value added from 2012 to 2021 would come to more than $11.4 billion, with more than 18,000 additional jobs in 2021 and approximately $214 million in state and local taxes by 2016 (see Appendix A).

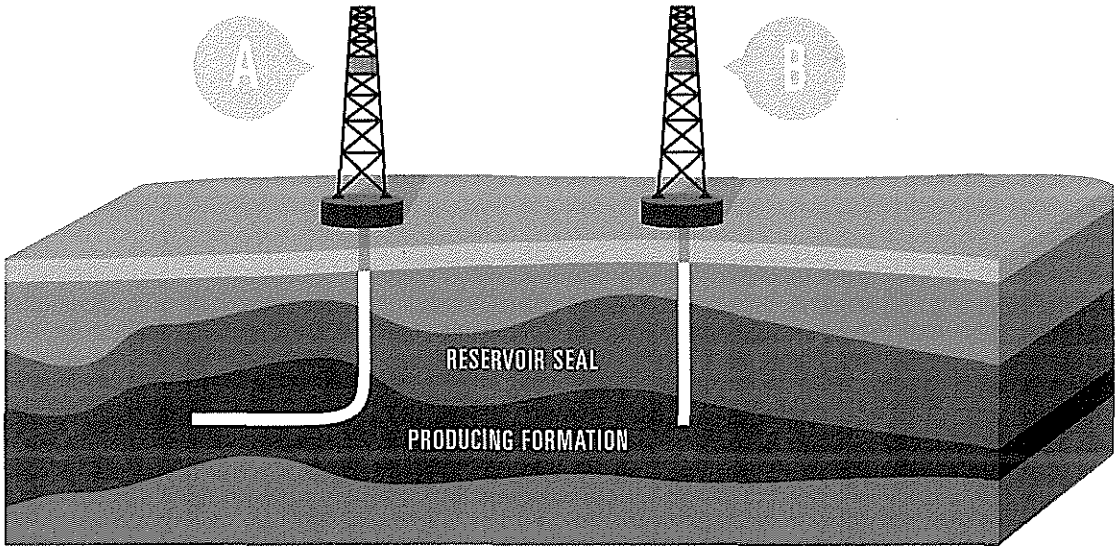
4. Producing Energy from Shale Formations

Two distinct technologies – horizontal drilling and hydraulic fracture stimulation – enable shale energy development. Horizontal drilling involves vertically drilling down to the shale-bearing strata and then drilling horizontally to establish lateral well sections that may be up to a mile in length. This approach allows greater surface contact with the energy-bearing shale layer. Producers then inject a water-based solution that contains between 2 and 4 percent sand and chemicals under high pressure into the well, which cracks the rock and increases the permeability of the reservoir. Most of the gas reserves in the Marcellus Shale are only economically recoverable using horizontal wells and hydraulic fracturing. Companies are constantly increasing the speed and efficiency of these operations.
The first step in drilling a well is to install a well pad to support a drilling rig. Land is cleared, an area for the well is leveled off, and gravel roads are laid. After a well is completed, all surrounding land is restored and replanted, typically required under regulatory and bond release programs.

Two types of wells can be constructed: a vertical well in which a large drilling rig rotates a steel pipe with a drill bit on the end; and a horizontal well in which a drilling motor pushes fluid through a stationary drill pipe, causing the bit to rotate. In either case, as the well is drilled, a new length of pipe is connected to the one already in use so that the latter can be pushed deeper into the hole. Currently, both vertical and horizontal wells are being drilled in most shale plays. Both types of wells are drilled to a predetermined vertical depth, but the latter then makes a turn, permitting it to be drilled sideways for several thousand feet. While the cost of a horizontal well is three to four times that of a vertical well, they are much more productive because they have far more contact with the gas-bearing rock (Figure 2).

Standard drilling practice includes several measures intended to protect the environment. Oil and gas wells penetrate the water table, generally extending several thousand feet below potable water supplies. As the well is drilled, steel pipe called casing is inserted into the well bore and then

FIGURE 2: HORIZONTAL AND VERTICAL WELLS

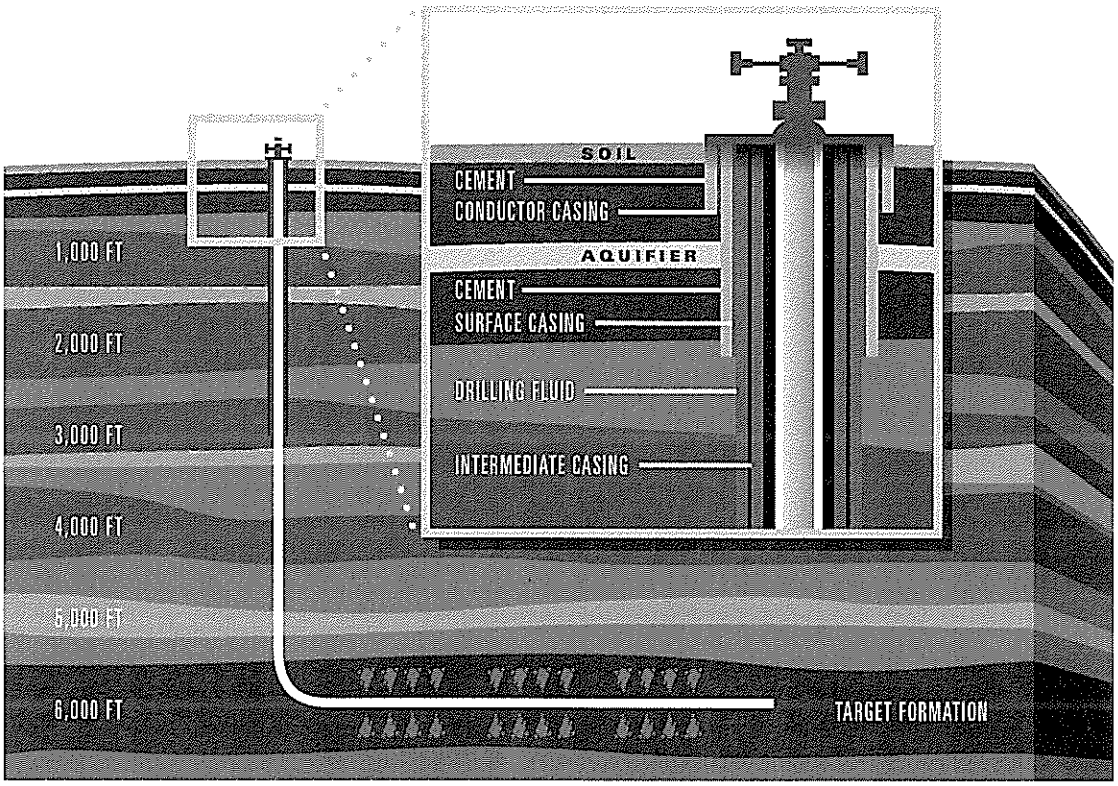


cemented into place to form a barrier that protects subsurface groundwater from contamination. Well drillers are also responsible for ensuring that any fluids or chemicals used or produced during drilling and completion of the well do not contaminate surface waters such as streams, rivers, or lakes. In Pennsylvania, all fluids on a well site are now contained within plastic tarpaulins, plastic-lined pits, or steel tanks, facilitating the recycling or transportation of these fluids to well-disposal sites permitted by the U.S. Environmental Protection Agency.

After the well is drilled to its final depth, another steel pipe is installed inside of larger ones above it and cemented into place. The drilling rig then leaves the site, and a wellhead is installed on the surface. The wellhead is a collection of valves, often referred to as a Christmas tree, which controls the flow of gas and allows it to be turned off completely if necessary and allows the use of equipment for performing well stimulation and maintenance.

Once drilling is complete, hydraulic fracturing, which stimulates the well to produce more gas by creating new fractures that intersect and connect to as many of the natural fractures to the well as possible, can occur. The first step in this process is to use shaped explosive charges to perforate the bottom section of the steel pipe. Doing so allows hydraulic fracturing fluid to be pumped into the rock to fracture the shale, and then allows hydraulic fracturing fluid and gas into the pipe casing and to the wellhead at the surface. The resulting well is a set of pipes within pipes known as casing strings. The point where one casing string ends and another extends is known as the "shoe." Most companies use multiple strings of casings of varying lengths, diameters, and grades (Figure 3).

FIGURE 3: GROUNDWATER PROTECTION THROUGH PROPER WELL CONSTRUCTION



5. Complications Associated With Natural Gas Development

The extraction, processing, and transportation of natural gas all affect the environment. Koomey and Krause (1997) outline the basic steps for estimating environmental externalities[5] and the costs they impose on society, involving these general steps:

- Identifying insults to the physical and human environment;
- Charting pathways that convert the insults to stresses;
- Estimating the physical or social consequences of the stresses; and
- Valuing the environmental and social costs of the stresses.

The first three steps collectively can be referred to as environmental-impact assessment and can be accomplished with varying degrees of accuracy or confidence. As a result, most studies estimating environmental externalities specify a degree of uncertainty.

Some upstream negative externalities of natural gas production are unavoidable. They involve the clearing of land for well pads and pipelines; local congestion due to truck traffic; and noise and dust. Lease and bonus payments to landowners or direct outlays by companies to repair infrastructure damage caused by gas drilling activity compensate for most of these impacts. Nonetheless, the sheer presence of gas wells has effects on the ecosystem.

Environmental hazards associated with natural gas production are infrequent, but can lead to contamination of local water supplies and impairment of air quality. Perhaps the most publicized environmental risk arises from the use and disposal of fluids used in hydraulic fracturing. The New York City Department of Environmental Protection (2009) study of the potential impacts of natural gas drilling on the New York City watershed raised the possibility that water from hydraulic fracturing could migrate from the gas-bearing layers, which are 5,000 feet below the surface, up to water tables less than 500 feet from the surface.

The presence of 4,500 feet of rock above the hydraulic fractured zone makes such an eventuality unlikely. Indeed, there exists no documented evidence of such an event since hydraulic fracturing was first introduced approximately 60 years ago. Vaughan (2010) argues that water-supply contamination from so-called stray gas occurs more often from failures in well design and construction, breaches in spent hydraulic-fracturing water-containment ponds, and spills of leftover natural gas liquids used in drilling.

Where groundwater has been impacted, the PA DEP has concluded that the issue stems not from hydraulic fracturing per se, but poorly formulated cement and improperly designed wells - traits that should be of concern in all wells, not just high-volume hydraulic fracture (HVHF) wells. Methane contamination of water is manageable with the use of water treatment systems that remove methane and metals related to methane contamination. Migration of natural gas into structures, however, poses a serious risk of explosions, which have happened on a number of occasions.

Stray gas events can be significantly mitigated by proper well construction. These methods, however, cannot entirely eliminate stray gas emissions because there are many sources of stray gas,

5 Environmental externalities refer to effects external to production and consumption activities by firms or households. For example, water pollution from natural gas production is a production externality, while air pollution during combustion of natural gas for home heating is a consumption externality.

entirely unrelated to shale gas drilling, such as shallow gas reserves, unplugged orphan wells, decaying plant and animal materials, and septic fields. To address this issue, mandatory standards for water-well construction should be adopted in Pennsylvania, which surprisingly do not yet exist due to strong opposition from rural communities and the agricultural industry. To determine the frequency of environmental incidents, a detailed examination of the environmental violations reported in the Pennsylvania Marcellus appears in the next section.

6. Notice of Violations in the Pennsylvania Marcellus

The Pennsylvania Department of Environmental Protection (PA DEP) regulates natural gas development in the Commonwealth of Pennsylvania. The responsibility of the PA DEP is to enforce a body of regulations that date back to the 1930s that recently have been updated to reflect the environmental impact of the development of the Marcellus Shale and other unconventional sources of natural gas. If an operating company fails to comply with these regulations, the PA DEP issues a Notice of Violation (NOV).

These violations are indicative of many different situations. To fully understand the effectiveness of current regulations in mitigating the environmental impacts of Marcellus Shale development and the various incidents that garnished an NOV, a closer examination of these violations is required: A notice of environmental violation often does not indicate an actual environmental event because many of these citations are for administrative violations or are issued to prevent pollution from occurring. Consequently, to estimate the actual environmental impact of shale gas drilling, a careful analysis is required of the environmental violations to determine what actually happened, which appears in section seven below and in greater detail in Appendix B. Meanwhile, this section provides an overview of environmental violations to provide a context for the identification and discussion of the environmental events that resulted in measurable pollution or harm to the environment that are discussed below.

The database for this inquiry includes NOVs issued to operators from January 2008 through August of 2011.[6] Each NOV is analyzed by first determining the legal statute that prompted its issuance, and then by comparing the statute with the descriptions of the violation provided by the PA DEP and its well site inspectors. This study classifies the violations into seven categories: cement & casing, blowouts & venting, major and non-major spills on land, gas migration, site restoration, and water contamination. More detailed definitions of these categories appear in Table 1 below.

TABLE 1: CLASSIFICATION OF ENVIRONMENTAL VIOLATIONS

Violation Type	Description
Cement & casing	Cement and casing job cited as defective and the cause of the pollution
Blowouts & venting	Citation for a blowout or hazardous venting
Major spills on land	Citation for major (> 400 gallons) spills of materials on land
Minor spills on land	Citation for minor (< 400 gallons) spills of materials on land
Gas migration	Citation for migration of gas in underground aquifers or substrates
Site restoration	Citation for violations of site restoration regulations
Water contamination	Citation for tainted water as the primary focus of the citation

The next step reconciles the legal citation with the description of the violation to determine if pollution took place. For example, if a statute discussed discharges of material into waters of the Commonwealth, then the NOV would be classified as a violation involving water contamination as long as this matched the PADEP description and inspector's comments. This close scrutiny of each

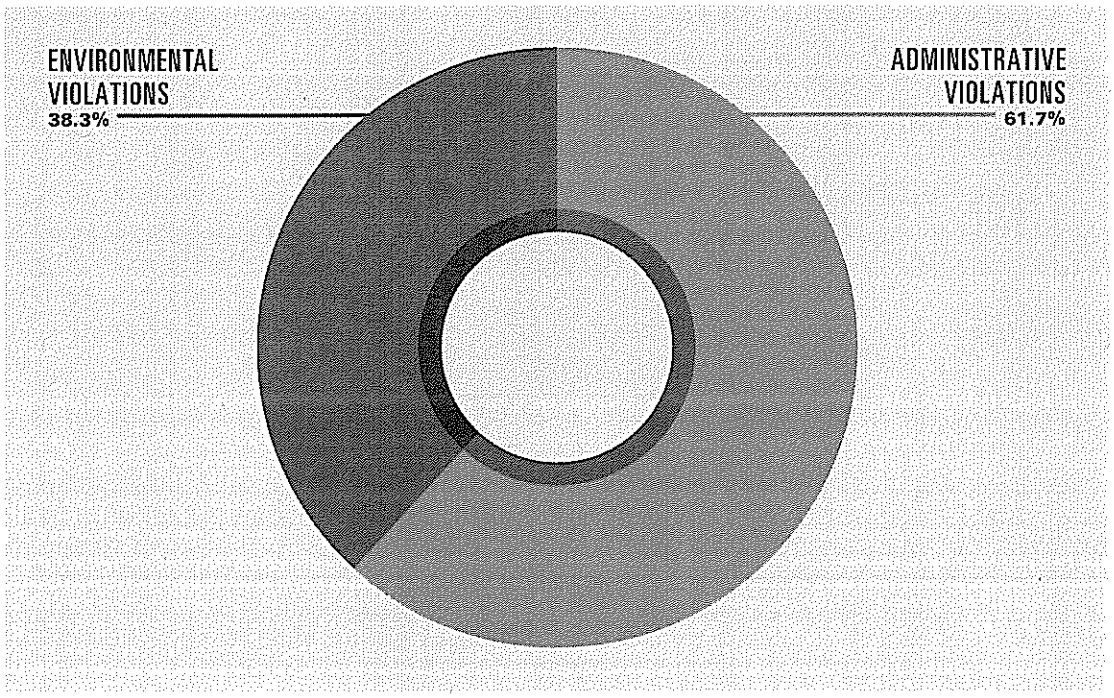
6 http://www.depreportingservices.state.pa.us/ReportServer/Pages/ReportViewer.aspx?/Oil_Gas/OG_Compliance

violation allows a more precise determination of the frequency of NOVs that result in measurable pollution or damage to the environment.

This approach also allows the identification of those violations that affected the environment. To identify these violations, our analysis used a series of indicators developed from the well inspector's comments for each NOV. These violations stood out based upon the amount of fluids spilled, the amount of water or land disturbed, and the potential threat to human health or safety. Once these violations had been identified, our analysis employed the Environmental Facility Applications Tracking System (eFACTS) from the PADEP to classify the violations into those that did and did not involve actual environmental harm.

The raw number of NOVs does not tell the whole story. Our analysis of the NOVs reveals that only a fraction of them were issued for a violation that involved an environmental impact. Among the 2,988 violations issued, only 1,144 were for a violation that involved an environmental event. The other 1,844 violations issued were administrative violations or citations to prevent pollution. Hence, 38.3 percent of the 2,988 NOVs issued were for environmental violations of some type, which is illustrated below in Figure 4. Determining what proportion of these environmental violations were preventative in nature is problematic because it is nearly impossible to assess whether pollution would have occurred had these violations not been issued. Regardless, the number of these violations that did not involve pollution should be considered as a good metric for regulatory oversight. While some in the industry may find these NOVs a nuisance, state oversight through robust regulation does provide incentives for companies to more closely comply with environmental regulations and, most importantly, adopt technological innovations to avoid these citations altogether.

FIGURE 4: SHARES OF ADMINISTRATIVE AND ENVIRONMENTAL VIOLATIONS



A further disaggregation of the environmental violations using the six categories of violations identified above in Table 1 is displayed below in Figure 5. Understanding the distinctions of these categories is important to understanding the key risks of concern to regulators. The environmental violations constitute 38.3 percent of all NOVs and are split seven ways in Figure 5. For example, the largest portion is the 13.4 percent of all NOVs arising from breaking site restoration rules (Figure 5). The next largest category is water contamination with 11.6 percent of all NOVs. Minor spills on land constitute 7.9 percent of all violations. Cement and casing violations comprise 3.3 percent of all NOVs. Violations for major land spills, blowouts and venting, and gas migration constitute 1.5, 0.3, and 0.2 percent of all violations, respectively (Figure 5).

FIGURE 5:
SHARES OF ADMINISTRATIVE VIOLATIONS AND ENVIRONMENTAL VIOLATIONS BY CATEGORY

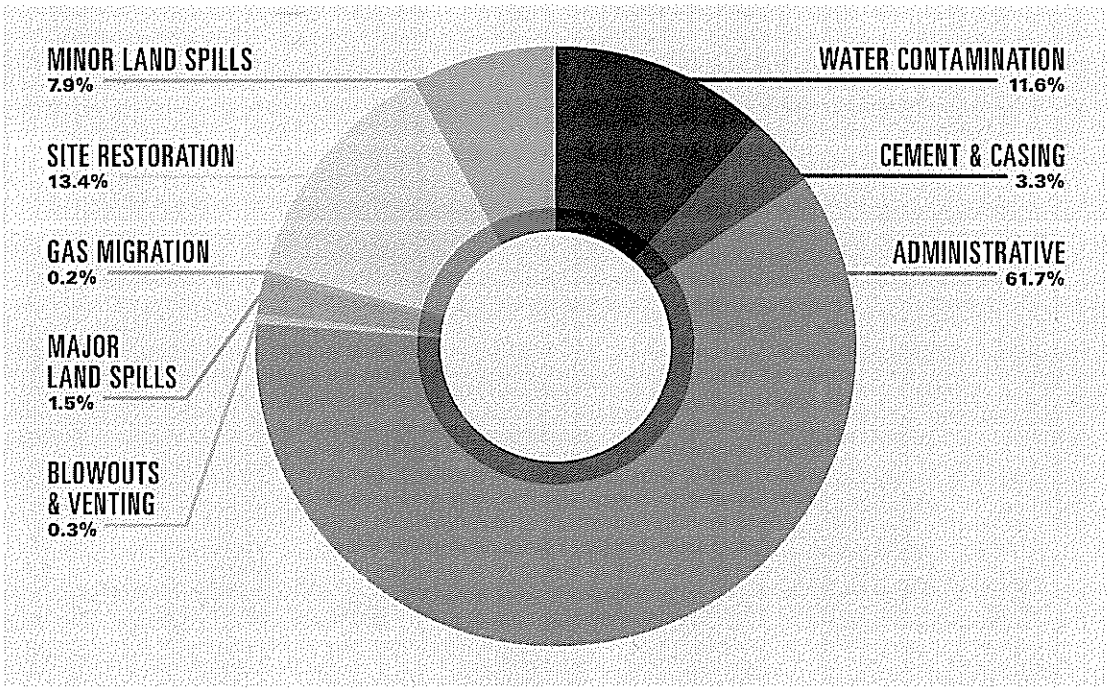
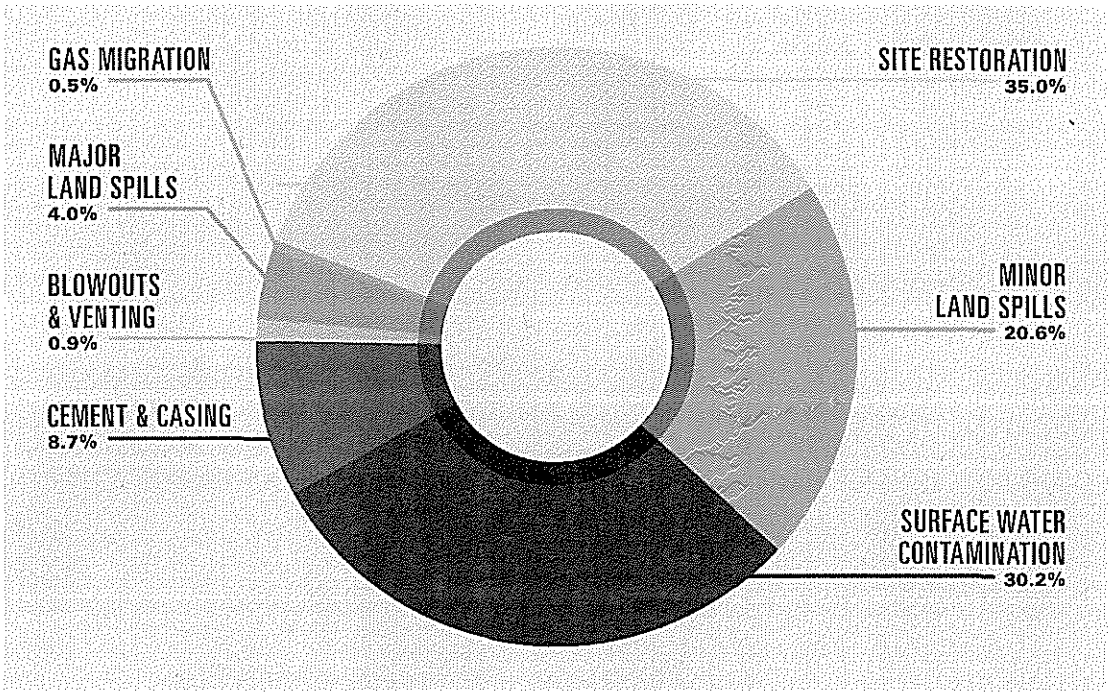


Figure 6 below displays a disaggregation of the environmental violations. Of these 1,144 violations, 35 percent involved site restoration issues, slightly more than 30 percent entailed surface water contamination, and almost 21 percent were for minor spills on land. Cement and casing violations constituted 8.7 percent of violations that resulted in pollution. Major land spills comprised 4 percent of these violations, while blowouts and venting and gas migration comprised 0.9 and 0.5 percent, respectively (Figure 6).

FIGURE 6: COMPOSITION OF ENVIRONMENTAL VIOLATIONS

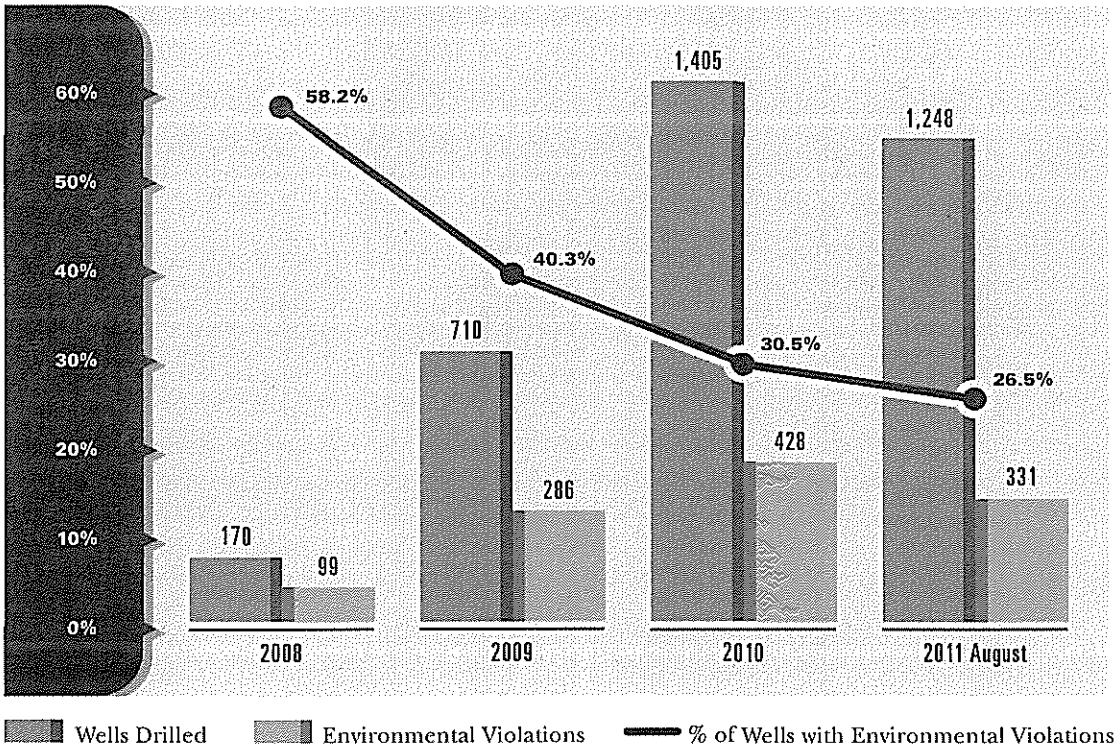


Many of the NOVs that resulted in measurable pollution, however, were rather minor, involving, for example, a gallon of diesel fuel or antifreeze spilled on the ground. The next section identifies the incidents that presented or had the potential to present significant environmental impact.

Significantly, the record of environmental violations in Pennsylvania shows that the rate of environmental violations expressed as a percentage of wells drilled declined over time. For example, in 2008 there were 170 wells drilled and 99 environmental violations, or more than 58 percent of all wells drilled in that year incurred some violation. In the first eight months of 2011, there were 331 recorded violations, or 26.5 percent of the 1,248 wells drilled during the first eight months of 2011. So, on this basis, the Marcellus industry has cut its incidence of environmental violations by more than half in three years, a rather notable indicator of improvement by the industry and oversight by the regulators. While a 26.5 percent rate of environmental violations appears high, it is important to note that most of these violations are not major.

The Marcellus industry has cut its incidence of environmental violations by more than half in three years, a rather notable indicator of improvement by the industry ...

FIGURE 7: WELLS DRILLED AND ENVIRONMENTAL VIOLATIONS



While difficult to conclusively illustrate causation between regulatory actions and decreases in environmental violations, the history of regulations in Pennsylvania suggests such a relationship may exist. The PA DEP has made significant regulatory changes over the four-year time frame. The agency opened up a new field office, hired additional staff, and made a number of rule changes that were heavily advertised. These regulatory milestones are summarized in Table 2. This trend is expected to continue as stronger regulatory requirements are promulgated, enforcement efforts become well established, and industry gains a better understanding of the new regulatory requirements.

TABLE 2: REGULATORY DECISIONS AND INCIDENCE OF ENVIRONMENTAL VIOLATIONS

Date	Decisions by Pennsylvania Department of Environmental Protection	Wells with Environmental Violations
2008		58.2%
August	Required companies to identify treatment and storage of wastewater	
December	Imposed permitting fees to facilitate the hiring of additional regulators	
2009		40.3%
January	Partnered with industry for new wastewater treatment plants and technologies	
February	Opened Scranton office for regulatory oversight of northeastern Marcellus	
April	Announced new standards for wastewater discharges with dissolved solids	
2010		26.5%
May	Announced new discharge rules and well construction standards	
June	Enforcement campaign to ensure compliance by trucks hauling wastewater	
October	"Operation FracNet," for compliance by vehicles hauling wastewater	

While the distinction between administrative and other violations is important, an additional delineation is required because some environmental events generate multiple environmental violations. Using a count of environmental violations, therefore, would over-estimate the number of actual environmental events that took place. Accordingly, to fully understand the effectiveness of current regulations on mitigating environmental impacts of Marcellus Shale development and the various incidents that garnished an NOV, an even closer examination of these events is required.

7. Environmental Events

In this section, the notices of environmental violation are analyzed to determine how many actual events took place that resulted in environmental pollution. These events were found by examining each individual inspection report and determining what took place based upon the various NOVs issued. The classification system for environmental events is the same as it is for environmental violations. Below is a closer look at each category of environmental event and their nature.

7.1 Blowouts & Venting

Blowout and venting events are among the most serious, and are classified as major for two primary reasons. First, they are uncontrolled in nature and, thus, innately dangerous. Blowouts are usually the result of excess pressure in the well and, as a result, often occur in a violent manner. The other reason blowout and venting events are considered major is their environmental impacts. When a blowout or uncontrolled venting occurs, the potential exists for large amounts of fluids and gases to be released from the wells, despite initial mitigation efforts by operators. In such cases, negative environmental impacts are almost impossible to avoid.

7.2 Spills on Land

As the title suggests, these events are spills in which a drilling substance is spilled onto a surface other than water. These spills often took place on the drilling pad itself and did not have environmental impacts as they are contained within the boundaries of the pad site. The majority of spills were small, and the average amount of fluid spilled was approximately 176 gallons for non-major events. This was determined by taking the average amount of fluid spilled from the events that reported the spilled fluid volumes. The types of fluids spilled vary greatly among the environmental events. The most common type of fluid spilled was diesel fuel. Other fluids spilled included drilling mud, production fluid, hydrochloric acid, drilling soap, produced water, freshwater, and gel friction reducer.

7.3 Gas Migration

Gas migration into freshwater is very rare but serious, usually occurring due to a flaw in the cement and casing of a well. These flaws can be repaired, and the volume of gas escaping from vents is very small. The environmental impacts of gas migration can be mitigated and, therefore, gas migration incidents do not necessarily represent a long-term or permanent environmental impairment. Gas migration, however, is a real danger to public safety because sequestered methane is very volatile and can be explosive. The highly publicized case of gas migration in Dimock, Pennsylvania, illustrates these environmental, health and safety, and public relations impacts. As the discussion below illustrates, however, the environmental impacts can be repaired and, therefore, diligent monitoring and inspection are typically required to minimize these occurrences to the extent possible, and the associated environmental, health, and safety impacts that could potentially result from gas migration.

7.4 Cement & Casing

In almost all cases of cement and casing violations, there was some measurable amount of gas escaping from the well itself. This is not to be confused with a blowout or gas migration, as gas venting from these wells is vented in a less extreme manner. The venting that took place is the primary environmental impact of these events, but the amount of gas that was released is difficult to quantify. The amount of time and quantity of gas was not listed in any of the well inspectors' comments in the NOVs, but in 73 of the 86 instances of casing and cementing events, it was explicitly noted that gas was vented from the well. In the other 13 cases, the pollution observed constituted small leaks coming from the casing. Cement and casing violations are in nature less dangerous than blowouts or gas migration, but in some cases can lead to those events.

7.5 Site Restoration

Our analysis above defines site restoration events when a company did not restore a drilling site properly under guidelines issued by the PA DEP. To properly restore a site, a company needs to restore 70 percent of the perennial vegetation cover, and remove all drilling equipment and waste from the site within nine months after drilling is completed. In most cases, the NOVs indicated how much land was disturbed or what types of problems existed. In most cases, erosion was a problem, and in some cases vegetation was not restored or equipment was left on-site. While these land disturbances had an impact on the environment, they were not as serious in nature as spills or water contamination events and can be completely rectified through minor reclamation efforts.

7.6 Surface Water Contamination

Water contamination events result from spills that impact bodies of water directly. In most cases, these events are minor. Our analysis tracks all types of spills from a gallon of diesel fuel to hundreds of barrels spilled into the many small creeks and ponds in rural Pennsylvania. The spilled substances included many of the same materials spilled on land: fuels, drilling mud, production fluids, hydrochloric acid, sediments, and produced fluids.

The impacts of these events varied by the amount of fluids spilled. Our analysis indicates that on average 105 gallons of fluid were spilled for minor water contamination events. Water contamination events could have direct negative environmental effects or none at all. In areas with sensitive ecosystems, like wetlands, certain forms of aquatic life could be adversely affected by the spill. In other instances, the impacts of the spills can be mitigated with no observable damage to plants or wildlife.

7.7 Analysis of Environmental Events

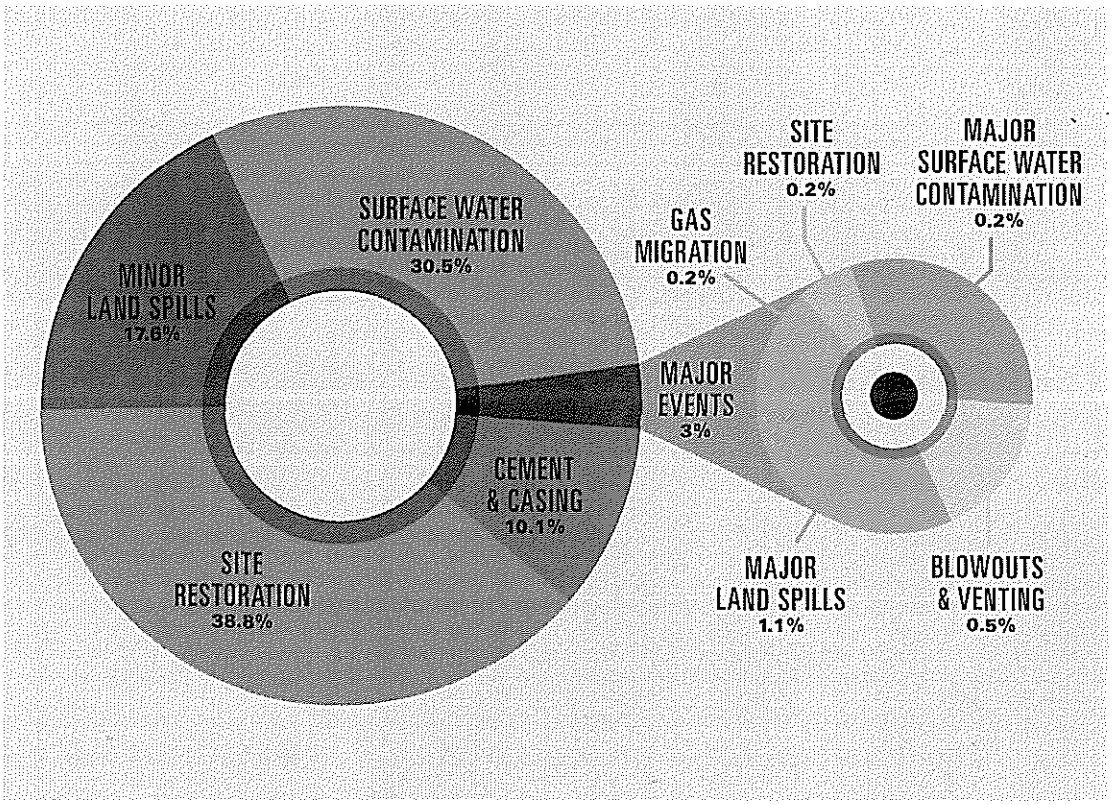
Our analysis of the environmental records from the PA DEP indicates the total number of unique incidents that resulted in environmental pollution is 845 over our sample period from January 2008 through August 2011, tabulated below in Table 3. Note from above that the total number of environmental violations is 1,144. Based upon our evaluation of the environmental impacts associated with each environmental event, there were 25 incidents that resulted in major environmental impact. Of these 25 incidents, nine involve major spills of materials on land, another eight entail spills that contaminated local water supplies, four incidents concern well blowouts and venting, two events incur major site restoration impacts, and two events concern gas migration. There were no reported cases of hydraulic fracturing fluid migrating into potable water supplies.

TABLE 3:
POLLUTING ENVIRONMENTAL EVENTS
IN THE PENNSYLVANIA MARCELLUS SHALE

	2008	2009	2010	Jan - Aug 2011	2008 to 2011
Major Impacts					
Blowouts & Venting	0	0	2	2	4
Major Land Spills	0	2	2	5	9
Gas Migration	0	1	1	0	2
Site Restoration	1	0	0	1	2
Water Contamination	0	5	1	2	8
Subtotal	**1**	**8**	**6**	**10**	**25**
Minor Impacts					
Cement & Casing	0	2	27	56	85
Site Restoration	72	68	90	98	328
Minor Land Spills	4	56	66	23	149
Water Contamination	13	39	133	73	258
Subtotal	**89**	**165**	**316**	**250**	**820**
Grand Total	**90**	**173**	**322**	**260**	**845**

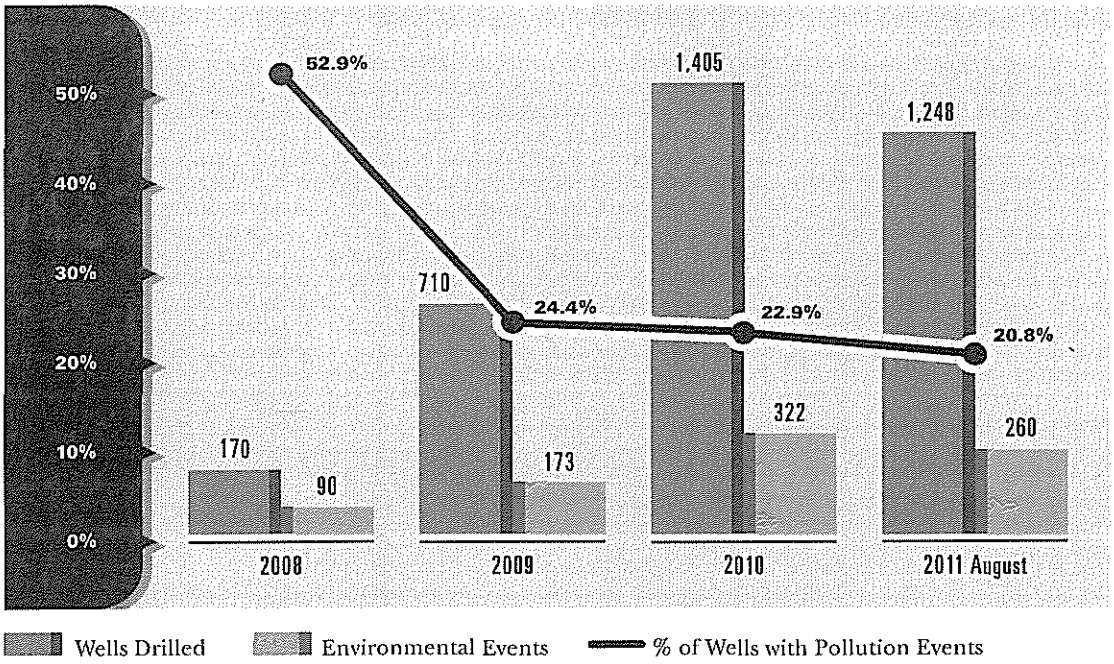
Of all the polluting environmental events, 38.8 percent involved site restoration, 30.5 percent involved spills contaminating surface water, 17.6 percent were nonmajor land spills, and 10.1 percent involved cement and casing problems. Three percent of all environmental events created major problems for the environment, 1.1 percent from major land spills, 0.9 percent involving major water contamination, 0.5 percent from blowouts and venting, 0.2 percent involving major site restoration problems, and 0.2 percent from gas migration (see Figure 8 below).

FIGURE 8: POLLUTING ENVIRONMENTAL EVENTS BY CATEGORY



Like the environmental violations, the number of environmental events varied with the number of wells drilled, as illustrated in Figure 9 below. The incidence of these events, however, steadily declined over the past four years. For example, more than half of all wells involved some level of environmental pollution in 2008, albeit most instances were minor, but that proportion declined to slightly over a fifth of all wells in 2011.

FIGURE 9: WELLS DRILLED AND POLLUTING ENVIRONMENTAL EVENTS



These findings are based solely on the Pennsylvania Marcellus record and are not necessarily indicative of the incidence of polluting environmental events one would expect to find in the future in other regulatory jurisdictions or involving other drilling companies. As indicated previously, however, enforcement activity and awareness of new regulatory requirements by the regulated community is likely to result in a decline in the incidence of polluting environmental events as illustrated above. Moreover, as the analysis presented in Appendix B illustrates, the long-term environmental impacts of these events are almost completely mitigated by remedial actions taken by the companies.

In most cases, due to the severity of these 25 major environmental events, information is available to determine what went wrong, who was responsible, and how the impact was remediated. Appendix B discusses each of the major environmental events that occurred during Marcellus Shale development in Pennsylvania.

The first major conclusion that can be reached from this analysis is that there are only two documented cases in which subsurface potable water supplies were tainted from Marcellus gas drilling activity. These subsurface water contamination events resulted from stray gas or gas migration into potable water supplies due to improper casing of multiple wells in the areas. According to our analysis, local water supplies have been completely restored to one of the affected areas, and in the second area the impacts are still being mitigated. Further, additional safety protocols and engineering measurements through proper state-based regulation can and should eliminate future incidents.

The second finding is that there were four serious well blowouts, implying a 0.11 percent probability of a well blowout. In other words, there is roughly a one-tenth of one percent chance of a serious

well blowout in the Pennsylvania Marcellus gas drilling industry. To put this in some context and relative perspective, there are 40,000 highway deaths in America each year. If an individual drives an average amount each year for 50 years, there is a one percent chance of dying in an accident, roughly 12 times higher than the odds of a well blowout in the Pennsylvania Marcellus. Also, it is important to keep in mind that these four well blowouts did not result in loss of life.

The third major conclusion is the environmental damages resulting from these events were mitigated with the exception of six cases, two of which are too early to determine if remediation has been completed and for the other four cases, remediation efforts have been undertaken but not verified as completely effective. Hence, even when there are serious environmental impacts, regulators and drilling companies act to completely remediate the environmental damages. This implies that the PA DEP is acting effectively to minimize and in many cases prevent environmental harm from occurring. Hence, the Pennsylvania data shows that of the polluting environmental events that resulted in environmental damage, the regulatory agencies and drilling companies acted to completely remediate those damages.

The fourth and final conclusion is that the majority of the events were due to operator error, negligence, or a failure to follow proper procedures when drilling. This suggests that the industry has room for improvement, and the frequency of environmental events can be reduced. The following subsections discuss the implications of these findings for Pennsylvania and New York.

7.8 Pennsylvania Regulatory Response to Environmental Events

Since 2008, more than 3,500 Marcellus wells have been drilled in Pennsylvania from more than 100 drilling rigs. The sudden creation of a multibillion-dollar industry of well development, including drilling and completion activities and major infrastructure construction - of pipelines, dehydration systems, gas-processing facilities, and compressor stations - had a range of environmental impacts that caught state regulators by surprise. This section discusses the environmental issues created, the response by regulators and industry, and the implications for regulatory policy for Pennsylvania and New York.

There is little debate that Marcellus Shale development caught the PA DEP unprepared with up-to-date environmental regulations for unconventional production from the Marcellus Shale despite ongoing conventional oil and gas industry activity that drilled thousands of wells annually.

The response of the PA DEP to Marcellus Shale development and its associated impacts on Pennsylvania land and potable water was predictable and justified. As noted above, NOVs of all types were issued, and significant monetary fines were assessed to the industry for the more serious violations. Coincidental to these actions, the PA DEP, through collaboration with its Technical Advisory Board and by working in concert with its various stakeholders, has moved to update its oil and gas regulations. These stakeholders include representatives from industry, academia, and various environmental groups. As such, its regulations have evolved with respect to well construction and protection of the environment. These regulations, like all good regulatory regimes, will likely undergo almost continuous refinement. The Commonwealth of Pennsylvania's efforts to update its regulations have involved audits of its regulations by members of the American Petroleum Institute (API).

In addition, the Commonwealth, with support from industry, has moved to add to the number of field inspectors. This addition was financed through a significant increase in permit fees. Also, the Corbett administration recently announced that the PA DEP itself has been reorganized, and that Oil and Gas Management has been elevated in stature and is now managed by a Deputy Secretary. Ostensibly, these changes reflect the Commonwealth's efforts for more consistent enforcement of the regulations from region to region and at the same time recognize regional differences.

In summary, the regulations associated with oil and gas development in Pennsylvania remain a work in progress. Much has been accomplished in terms of updating the regulatory framework that had effectively functioned for more than 70 years. New regulations reflect the development of unconventional oil and gas resources. It should be noted that the industry has responded in positive fashion to complex geography and water-related challenges in Pennsylvania that are not common elsewhere. Revisions in the regulatory framework through significant improvements in well site construction and completion methodologies are a positive development, and must continue to address lessons learned.

8. Implications for Regulatory Policy in New York State

The oil and gas industry in New York dates back to the early 1800s, and the state has formally regulated the industry since 1963. New York State regulates the oil and gas industry using a combination of statute, regulation, and a generic environmental impact statement with authority under the State Environmental Quality Review Act (SEQRA) passed in 1976.

The Environmental Conservation Law, Article 23 – Mineral Resources, and Article 71 – Enforcement, govern the industry. Regulations affecting oil and gas are found in Title 6 of the New York State Register and Official Compilation of Codes, Rules and Regulations of the State of New York (NYCRR) Chapter V – Resource Management Services, Subchapter B: Mineral Resources.[7] At first glance, these seem somewhat limited in breadth. However, SEQRA gave state regulators significant authority to develop a robust regulatory program to identify potential environmental risks and provided the flexible framework to mitigate them.

Adopted in 1976, SEQRA was designed to "encourage productive and enjoyable harmony between man and his environment." SEQRA requires that government agencies "review the environmental impact of its actions, not limited to a specific environmental medium, such as air or water, but includes all environmental and many socioeconomic issues that arise in considering the result of any governmental action." The agency must disclose and address impacts that can be reasonably anticipated and, to the best of their ability, attempt to avoid or minimize adverse environmental impacts. The goal of the SEQRA process is not to eliminate all activities that may have risk, but to identify potential adverse impacts and ways to mitigate them. Ultimately, this is a subjective decision making legal challenges complex and difficult.

Until three decades ago, New York's oil and gas industry was regulated through inconsistent state and municipal requirements for drilling. This approach resulted in a few well site issues and generally inconsistent state and local rules governing the industry. In 1980, state legislators chose to revise the regulatory program using its SEQRA authority rather than promulgate new regulations. The process started in 1980 and ended in 1992 with the adoption of the final Generic Environmental Impact Statement (GEIS). The GEIS abrogated the right of municipalities to regulate any aspect of oil and gas development, and provided a flexible permitting program that could react quickly to changes on the ground and allow the issuance of permits in a timely fashion.

The 1992 GEIS looked at all common impacts deemed significant, including surface waters, groundwater, agriculture, historical sites, archaeological sites, significant habitats, floodplains, freshwater wetlands, state lands, coastal zones, streams, and general habitat loss. A unique environmental assessment form for drilling was developed from the GEIS.

8.1 Supplemental Generic Environmental Impact Statement (SGEIS)

In 2008, the New York State Department of Environmental Conservation (NYS DEC) began reviewing the 1992 Generic Environmental Impact Statement for oil, gas, and solution mining (GEIS) to determine the extent to which it should be supplemented to address the potential environmental

7 http://www.dos.ny.gov/info/nycrr.html

impacts of the high-volume hydraulic fracture stimulations (HVHF) used to develop the natural gas resources in the Marcellus Shale formation.

In accordance with SEQRA, the purpose of the 2009 draft SGEIS (DSGIES) was to inventory the potential environmental risks, determine which impacts are significant, and provide mitigation measures. This process is routinely used to address the environmental impacts of many industrial processes. The host of complex environmental impacts analyzed in the draft SGEIS range from the initial water withdrawals to the ultimate disposal of the waste products. In preparing the DSGEIS, NYS DEC sought to recognize, characterize, and provide appropriate mitigation measures based upon sound science, engineering, and experience.

The 2009 DSGEIS was put forth for public comment, a process that ended December 31, 2009, with the receipt of more than 13,000 comments. Comment evaluation lasted through 2010 and well into a new state executive administration.

In 2011, the DEC released a revised DSGEIS (RDSGEIS), which outlines a much more procedural approach to regulating wells using high-volume hydraulic fracture stimulations (HVHF), defined in the RDSGEIS as a completion using 300,000 gallons of water or more. Concurrently, NYSDEC issued revised draft regulations based on the RDSGEIS. This can be seen as a major change in approach. Since 1992, the GEIS has been used as a flexible regulatory tool allowing real-time modernization of regulations to match industry innovation. Now, a much more detailed and formal regulatory structure is proposed for wells using HVHF.

The most productive way to evaluate whether this framework will be ultimately successful is to study prior environmental incidents using the new RDSGEIS. The Department has indicated that they have done this. In 2011, DEC staff studied high-volume hydraulic fracturing incidents throughout Pennsylvania to assess their causes and identify solutions. Given the above analysis that aggregates all environmental incidents occurring in Pennsylvania, we will be able to assess the degree to which New York regulators have been successful in incorporating lessons learned into the RDSGEIS.

8.2 New York Regulations and Environmental Events

Through statutes, regulations, and permit conditions derived from the 1992 GEIS, New York State's program for regulating the oil and gas industry is quite comprehensive. The RDSGEIS and proposed regulations dramatically increase regulatory scrutiny of wells using HVHF. Using the categories defined in *Table 1: Classification of Environmental Violations*, this section will summarize how the regulatory structure of New York State is designed to avoid or mitigate these types of events.

8.21 Blowouts & Venting

Both New York State's existing and proposed regulations acknowledge the potential environmental damage caused by emissions of methane into the atmosphere, and the potential health, safety, and environmental hazards of blowouts. Consideration is given both to avoidance and mitigation.

New York State's regulatory emphasis is placed on avoiding uncontrolled emissions of hydrocarbons. Since the 1992 GEIS, the state has required blowout preventers, equipment inspections, equipment testing, and permits to flare. The RDSGEIS and proposed regulations build on this by requiring advanced equipment, redundant systems, certified staff, and systematic equipment

testing to avoid blowout preventer failure and reduce blowout severity:

> "The current DSGEIS requires pressure testing of blowout prevention equipment, the use of at least two mechanical barriers that can be tested, the use of specialized equipment designed for entering the wellbore when pressure is anticipated, and the on-site presence of a certified well control specialist." (NYS DEC 2011A, p. ES-25)

> "A remote blowout preventer actuator, which is powered by a source other than rig hydraulics, shall be located at least 50 feet from the wellhead. All lines, valves and fittings between the blowout preventer and the remote actuator and any other actuator must be flame resistant and have an appropriate rated working pressure." (NYS DEC 2011B)

Rigorous testing may prevent problems with blowout preventers. Also, requiring properly certified staff and remote actuation also may limit the severity of a blowout. Berms and other secondary containment may help mitigate the impact. These types of systems may help prevent blowouts similar to those described in Appendix B.

8.22 Spills on Land

Site design guidelines included in both the 1992 GEIS and subsequent supplemental drafts include detailed descriptions of site design, operations design, and containment technology to avoid and mitigate the impact of spills. Predrilling inspections by NYS DEC staff are and will continue to be required. In the RDSGEIS, it is clear that well design reviews will be a critical part of the permitting process:

> "Before a permit is issued, Department staff would review the proposed layout of the well site based on analysis of application materials and a site visit. Risky site plans would either not be approved or would be subject to enhanced site-specific construction requirements." (NYS DEC 2011A, p. ES-24)

Also, the RDSGEIS requires testing of equipment used for hydraulic fracture stimulation:

> "Fracturing equipment components would be pressure tested with fresh water, mud or brine prior to the introduction of chemical additives." (NYS DEC 2011A, p. ES-25)

With this approach, any faulty equipment should be identified prior to the commencement of completion operations. The foregoing requirements are likely to have a positive impact in avoiding or reducing the occurrence of the impacts of the types of spills identified in Appendix B.

8.23 Gas Migration, and Casing & Cementing

Gas migration issues were a concern before the GEIS was finalized in 1992. In the 1980s, in order to avoid hydrocarbon migration into shallower zones, NYS DEC felt it important to require submission of a casing and cementing plan to help assess the appropriateness of the design, given the local geology. Ultimately, the regulation developed requires a minimum of two casing strings, except in aquifers where three are required. NYS DEC conducts inspections of the casing during operations. In the case of an aquifer area, NYS DEC must be on-site to witness the cement returning to the surface.

The revised DSGEIS continues this practice, but adds a wellbore integrity review for wells proposing to use HVHF:

> "The Department's staff reviews the proposed casing and cementing plan for each well prior to permit issuance. Permits are not issued for improperly designed wells, and in the case of high-volume hydraulic fracturing the as-built wellbore construction would be verified before the operation is allowed to proceed." (NYS DEC 2011A, p. ES-23- 24)

In the proposed regulations, NYS DEC will also require extensive testing of the casing to make sure it can adequately ensure a sufficient margin of safety in HVHF operations, avoiding a casing breach, and potential migration of methane and fluids. These proposed regulations also set boundaries on how hard a well can be pushed during operations:

> "If hydraulic fracturing operations are performed down casing, prior to introducing hydraulic fracturing fluid into the well, the casing extending from the surface of the well to the top of the treatment interval must be tested with fresh water, mud or brine to at least the maximum anticipated treatment pressure for at least 30 minutes with less than a 5 percent pressure loss. This pressure test may not commence for at least 7 days after the primary cementing operations are completed on this casing string. A record of the pressure test must be maintained by the operator and made available to the department upon request. The actual hydraulic fracturing treatment pressure must not exceed the test pressure at any time during hydraulic fracturing operations." (NYS DEC 2011B)

Under the proposed regulations, the operator must sample water wells within a 1,000- to 2,000-foot radius before any site disturbance, and for a period after drilling and completion of a well using HVHF. If gas migration is detected, NYS DEC, like the PA DEP, can begin an enforcement action to force the operator to mitigate the problem. The proposed regulations also give NYS DEC the authority to revoke previously issued permits and approvals for noncompliance (as described in proposed regulations 750-3.5).

8.24 Site Restoration

Existing and proposed regulations outline detailed site restoration requirements, including how to mitigate erosion, sedimentation, and general agricultural issues such as topsoil stockpiling. The RDSGEIS and proposed regulations are much more specific as to the impacts on site locations by identifying specific areas such as Grassland and Forest Focus Areas that require extensive predevelopment studies. The proposed regulations are explicit in terms of site restoration after drilling. Partial site reclamation is defined as having occurred after:

1) all planned wells at the well pad have been completed, and a DEC inspector verifies that the drilling/fracturing equipment has been removed,
2) pits used for those operations have been reclaimed, and surface disturbances not associated with production activities have been scarified or ripped to alleviate compaction prior to replacement of topsoil, and
3) reclaimed areas are seeded and mulched after topsoil replacement, and vegetative cover reestablished that will ultimately return the site to pre-construction conditions (as described in proposed regulations 750-3.11 (e) (1) (vi)).

As with the PA DEP's approach, an improperly restored site would subject the operator to fines and other enforcement actions. This enforcement power rests in statute and regulation.

8.25 Water Contamination

Section 553.2 of the Environmental Conservation Law defines offsets from streams and other water bodies at a minimum of 50 feet and offsets from water wells at a minimum of 150 feet. In practice, proposed sites near water bodies usually trigger an enhanced review due to the presence of floodplains, aquifers, and other sensitive areas. This approach allows the conditions on the ground to define locations. For non-stimulated and low-volume hydraulic fracture stimulations, this remains the case.

Under the RDSGEIS and proposed regulations, wells proposing to use HVHF will be required to follow very strict "bright line" setbacks from water bodies and aquifers. Surface locations, including drilling and ancillary equipment, are prohibited in the following areas:

- within 2,000 feet of public drinking water supplies;
- on the state's 18 primary aquifers and within 500 feet of their boundaries;
- within 500 feet of private wells, unless waived by landowner;
- in floodplains;
- on principal aquifers without site-specific reviews; and
- within the Syracuse and New York City watersheds.

Looking at the incidences described in Appendix B, it is not clear that these offsets alone would necessarily eliminate contamination of streams or aquifers. Topography and the severity of the incident played a role. It seems that improved site design and better containment, if used in conjunction with "bright line" setbacks, is likely to avoid or reduce the occurrence of these impacts.

8.26 Commentary

New York State has the luxury of learning from the experience of Pennsylvania. As shown above, some of the strict procedures included in the RDSGEIS and proposed regulations may indeed help avoid or mitigate the impact of well site events. Many others, however, might provide little extra protection, while creating restrictions that ultimately stifle industry and investment. The 1992 GEIS recognized the need for flexibility when complex engineered systems are involved. Only time will tell if this strict approach fares as well or better than the landmark 1992 GEIS. Below in Table 4 is a summary of some of the major environmental events discussed in Appendix B if SGEIS requirements had been applied to the five polluting environmental categories.

TABLE 4: MAJOR ENVIRONMENTAL EVENTS AND NY SGEIS REQUIREMENTS

Category	PA Event	Example 2011 NY SGEIS Requirements
Blowouts & Venting	**Incident B.12:** Chief Oil and Gas – Bradford County uncontrolled flowback **Incident B.13:** EOG Resources – Clearfield County well blowout **Incident B.17:** Talisman Energy – Tioga County blowout **Incident B.23:** Chesapeake Energy – Leroy Township blowout	• Pressure testing of blowout prevention equipment • Using at least two mechanical barriers that can be tested • Using specialized equipment designed for entering the wellbore when pressure is anticipated • A certified well control specialist to be present during post-fracturing cleanout activities • Requiring a remote blowout preventer actuator, which is powered by a source other than rig hydraulics • Requiring that all lines, valves, and fittings between the blowout preventer and the remote actuator and any other actuator must be flame resistant, and have an appropriate rated working pressure
Spills on Land	**Incident B.7:** Atlas Resources – Diesel spill **Incident B.12:** Chief Oil and Gas – Susquehanna County fluid spill **Incident B.11:** Anadarko – Clinton County mud spill **Incident B.14:** JW Operating Company – Mud spill **Incident B.15:** Cabot Oil & Gas – Susquehanna County hose failure **Incident B.18:** Talisman – Jackson production fluid release **Incident B.19:** Carrizo – Monroe mud spill **Incident B.20:** Carrizo – Wyoming County drilling mud spill **Incident B.22:** Ultra Resources – Flowback spill	• Requiring a Spill Prevention Control and Countermeasure Plan (SPCC) • Completing a regulatory review of the proposed layout of the well site • Requiring a site visit by DEC staff to make sure the site can be designed for adequate containment • Prior to the initiation of HVHF operations, pressure test all fracturing equipment components • Approval of risky site plans would be subject to enhanced site-specific construction requirements • Bans surface access on most state lands • The authority by regulators to revoke previously issued permits and approvals for noncompliance (e.g., chemical spills)
Spills into Surface Water	**Incident B.2:** PA General Energy – Creek discharge **Incident B.4:** Cabot Oil & Gas – Stevens Creek fish kill **Incident B.5:** Range Resources – Stream discharge into Brush Run **Incident B.6:** EOG Resources – Clearfield County stream discharge **Incident B.8:** Talisman Energy – Armenia pit overflow **Incident B.9:** Atlas Resources – Hopewell pit overflow into Dunkle Creek **Incident B.16:** Chief Oil and Gas – Susquehanna County fluid spill **Incident B.24:** CNX Gas Company – Mud spill	• Require a State Pollutant Discharge Elimination System (SPDES) permit covering HVHF operations • Including restrictions on siting of surface locations will take substantial acreage out of possible production, including (1) within 4,000 feet of, and including, the unfiltered surface water supply watersheds; (2) within 500 feet of, and including, a primary aquifer; (3) within 100-year floodplains; (4) within 2,000 feet of any public (municipal or otherwise) water supply, including wells, reservoirs, natural lakes, or man-made impoundments, and river or stream intakes; and (5) in the New York City and Skaneateles Lake watersheds • Demonstrate a source to treat or otherwise legally dispose of wastewater associated with flowback and production water

continued on next page

TABLE 4: MAJOR ENVIRONMENTAL EVENTS AND NY SGEIS REQUIREMENTS

Category	PA Event	Example 2011 NY SGEIS Requirements
Gas Migration, Casing & Cementing	**Incident B.3:** Cabot Oil & Gas – Dimock gas migration **Incident B.10:** Chesapeake Energy – Bradford County gas migration incident	• Regulatory preapproval of casing and cementing plan • Additional layers of cement and steel casing around each underground well • Cement and steel casings to extend at least 75 feet below the deepest freshwater zone – going beyond regulations required in other natural gas producing states • Require extensive testing of the casing to make sure it can adequately handle HVHF operations • Set hydraulic fracture stimulation operating boundaries to never exceed test pressure to protect casing from excessive pressure • Water samples within a 1,000- to 2,000-foot radius before any site disturbance for a period after drilling and completion of a well using HVHF • Identify any abandoned wells within the proposed spacing unit and within one mile of the proposed surface location • The authority by regulators to revoke previously issued permits and approvals for noncompliance
Site Restoration	**Incident B.1:** Atlas Resources – Major site restoration failure **Incident B.21:** Chesapeake Energy – Washington County pit fire **Incident B.25:** Ultra Resources – Major site restoration failure	• Sites must be designed to mitigate erosion, sedimentation • During operations, topsoil must be stockpiled • Require partial site reclamation after all planned wells at the well pad have been completed • Department inspectors must verify that the drilling/fracturing equipment has been removed; pits used for those operations have been reclaimed, and surface disturbances not associated with production activities have been scarified or ripped to alleviate compaction prior to replacement of topsoil • Reclaimed areas must be seeded and mulched after topsoil replacement, and vegetative cover reestablished that will ultimately return the site to pre-construction conditions

9. Conclusions

Since 2008, more than 3,533 Marcellus wells have been drilled in Pennsylvania from more than 100 drilling rigs. This study assesses the effectiveness of the state's regulations in mitigating environmental impacts associated with the development of Marcellus Shale in Pennsylvania by surveying records of notices of violations from the Pennsylvania Department of Environmental Protection (PA DEP) from January 2008 through August 2011. The major findings are as follows:

- Of the 2,988 notices of environmental violations (NOVs), the majority (62 percent) are administrative violations or violations issued to prevent pollution from occurring. The remaining citations (38 percent) were in response to an event that impacted the surrounding environment.
- Of the 845 incidents that caused measurable amounts of pollution, 820 were classified as non-major, and only 25 involved major impacts to air, water, and land resources. This implies that over the 44 months surveyed, there was a [0.7 percent] probability of a major environmental event.
- Of the 25 problematic incidents that involved major environmental impacts, six cases did not have their environmental impacts completely mitigated.
- Both the rate of environmental violations and subsequent environmental events that caused some physical impact on the environment steadily declined over the past four years, in conjunction with action by state regulators. Notably, the percentage of wells resulting in a major environmental event declined significantly; an indicator that the attention of regulators was focused on the areas of greatest concern. The foregoing suggests that surface activity, rather than the drilling or development process itself, remains the greatest ongoing risk.

The findings are significant as they illustrate how the PA DEP has been able to effectively manage the brisk pace of unconventional gas development, while preserving the economic opportunity that development has afforded the community.

Pennsylvania provides a strong metric to gauge the regulatory proposal being proposed for New York State. Our research classifying the 25 major events that occurred in Pennsylvania with the 2011 New York SGEIS guidelines demonstrates that each of these specific events would be avoided or mitigated under New York State's regulatory framework currently in place.

10. References

Considine, Timothy (2010) "The Economic Impacts of the Marcellus Shale: Implications for New York, Pennsylvania, and West Virginia," American Petroleum Institute, July, 38 pages.

Considine, Timothy, R. Watson, and N. Considine (2011a) "The Economic Opportunities of Shale Energy Development," The Manhattan Institute, June, 28 pages.

Considine, Timothy, R. Watson, and S. Blumsack (2011b) "The Pennsylvania Marcellus Shale Natural Gas Industry: Status, Economic Impacts, and Future Potential," The Pennsylvania State University, Department of Energy and Mineral Engineering, July 2011, 59 pages.

Energy Information Administration (2011) "Review of Emerging Resources: U.S. Shale Gas and Shale Oil Plays," July, ftp://ftp.eia.doe.gov/natgas/usshaleplays.pdf.

Koomey, Jonathan, and F. Krause (1997). "Introduction of Environmental Externality Costs." In *CRC Handbook on Energy Efficiency*, ed. Frank Kreith and Ronald E. West (Boca Raton, Fla.: CRC).

Martin, John P. and F. Charles Dayter, "Developing Shale Resources in New York State: A Brief Review of Technical, Environmental and Legal Issues," Paper developed for the *Drilling into Hydraulic Fracturing and Shale Gas Development: A 3-State Perspective (PA, TX and NY)*, a seminar sponsored by the ALI - ABA, October 18, 2011.

New York State Department of Environmental Protection (2009) "Final Impact Assessment Report: Impact Assessment of Natural Gas Production in the New York City Water Supply Watershed" (December).

New York State Department of Environmental Conservation (Lead Agency), *Generic Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program*, September 1992 (http://www.dec.ny.gov/energy/45912.html).

New York State Department of Environmental Conservation (Lead Agency), *Draft Supplemental Generic Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program Well Permit Issuance for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low-Permeability Gas Reservoirs*, September 2009 (http://www.dec.ny.gov/energy/58440.html).

New York State Department of Environmental Conservation (Lead Agency), *Revised Draft Supplemental Generic Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program Well Permit Issuance for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low-Permeability Gas Reservoirs*, September 2011A (http://www.dec.ny.gov/energy/75370.html).

New York State Department of Environmental Conservation, High-Volume Hydraulic Fracturing Proposed Regulations 6 NYCRR Parts 52, 190, 550-556, 560, and 750, September, 2011B (http://www.dec.ny.gov/regulations/77353.html).

North Dakota State Government, Department of Natural Resources, Oil and Gas Division, https://www.dmr.nd.gov/oilgas/stats/statisticsvw.asp.

Pennsylvania Fish and Boat Commission (2011) "Texas Company Pays $208,625 in Settlements for Polluting Creeks in Clearfield County" http://www.fish.state.pa.us/newsreleases/2011press/EOG_settle.htm.

Railroad Commission of Texas, "Eagle Ford Information" http://www.rrc.state.tx.us/eagleford/index.php.

Vaughan, A. (2010). "Frac Attack: Risks, Hype, and Financial Reality of Hydraulic Fracturing in the Shale Plays." Reservoir Research Partners; and Tudor, Pickering, Holt & Co. (July 8).

Sovas, Gregory, "Oil & Gas Permitting and Regulation in NY," presentation to the *Marcellus Shale Lecture Series*, University at Buffalo, Amherst, NY, April 21, 2011.

APPENDIX

A. Economic Impact Analysis

The development path for New York shale energy will likely follow one similar to that experienced in northern Pennsylvania. During 2008, 52 Marcellus wells were drilled in five counties in northern Pennsylvania: McKean, Potter, Tioga, Bradford, and Susquehanna. The number of Marcellus wells drilled in the same five counties during 2009 was 296 (see Considine et al. 2011b). The New York counties due north of this zone include, from west to east: Allegany, Steuben, Chemung, Tioga, and Broome. As the Marcellus Shale formation extends northward into New York State, it comes closer to the surface, making it less attractive to drilling companies to exploit. Therefore, drilling would probably be concentrated in the southern half of the New York border counties mentioned above.

The Utica shale is another promising natural gas resource extending into New York, but there is no evidence to date that the New York Utica shale is productive. Range Resources completed and tested a horizontal Utica well in western New York, but the results are confidential. Range's only comment is that it plans to drill additional Utica wells. Hence, prospects for the Utica shale in New York are promising, but there is simply not enough evidence of commercial prospects that would justify its inclusion in the scenarios developed below. Leasing activity in the Utica shale in northeastern Ohio, however, is rather intense, given the prospects of rich deposits of oil and natural gas liquids, especially in Stark County. In light of these considerations, a safe assumption is that the Marcellus Shale will be the first formation to be developed in New York State if horizontal drilling with hydraulic fracturing is allowed. Hypothetical trajectory of future drilling appears in Table A1 (Considine, et al. 2011a).

TABLE A1: PROJECTED MARCELLUS ACTIVITY IN NEW YORK (2012, 2016, 2021)

	2012	2016	2021
	Millions of Current Dollars		
Total spending	**172.6**	**1,899.9**	**2,209.9**
Lease and bonus	66.6	502.2	502.2
Exploration	5.9	68.9	73.8
Drilling and completion	78.2	918.5	984
Pipeline and processing	19.1	224.5	240.5
Royalties	0	152.3	373.5
Other	2.9	33.5	35.9
	Assumed Number of Wells*		
Horizontal	14	304	330
Vertical	28	9	10
Total	**42**	**314**	**340**
	Gas Equivalents of Million Cubic Feet per Day		
Production	0.1	487.6	952.1

Under this scenario, 42 wells would be drilled in the first year, 314 wells four years later, and 340 wells in 2021. Horizontal drilling's share is based on the observed ratio in northern Pennsylvania (Considine, et al. 2011a). Total spending under this scenario would start out at $172.6 million; increase eleven fold, to $1.9 billion by 2016; and reach $2.2 billion in 2021 (Table A1). The value added that such activity from direct, indirect, and induced effects would create is $1.7 billion in 2016 (see Table A2). Note that the impacts are spread across a broad array of industries, which reflects the stimulus that natural gas investments have on the supply chain, boosting output in key shale energy supply chain industries, such as construction, wholesale trade, truck transportation, and engineering and scientific services (see Table A2). Similar gains in employment are achieved with Marcellus development supporting more than 15,000 jobs in 2016 alone. Assuming a 3 percent discount rate, the accumulated value added from 2012 to 2021 would come to more than $11.4 billion. There would be more than 18,000 additional jobs in 2021 (see Table A2). And local and state tax revenues would have grown by more than $214 million in 2010 dollars by 2016 (Considine, et al. 2011a).

TABLE A2: PROJECTED VALUE ADDED IN NEW YORK BY SECTOR (2012, 2016, 2021)

Sector	Millions of 2010 Dollars		
	2012	**2016**	**2021**
Ag., forestry, fishing, and hunting	0.3	3.3	3.8
Mining	19.8	232.3	249.2
Utilities	3.5	38.1	44.8
Construction	14	163.4	175.7
Manufacturing	4	44.8	51.1
Wholesale trade	16.4	189.1	207
Retail trade	9.9	107.4	125.9
Transportation and warehousing	3.9	43.6	48.9
Information	4.9	53.9	62.9
Finance and insurance	12.5	136.9	158.6
Real estate and rental	21	224	268.3
Professional/scientific and tech services	13.2	150.1	166.5
Business management	2.3	25.9	28.8
Administrative and waste services	4.1	45.5	51.6
Educational services	3.1	32.1	40.6
Health and social services	10.6	112.1	135.3
Arts/entertainment and recreation	1.2	13.1	15.7
Hotel and food services	3.3	35	42.1
Other services	3.4	35.8	42.9
Government and misc.	1.7	18.4	21.6
Total	**153**	**1,704.8**	**1,941.2**

APPENDIX

B. Detailed Discussion of Major Environmental Events

The sections below explain the nature of the 25 major environmental events and their impacts. For each event, this discussion explains what went wrong, why, who was responsible, and what remedies were followed.

B.1 Atlas Resources – Major site restoration failure

On December 4, 2008, Atlas Resources was issued an NOV for failing to properly restore a site after drilling had been completed earlier that year (PA DEP 2008). This instance was considered major because Atlas allowed 15 acres of land to remain disturbed after drilling was completed (PA DEP 2008). This amount of land disturbance was the second-largest site restoration failure in the sample and for this reason is considered a major environmental event. After receiving the NOV, Atlas did eventually clean up the site and mitigate the impacts that the drilling had in the area. Atlas was fined $9,641 for the violation, and was at fault because there were no circumstances that prevented it from restoring the site (PA DEP 2008).

B.2 PA General Energy – Creek discharge

On March 15, 2009, PA General Energy was cited for discharging Airfoam into a stream in Lycoming County, Pennsylvania (Swift 2011). Airfoam is a substance used to help lift water and drill cuttings to the surface during drilling. The Airfoam escaped when snowmelt and rain washed over the well pad, causing the substance to migrate to a nearby stream (Swift 2011). The site was restored, and the impacts of the Airfoam runoff were mitigated. PA General Energy was fined $28,960 for the event because of impacts on the waters of the Commonwealth.

The pollution caused by the event was difficult to avoid because the operator did not anticipate the level of snowmelt and rain that occurred. Preventing such events, however, is possible. Once the event happened, the operator was able to mitigate the impacts by placing a protective barrier around the stream that had been contaminated by Airfoam. While barriers like this are not always feasible, they can be effective when used in such situations.

B.3 Cabot Oil & Gas – Dimock gas migration

On May 13, 2009, the Pennsylvania Department of Environmental Protection issued multiple environmental violations to Cabot Oil & Gas because 19 families in Dimock had their water wells contaminated with methane. This contamination arose from gas migration that occurred after Cabot improperly cemented multiple gas wells in the area (PA DEP 2010a). Cabot was initially fined $120,000, but later was fined more than $500,000 by the PA DEP. In addition to the $500,000 fine, Cabot later settled for $4.1 million with the residents who had their water affected (PA DEP 2010a).

This incident carried the largest fine of any environmental event in the Pennsylvania Marcellus and could be considered the most severe. The gas migration contaminated a large amount of drinking

water. The three wells that were found to be the source of the migrating gas were plugged, and since then there has been a noticeable improvement in the water quality of the affected water wells.

B.4 Cabot Oil & Gas – Stevens Creek fish kill

In Dimock, Pennsylvania, on September 16, 2009, the Pennsylvania Department of Environmental Protection reported that approximately 8,000 gallons of produced fracturing fluids spilled into Stevens Creek (Lustgarten 2009). The cause of the spill was reportedly linked to the failure of a supply pipe near the creek and resulted in reports of fish swimming erratically in the affected area. Some fish were also found dead in the creek, and the PA DEP reported that the surrounding wetland area was affected as well. Cabot Oil & Gas eventually cleaned up the impacted area, but received a $56,650 fine for the spill.

The Stevens Creek fish kill was considered to be a major event because of the large volume of fracturing fluid that was spilled, and the incident was classified as water contamination. The environmental impacts of this event were very severe. Equipment failure is a part of any industry, and natural gas drilling is no different. However, this event still had such a significant environmental impact that Cabot was still held responsible. The impacts of this event were not easily mitigated, and significant effort was required to restore the site, but eventually the area was restored. This event was severe and the regulatory actions of the PA DEP reflected this reality.

B.5 Range Resources – Stream discharge into Brush Run

On October 10, 2009, Range Resources reported that a temporary aboveground water transfer line had a connection failure that resulted in the accidental release of 250 barrels, or 10,500 gallons, of partially recycled flowback water into Brush Run creek (PA DEP 2010b). Approximately 300 minnows were killed by the spill, but other aquatic life in the stream survived. Range was fined $141,175 for the spill (PA DEP 2010b), which resulted from equipment failure. The site was restored under supervision of the PA DEP, and the environmental impacts have been mitigated.

This event was major due to its direct impact on waters of the Commonwealth and was classified as water contamination. Equipment failure is something that cannot be avoided in most cases, and Range Resources was able to quickly mitigate the impacts from this spill. The reason Range was fined so heavily for the event is twofold. The first reason is that the spill occurred in a high-quality watershed that fed multiple fisheries in the area, and the second is the fact that Range did not report the spill immediately (PA DEP 2010b). This event is interesting because while Range was not entirely responsible for the event, they failed to follow proper procedures for dealing with the spill.

B.6 EOG Resources – Clearfield County stream discharge

On October 12, 2009, an independent consultant found that a cap on a holding tank had gone bad and allowed approximately 190 barrels, or 7,980 gallons, of produced fluid to enter Little Laurel Creek (PA DEP 2009a). EOG Resources was unaware of the leak until it was reported to the company, and a quantity of a foamy substance was observed in the creek that the produced fluid had entered. EOG Resources was fined $99,125 for the incident but was able to mitigate some of the impacts by flushing the stream (PAFBC 2009). EOG Resources was at fault for this event and could have prevented it by better inspecting its storage tanks.

This event was considered a water contamination event and is another example of a company being negligent. The area that was affected by this spill was also heavily used for fishing, so the Fish and Boat Commission was also present during the evaluation of this incident. The impacts from the incident were mitigated, but the area is still undergoing testing to ensure that water quality is normal. With better training of crews and the paying of more attention to details like storage containers, events like this one can easily be prevented in the future.

B.7 Atlas Resources – Diesel spill

On October 30, 2009, Atlas Resources experienced a 790-gallon diesel fuel spill due to the improper connection of a fuel line at its drilling site in Westmoreland County (PA DEP 2009b). Atlas was able to recover 250 gallons of fuel from the spill, but the rest was unaccounted for (PA DEP 2009b). Atlas also placed other collection devices around the spill in hopes of mitigating the impacts further, but was unable to successfully clean up the entire spill. The PA DEP found Atlas at fault and fined the company $17,500 for the spill (PA DEP 2009b). This event could have been prevented by following procedures for equipment inspection.

B.8 Talisman Energy – Armenia pit overflow

On November 23. 2009, Talisman Energy experienced a pit overflow into a small un-named waterway in Bradford County (PA DEP 2010c). Between 4,200 to 6,300 gallons of fracturing fluid were spilled into the waterway, which is upstream from a fishery. The flowback was caused when a pump failed and sand collected around the valve, causing fluid to flow uncontrolled toward the waterway (PA DEP 2010c). Talisman Energy was fined $15,506 for the event and was able to clean up the spill (PA DEP 2010c).

This event is considered a major water contamination event because it affected a high-quality watershed. Talisman was not at fault for this event because the equipment failure was not due to negligence and was unavoidable. Talisman also responded quickly to the spill and was able to mitigate most of the impacts of the spill.

B.9 Atlas Resources – Hopewell pit overflow into Dunkle Creek

On December 5. 2009, the Pennsylvania Department of Environmental Protection discovered multiple environmental violations that led to the contamination of a high-quality watershed in Hopewell County, Pennsylvania (PA DEP 2010d). This event was severe due to the type of watershed that was affected. While the overflow of the pit had significant environmental effects, the pollution impacts were mitigated. Atlas Resources was fined $97,350 for allowing diluted fracturing fluids to overflow from a wastewater pit (PA DEP 2010d). This incident violated the Pennsylvania Oil and Gas Act, as well as the Solid Waste Management Act, and although the impacts were mitigated, Atlas failed to notify the PA DEP (PA DEP 2010d).

This event is considered a major water contamination because a significant amount of high-quality water was tainted by the spill. A large fine is usually indicative of a significant amount of pollution. A large amount of pit fluid flowed directly into Dunkle Creek and despite the ability of Atlas to clean up the spill, a large fine was assessed. This large fine was likely due to the fact that Atlas could have prevented this incident by better maintaining the storage pit that held the diluted fracturing fluid. Also,

the situation was exacerbated by the fact that Atlas failed to report this event to the PA DEP. The cause of this event was considered negligence on the part of Atlas Resources and should have been prevented. This event is an example of what can go wrong when an operator fails to follow regulations and guidelines for pit construction. In conclusion, this event could have been avoided.

B.10 Chesapeake Energy – Bradford County gas migration incident

On May 17, 2011, the PA DEP fined Chesapeake Energy $900,000 for violations related to natural gas drilling activities in Bradford County (PA DEP 2011g). This was the largest fine issued by the PA DEP to date and was issued due to the severity of the gas migration. At various times throughout 2010, the PA DEP investigated private water well complaints from residents of Bradford County's Tuscarora, Terry, Monroe, Towanda, and Wilmot townships near Chesapeake's drilling operations (PA DEP 2011g). Gas was also observed to have been bubbling up from the Susquehanna River during the initial investigation (Efstathiou 2010g). The PA DEP determined that due to improper well casing and cementing in shallow zones, natural gas from non-shale shallow gas formations had experienced localized migration into groundwater and contaminated 16 families' drinking water supplies (PA DEP 2011g). Chesapeake has agreed to take corrective action to mitigate the impacts of this migration and restore water supplies (PA DEP 2011g). Currently, the impacts have yet to be fully mitigated, and the 16 families are currently receiving alternative water supplies from Chesapeake (PA DEP 2011g).

B.11 Anadarko – Clinton County mud spill

On April 23, 2010, Anadarko Resources spilled 9,300 gallons of drilling mud at its drilling site in Clinton County (PA DEP 2010e). The spill was restricted mostly to the well pad, and the effects were completely mitigated (PA DEP 2010e). The PA DEP confirmed that there was no impact on the land or water on or around the site. The cause of the spill was operator error, but even though there were no impacts on the surrounding water or land, Anadarko was fined $58,000 for the event (PA DEP 2010e). Events like this one can be avoided, but Anadarko did make the best of a bad situation and cleaned up the spill very quickly.

B.12 Chief Oil and Gas – Bradford County uncontrolled flowback

On May 27, 2010, Chief Oil and Gas experienced an uncontrolled flow-back in Bradford County. Pennsylvania (PA DEP 2010f). This flow-back caused more than 1,000 feet of dead vegetation adjacent to the well pad and was found to be major due to this impact on land (PA DEP 2010f). Uncontrolled flow-back falls under the category of blowouts and venting using our classification system, and thus is considered to be a serious event. This event, in particular, was interesting because of the amount of vegetation that was killed. Blowouts are typically caused when there is an excess amount of pressure in the well; however, no official report was filed on the cause of this event. Given the absence of a report of what caused the uncontrolled flow-back, it is difficult to determine if the operator was at fault or not. This event also caused the soil surrounding the well to be considered residual waste, which means that the same containment procedures had to be used for this soil as diluted fracturing fluids (PA DEP 2010f). There is no report of this event being resolved, and it is likely that it will be difficult for Chief to fully restore the site.

B.13 EOG Resources – Clearfield County well blowout

On June 3. 2010, EOG Resources experienced a well blowout at its Punxsutawney Hunting Club well in Clearfield County, Pennsylvania (WJACTV 2010). The blowout lasted for 16 hours, and spewed both gas and produced chemicals onto the surrounding countryside (WJACTV 2010). The blowout was caused when blowout equipment failed due to lack of maintenance, and the spill went unchecked due to excess pressure in the well. An estimated 1 million gallons of fracturing fluid were spilled, and fortunately the impacts have been mitigated (WJACTV 2010). Proper maintenance of well blowout equipment could have prevented this event, and EOG Resources was fined $353,419 for the event, making it the second-largest fine issued by the PA DEP to Marcellus operators.

What makes the Clearfield well blowout such a significant event was the poor response by EOG Resources. The company was not able to get control of the situation for a significant period after the initial event occurred, and an evacuation of the area was required. Moreover, the impacts of this event were also very severe, with a large amount of forest contaminated by the fluids that were released. This event was entirely preventable and could have had a far less damaging effect on the area had it been properly handled by EOG.

B.14 JW Operating Company – Mud spill

On July 30, 2010, The JW Operating Company spilled 1,500 gallons of drilling mud at its site in Cameron County (PA DEP 2010g). The impacts of the spill were mitigated, and JW was fined $8,000 for the event (PA DEP 2010g). The PA DEP records do not indicate the cause of the event. Due to the large volume of drilling mud spilled, this event is major. The JW Operating Company also failed to notify the PA DEP, who was notified by a contractor working on the site.

B.15 Cabot Oil & Gas – Susquehanna County hose failure

On November 3, 2010, Cabot Oil and Gas reported a spill of 135 barrels, or 5,670 gallons, of drilling mud onto plastic (PA DEP 2010h). Cabot was quick to act and was able to vacuum up all of the drilling mud before any major environmental impacts occurred. This event was indeed Cabot's fault, so an NOV was issued, but since all environmental impacts were mitigated, no fine was issued. We consider this a major event given the large volume of drilling mud that was spilled. There was no environmental impact because remedial action was taken.

B.16 Chief Oil and Gas – Susquehanna County fluid spill

On January 10, 2011, Chief Oil and Gas reported a release of production fluid at its drill site in Susquehanna County (PA DEP 2011a). The PA DEP reported that 150 barrels of production fluid were spilled, but there is no information on whether the environmental impacts had been mitigated (PA DEP 2011a). The PA DEP conducted an Act 2 assessment of the site to determine if the polluted land should be considered solid waste and whether it should be removed from the site (PA DEP 2011a). This event was caused by a partially open valve and was the fault of Chief Oil and Gas. The PA DEP has yet to assess a fine for this incident. Chief did follow the proper protocol for reporting the spill.

B.17 Talisman Energy – Tioga County blowout

On January 17, 2011, Talisman Energy experienced a minor well blowout in Tioga County, Pennsylvania. The blowout lasted for several hours and spilled a large amount of fracturing fluids on the well pad located in a state forest (Levy 2011). The blowout was caused when blowout preventers failed due to excess pressure. This pressure buildup could have been avoided had Talisman properly monitored the well. The impacts of this spill were mitigated, and Talisman was able to clean up the well site. Talisman was fined $51,478 for the event, and was cited for an uncontrolled discharge and hazardous venting (Levy 2011).

The root cause of this event was failure of blowout prevention equipment to contain the pressures that were encountered. This was preventable, and the reason that Talisman was at fault was the fact that the pressure buildup was allowed to continue as long as it did, leading to the blowout.

B.18 Talisman Energy – Jackson production fluid release

On January 26, 2011, Talisman Energy released production fluid at its drilling site in Tioga County. Approximately 500 barrels, or 21,000 gallons, of production fluid were spilled into state forestland (PA DEP 2011b). PA DEP found that Talisman was responsible for this spill. Talisman complied with the PA DEP's investigation of the site and conducted sampling of the site to determine if the land that was affected needs to be removed (PA DEP 2011b). Due to the swift action of the PA DEP and Talisman, much of the possible impacts of this spill was avoided. This event is still considered serious due to the large amount of fluid that was spilled and its proximity to state forestland.

B.19 Carrizo – Monroe mud spill

On January 25, 2011, Carrizo, LLC experienced a mud spill at its drilling location in Washington County near the town of Monroe (PA DEP 2011c). Approximately 1,500 gallons of drilling mud and cuttings were spilled when mixing the substance. The spill was completely confined to plastic beneath the rig, so any potential impacts were mitigated (PA DEP 2011c). The spill was unavoidable and not the fault of Carrizo because it was following proper procedures. Carrizo also reported this spill to the PA DEP in a timely manner, and as of now, there has not been a fine issued to Carrizo.

B.20 Carrizo – Wyoming County drilling mud spill

On February 14, 2011, Carrizo, LLC received an NOV for spilling 1,500 gallons of drilling mud outside of a containment area (PA DEP 2011d). Drilling mud can consist of many different things, but it is typically made of bentonite clay, water, and other drilling additives. This mud spill was considered major given the volume of mud released. Carrizo cleaned up the spill, but did not follow proper procedures for reporting it. The PA DEP found Carrizo responsible for the spill, but no information is yet available on the penalty or if the impacts of the spill have been mitigated.

B.21 Chesapeake Energy – Washington County pit fire

On February 23, 2011, while testing and collecting fluid from wells on a drill site in Washington County, three condensate separators caught fire, injuring three subcontractors working on the site (PA DEP 2011g). The PA DEP conducted an investigation of the incident and determined that the cause was improper handling of condensate, which is a wet gas found only in certain geological areas. Chesapeake was fined $188,000 for the event, which was the maximum penalty that could be assessed for a fire of this type (PA DEP 2011g). There was minimal environmental damage, according to the PA DEP, and the fire was contained (WTAE 2011). To ensure the fire was contained, approximately 20 acres of land was cleared and will need to be restored (WTAE 2011). The men who were injured in the fire were wearing flame-resistant clothing at the time the fire erupted, and it was stated that none of their injuries were life threatening (CBS 2011).

B.22 Ultra Resources – Flowback spill

On March 15, 2011, Ultra Resources left a valve to a storage tank open and allowed 5,300 gallons of produced fluid to spill (Myers 2011). This spill was cleaned up, but did present a high threat to a nearby high-quality water source in Tioga County. Ultra also waited two hours to contact the PA DEP, and although the impacts from this spill have been mitigated, Ultra was still issued an NOV for the event, due to negligence on its part. This event was major given its impact on the environment and the large amount of fluid spilled. Ultra also could have handled the situation much better, and events like this one should be easy to avoid.

B.23 Chesapeake Energy – Leroy Township blowout

On March 19, 2011, Chesapeake Energy experienced a well blowout in Bradford County, Pennsylvania. The cause of this incident was equipment failure and resulted in a large amount of produced water flowing into nearby Towanda Creek (Hamill 2011). The impacts of this event are still being monitored, but no aquatic life was harmed, and the water quality of the surrounding wetlands is still normal. Blowouts are significant events because they are indicative of both environmental damage, and a threat to human health and safety. In some instances, blowouts can be prevented, but in this case, it was beyond the operator's control. Equipment failure was the cause of the blowout, and despite careful measures taken by Chesapeake, the equipment still failed.

B.24 CNX Gas Company – Mud spill

On July 5, 2011, CNX Gas Company spilled 2,400 gallons of drilling mud into an unnamed tributary that feeds into Ten Mile Creek (PA DEP 2011e). This spill was significant given the size of the spill and the area affected. Any time a substance is leaked into water, serious environmental impacts are likely. In this case, the extent of the damage has yet to be fully reported, but water contamination has been cited. The cause of this spill is also still unknown, but the event was cited as a violation of the Pennsylvania Clean Streams Act, and NOVs were issued. The impacts of this event have yet to be fully mitigated, and the PA DEP will be investigating this incident further to determine the extent of any damage.

B.25 Ultra Resources – Major site restoration failure

On August 16, 2011, Ultra Resources was issued an NOV for failing to restore 21 acres of land affected by drilling activity in Tioga County (PA DEP 2011f). This was the largest amount of land not restored after drilling activities. Site restoration is important because it allows the local ecosystem to return to its natural condition, and if it is not completed, major erosion can take place and damage more land than was originally affected by drilling. Ultra did eventually clean the site. Given the large amount of land that was disturbed, Ultra was fined $58,000 for the incident (PA DEP 2011f). This event was both the fault of Ultra and preventable, and shows how seriously the PA DEP takes site restoration.

B.26 References

Hamill, James (2011) "Gas Drilling Emergency in Bradford County" http://www.wnep.com/wnep-brad-leroy-gas-drillingemergency20110420,0,1884646.story

Levy, Marc (2011) "Talisman Cited for Gas Well Blowout" http://thetimes-tribune.com/news/gas-drilling/talisman-cited-for-gas-well-blowout-1.1095503#axzz1doztpMg8

Lustgarten, Abraham (2009) "Frack Fluid Spill in Dimock Contaminates Stream, Killing Fish" http://www.propublica.org/article/frack-fluid-spill-in-dimock-contaminates-stream-killing-fish-921

Myers, Robert (2011) "Frac Record," August 24, The Express, http://www.lockhaven.com/page/content.detail/id/533549/Frac-record.html

Pennsylvania Department of Environmental Protection (2008) "Marcellus Shale inspections/violations 2008 Inspection comment ID 1742054" http://www.dep.state.pa.us/dep/deputate/minres/oilgas/OGInspectionsViolations/OGInspviol.htm

Pennsylvania Department of Environmental Protection (2009a) "Marcellus Shale inspections/violations 2009 Inspection comment ID 1836100" http://www.dep.state.pa.us/dep/deputate/minres/oilgas/OGInspectionsViolations/OGInspviol.htm

Pennsylvania Department of Environmental Protection (2009b) "Marcellus Shale inspections/violations 2009 Inspection comment ID 1843344" http://www.dep.state.pa.us/dep/deputate/minres/oilgas/OGInspectionsViolations/OGInspviol.htm

Pennsylvania Department of Environmental Protection (PA DEP2010a) "Dimock Residents to Share $4.1 Million, Receive Gas Mitigation Systems Under DEP-Negotiated Settlement with Cabot Oil and Gas; Additional $500,000 to Reimburse DEP for Investigative Costs DEP to Drop Montrose Water Line Plan Given Uncertain Prospects" http://www.portal.state.pa.us/portal/server.pt/community/search_articles/14292

Pennsylvania Department of Environmental Protection (2010b), "DEP Penalizes Range Resources $141,175 for Spill in High-Quality Waterway," Newsroom Press Release May 14 http://www.portal.state.pa.us/portal/server.pt/community/newsroom/14287?id=11412&typeid=1

Pennsylvania Department of Environmental Protection (2010c) "DEP Fines Talisman Energy USA for Bradford County Drilling Wastewater Spill, Polluting Nearby Water Resource," Newsroom Press Release August 2, 2010 http://www.portal.state.pa.us/portal/server.pt/community/newsroom/14287?id=13249&typeid=1

Pennsylvania Department of Environmental Protection (2010d) "DEP Fines Atlas Resources for Drilling Wastewater Spill in Washington County," Newsroom Press Release August 17, 2010 http://www.portal.state.pa.us/portal/server.pt/community/newsroom/14287?id=13595&typeid=1

Pennsylvania Department of Environmental Protection (2010e) "Marcellus Shale inspections/violations 2010 Inspection comment ID 1872559" http://www.dep.state.pa.us/dep/deputate/minres/oilgas/OGInspectionsViolations/OGInspviol.htm

Pennsylvania Department of Environmental Protection (2010f) "Marcellus Shale inspections/violations 2010 Inspection comment ID 1887635" http://www.dep.state.pa.us/dep/deputate/minres/oilgas/OGInspectionsViolations/OGInspviol.htm

Pennsylvania Department of Environmental Protection (2010g) "Marcellus Shale inspections/violations 2010 Inspection comment ID 1832875" http://www.dep.state.pa.us/dep/deputate/minres/oilgas/OGInspectionsViolations/OGInspviol.htm

Pennsylvania Department of Environmental Protection (2010h) "Marcellus Shale inspections/violations 2010 Inspection comment ID 1926568" http://www.dep.state.pa.us/dep/deputate/minres/oilgas/OGInspectionsViolations/OGInspviol.htm

Pennsylvania Department of Environmental Protection (2011a) "Marcellus Shale inspections/violations 2011 Inspection comment ID 1944136" http://www.dep.state.pa.us/dep/deputate/minres/oilgas/OGInspectionsViolations/OGInspviol.htm

Pennsylvania Department of Environmental Protection (2011b) "Marcellus Shale inspections/violations 2011 Inspection comment ID 1945795" http://www.dep.state.pa.us/dep/deputate/minres/oilgas/OGInspectionsViolations/OGInspviol.htm

Pennsylvania Department of Environmental Protection (2011c) "Marcellus Shale inspections/violations 2011 Inspection comment ID 1946716" http://www.dep.state.pa.us/dep/deputate/minres/oilgas/OGInspectionsViolations/OGInspviol.htm

Pennsylvania Department of Environmental Protection (2011d) "Marcellus Shale inspections/violations 2011 Inspection comment ID 1950300" http://www.dep.state.pa.us/dep/deputate/minres/oilgas/OGInspectionsViolations/OGInspviol.htm

Pennsylvania Department of Environmental Protection (2011e) "Marcellus Shale inspections/violations 2011 Inspection comment ID 1989916" http://www.dep.state.pa.us/dep/deputate/minres/oilgas/OGInspectionsViolations/OGInspviol.htm

Pennsylvania Department of Environmental Protection (2011f) "Marcellus Shale inspections/violations 2011 Inspection comment ID 1974213" http://www.dep.state.pa.us/dep/deputate/minres/oilgas/OGInspectionsViolations/OGInspviol.htm

Pennsylvania Department of Environment Protection (2011g), "DEP Fines Chesapeake Energy More Than $1 Million; Penalties Address Violations in Bradford, Washington Counties" http://www.portal.state.pa.us/portal/server.pt/community/search_articles/14292

Swift, Robert (2011) "Driller Fined for Spill" http://thetimes-tribune.com/news/driller-fined-for-spill-1.1099217#axzz1doztpMg8

WJAC TV (2010) "Gas Well Blowout Under Control in Clearfield County" http://www.wjactv.com/news/news/gas-well-blowout-under-control-in-clearfield-count/nD4kX/

Jim Efstathiou (2010) "Chesapeake Gas Wells May Cause Susquehanna's Bubbles, State Says," Bloomberg http://66.147.244.96/~damascu5/wp-content/uploads/2011/12/Susquehanna-gas-migration-Chesapeake-Gas-Wells-May-Cause-Susquehanna-Bubbles_State-Says_Bloomberg_090710.pdf

WTAE Pittsburg (2011) "Explosion, Fire At Marcellus Shale Gas Well Site Under Investigation" http://www.wtae.com/r/26973100/detail.html

CBS Pittsburg (2011) "Authorities Identify Workers Injured in Gas Well Fire" http://pittsburgh.cbslocal.com/2011/02/24/authorities-identify-workers-injured-in-gas-well-fire/

ENVIRONMENTAL IMPACTS
DURING MARCELLUS SHALE GAS DRILLING:
CAUSES, IMPACTS, AND REMEDIES

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Attachment – G

University Responses to Inquiries

And Statements Regarding

The Shale Resources & Society Institute

4/9/12 to 9/12/12

University at Buffalo The State University of New York

UB REPORTER

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NEWS

New institute to analyze shale as energy resource

By JOHN DELLACONTRADA
Published: April 9, 2012

A new Shale Resources and Society Institute based in the Department of Geology, College of Arts and Sciences, will serve as a resource to help the public, policymakers and other stakeholders understand shale's potential as an energy resource.

The goal of the institute is to provide accurate, research-based information on the development of shale and other unconventional resources, says John P. Martin, the institute's director.

Specifically, the institute will conduct and disseminate peer-reviewed research that can help guide policymakers on issues relating to hydraulic fracturing and the development of energy resources. The institute will also educate students and provide the public with accurate information.

"We're really trying to provide fact-based, objective information. We're guided by science."

John P. Martin
Director, Shale Resources and Society Institute

The institute's work will draw on the expertise and perspectives of external research partners and UB faculty members in disciplines ranging from engineering to law and the social sciences. Activities will focus on four areas relating to shale development: fractures, fluids and migration; groundwater and surface environmental impacts; societal impacts; and policy and regulation.

"We're really trying to provide fact-based, objective information," Martin says. "We're guided by science."

"Many people in New York State have a strong opinion on this issue," says Robert Jacobi, the center's co-director and a longtime UB professor of

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geology. "We want to become a valuable community resource where anyone can come and read about current research, outreach and education, and have a feeling that they can trust these data."

Martin said the institute plans to seek funding from sources including industry and individuals, as well as agencies that support scientific research relating to energy. Future plans include establishing a management committee for the institute that includes the voices of environmental organizations and other stakeholders.

In addition to serving as director of the Shale Resources and Society Institute, Martin is the founder and principal consultant of JPMartin Energy Strategy LLC, which provides strategic planning, resource evaluation and other services to the energy industry, academic institutions and governments.

Prior to forming the consultancy in 2011, Martin spent 17 years working on energy research and policy issues at the New York State Energy Research and Development Authority (NYSERDA) and developed a series of projects targeting oil and gas resources, renewable energy development and environmental mitigation. He holds a PhD in urban and environmental studies from Rensselaer Polytechnic Institute.

Jacobi, a field and lab geoscientist, has extensive experience in academia and industry. A member of UB's faculty since 1980, he has over 30 years of experience teaching the structure, tectonics and evolution of North America, marine geology and geophysics, sedimentology and stratigraphy.

His present research focus includes identifying, understanding and predicting the trends of faults, fractures and folds in black shales. In addition to his work at UB, Jacobi is senior geology advisor for EQT Production, a Pittsburgh-based energy company. He recently consulted for the New York State Department of Environmental Conservation concerning hydraulic fracturing, with respect to faults and potential seismic activity. He holds a PhD in geology from Columbia University.

Reader Comments

Sue Tannehill says:

How will this university and the people doing the research here at UB distance themselves from the money being poured into acceptance and encouragement of hydraulic fracturing by energy and gas corporations?

How can you be an academic with integrity when your funding may come from the various organizations whose work may NOT be supported by your research? Is there enough courage in this group to publish negative findings if they are discovered, or, will the temptation to "torture the data until it confesses" be too great?

I am in no way casting aspersions on the integrity of these researchers. I am simply expressing a strong concern.

University at Buffalo The State University of New York

UB REPORTER

LAST UPDATED: Thursday, September 13, 2012

NEWS

Institute examines fracking violations

Editor's note: An earlier version of this story described the report as "peer-reviewed." This description may have given readers an incorrect impression. The story has been edited to more accurately describe the process by which the report's authors gathered comments before finalizing their report.

By CORY NEALON
Published: May 17, 2012

UB's Shale Resources and Society Institute has issued a report, "Environmental Impacts During Shale Gas Drilling: Causes, Impacts and Remedies," that offers the first quantitative data review of Pennsylvania's regulation of hydraulic fracturing of natural gas.

The report's authors—institute Director John P. Martin, University of Wyoming professor Timothy J. Considine and Pennsylvania State University professor emeritus Robert W. Watson—examined 2,988 violations from nearly 4,000 natural gas wells processed by the Pennsylvania Department of Environmental Protection from January 2008 through August 2011.

"New York's current regulations would prevent or mitigate each of the identified major environmental events that occurred in Pennsylvania."

John Martin
Director, Shale Resources and Society Institute

They found that 1,844 of the violations, or 62 percent, were administrative and preventative in nature. The remaining 1,144 violations, or 38 percent, were environmental in nature. The environmental violations were the result of 845 events, with 25 classified as "major" environmental events. The report defines major environmental events as major site restoration failures, serious contamination of local water supplies, major land spills, blowouts, and venting and gas migration.

The authors found that the percentage of environmental violations in relation to the number of wells drilled declined from 58.2 percent in 2008 to 30.5 percent in 2010. The number dropped to 26.5 percent during the

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first eight months of 2011. The report suggests that Pennsylvania's regulatory approach has been effective at maintaining a low probability of serious environmental events and in reducing the frequency of environmental violations.

"This study presents a compelling case that state oversight of oil and gas regulation has been effective," says lead author Considine. "While prior research has anecdotally reviewed state regulations, now we have comprehensive data that demonstrates, without ambiguity, that state regulation coupled with improvements in industry practices result in a low risk of an environmental event occurring in shale development, and the risks continue to diminish year after year."

The authors also analyzed how the violations and environmental events that occurred in Pennsylvania would be dealt with by emerging regulations, such as those under review in New York. They found that the proposed regulatory framework in New York could help avoid or mitigate the 25 major events identified in Pennsylvania.

"New York's current regulations would prevent or mitigate each of the identified major environmental events that occurred in Pennsylvania," Martin says. "It's important that states continue to learn from the regulatory experience—both strengths and weaknesses—of others."

Watson concludes that "remedial actions taken by operators largely mitigated the environmental impacts of environmental events. Only a handful of events resulted in environmental impacts that have not yet been mitigated."

Drafts of the report were reviewed by several individuals with expertise in related areas, who provided comments to the authors. They are:

- Andrew Hunter, a lecturer at Cornell University's School of Chemical and Biomolecular Engineering
- Brigham McCown, a former U.S. Department of Transportation executive and consultant with United Transportation Advisors
- George Rusk, a regulatory specialist at Ecology and Environment Inc.
- Scott Anderson, senior policy advisor with the Environmental Defense Fund's Energy Program
- Robert Jacobi, co-director of the Shale Resources and Society Institute, and longtime UB professor of geology.

The Shale Resources and Society Institute's goal is to provide accurate, research-based information on the development of shale gas and other unconventional energy sources. The institute conducts and disseminates peer-reviewed research that can help guide policymakers on issues relating to hydraulic fracturing.

This is the first report produced by the Shale Resources and Society Institute, which is funded by UB. The work of the institute was not funded or commissioned by external sources.

Reader Comments

University at Buffalo The State University of New York

UB REPORTER

LAST UPDATED: Thursday, September 13, 2012

NEWS

UB releases statement regarding Shale Resources and Society Institute

Statement from E. Bruce Pitman, dean, College of Arts and Sciences
Published: May 25, 2012

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COMMENTS

The University at Buffalo views academic freedom as a core principle. Faculty members are free to conduct research on any topic, including controversial ones, and to disseminate their findings without prior review or approval by the university. The university's role is to create a forum for objective research and informed debate—not to dictate the positions taken by its faculty members.

Under this principle, the findings presented in a recent report produced by the Shale Resources and Society Institute (SRSI) are the work of the authors, and any conclusions drawn are their views, not the views of the institution. Any questions related to the analysis and interpretation of the data must be referred to the authors.

The College of Arts and Sciences formed the Shale Resources and Society Institute (SRSI) in April 2012, with the goal of providing scientific research and analysis on all sides of the issues surrounding shale gas.

This topic is important and timely, and the work of such an institute is fully consistent with the university's mission of teaching, research and public service.

On May 15, the institute released its first report, "Environmental Impacts During Marcellus Shale Drilling: Causes, Impacts and Remedies."

In the days since, some criticisms of the authors' conclusions have been raised. UB will examine all relevant concerns, in accordance with the university's strong commitment to academic and research excellence.

There also have been questions raised about funding for the institute and for the report. UB has received no industry funding for SRSI. The institute's expenses and the salary of its part-time director, John P. Martin, have been paid entirely by the College of Arts and Sciences using discretionary funds,

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which come from sources that include indirect cost recovery from research grants, investment income and unrestricted gifts.

The University at Buffalo remains committed to conducting research and providing opportunities for public debate on subjects of vital importance, including questions related to shale gas, other alternative energy sources and the environment.

University at Buffalo The State University of New York
NewsCenter

NEWS RELEASE

University at Buffalo Statement Regarding Shale Resources and Society Institute

Release Date: June 28, 2012

Contact
Joe Brennan
brennanj@buffalo.edu
716-645-4094

The University at Buffalo recognizes that shale gas and hydraulic fracturing is an important, timely and controversial topic.

The university upholds academic freedom as a core principle. In accordance with this principle, faculty members are free to conduct research on any topic, including controversial ones, and to disseminate their findings without prior review or approval by the university. The university's role is to create a forum for objective research and informed debate -- not to dictate the positions taken by its faculty members. Thus the university views the work of the Shale Resources and Society Institute as fully consistent with UB's mission as a public research university. UB has no plans to alter or suspend the operations of the institute.

There continue to be many opportunities for faculty, staff, students and the public to be engaged in this subject. UB's Geology Department hosted a seminar series on Marcellus Shale topics in 2011 which was open to the public. The Shale Resources and Society Institute held an open meeting in early April prior to its inauguration to discuss its plans. In mid-May, the institute held another open meeting for faculty to talk about its research agenda and invite collaboration. In addition the institute's leaders have met individually with several faculty members from across the university.

The institute is committed to sustaining an environment of scientific integrity, honest investigation and freedom from interference.

On May 25, the dean of the College of Arts and Sciences responded to concerns raised in some quarters about the inaugural SRSI report: http://www.buffalo.edu/ubreporter/2012_05_31/shale_statement.

Other relevant information can be found at the institute's website [http://www.srsi.buffalo.edu] and in the press release http://www.buffalo.edu/ubreporter/2012_05_17/shale_violations.

From: UB Provost
To: "jamesholstun@hotmail.com"
Subject: RE: WIRED SCIENCE: Natural Gas Fracking Industry May Be Paying Off Scientists
Date: Thursday, August 09, 2012 2:05:00 PM

Dear Professor Holstun,

Thank you for your email of July 30, 2012.
I have written a letter of response which has been mailed to your UB office address.

Best,

Chip

Charles F. Zukoski
Provost and Executive Vice President for Academic Affairs
University at Buffalo
562 Capen Hall
Buffalo, NY 14260
716.645.2992
ubprovost@buffalo.edu

From: James Holstun [mailto:jamesholstun@hotmail.com]
Sent: Monday, July 30, 2012 10:04 AM
To: UB UUP; ubfsd-list@listserv.buffalo.edu; Pitman, E Bruce; UB Provost; President Satish K. Tripathi
Cc: ENGLISH@LISTSERV.BUFFALO.EDU
Subject: WIRED SCIENCE: Natural Gas Fracking Industry May Be Paying Off Scientists

Dear UB-UUP and Faculty Senate Colleagues, Dean Pitman, Provost Zukoski, and President Tripathi:

Too often, university administrations make bold and controversial moves in the bright light of summertime, when faculty governance is weakened or non-existent. The founding of the Shale Resources and Society Institute is an example: it was rushed into public view in April by an exposé in *Artvoice*, and its now-notorious first publication was issued by the university on May 15.

But this has been an unusual summer —the hottest and driest on record, and the first in my memory in which this strategy has run into a ditch. In fact, the former phenomenon may have something to do with the latter.

I think we've reached critical media mass on the UB SRSI controversy, and it has taken on a nationwide context and importance. Until the UB Administration admits it has a problem and does something to address it, we can count on UB forming a humiliating part of every single story on the corruption of academic standards by shale gas money.

There's a bright side: UB still has the opportunity to take a leading role in the nationwide house-cleaning that seems to be on its way. Just as the MIT administration got some good

and well-deserved PR out of responding vigorously and frankly to its demonstrated gender equity problems, so can UB with this problem. (In fact, the UB Administration can *also* gain a little credit for responding vigorously and frankly to *its* gender equity problems, shown by last spring's report by the Commission on Academic Excellence and Equity).

But denialism about the corruption of higher education by shale gas money will fare just about as well as climate change denialism. We may be reaching the tipping point for both rather soon.

Burgeoning bibliography on the controversy thus far:
https://dl.dropbox.com/u/17785940/Holstun_BIBLIOGRAPHY_ON_UB_SRSI.docx

Jim Holstun
Professor of English

McDonnell, Tim. "Natural Gas Fracking Industry May Be Paying Off Scientists." *Wired Science* 30 July, 2012.
Last week the University of Texas provost announced he would re-examine a report by a UT professor that said fracking was safe for groundwater after the revelation that the professor pocketed hundreds of thousands of dollars from a Texas natural gas developer. It's the latest fusillade in the ongoing battle over the basic facts of fracking in America.

Texans aren't the only ones having their fracking conversations shaped by industry-funded research. Ohioans got their first taste last week of the latest public-relations campaign by the energy policy wing of the US Chamber of Commerce. It's called "Shale Works for US," and it aims to spend millions on advertising and public events to sell Ohioans on the idea that fracking is a surefire way to yank the state out of recession. . . .

"It's hard to find someone who's truly independent and doesn't have at least one iron in the fire," said Ohio oil and gas lease attorney Mark F. Okey. "It's a good ol' boys network and they like to take care of their own. . . .

Timothy Considine, another Penn State grad who's now a geologist at the University of Wyoming, was the lead author on a SUNY-Buffalo report in May that claimed state regulation had made fracking safe in Pennsylvania. Within days, a top Pennsylvania environmental official quoted the Buffalo study in testimony to Congress about the effectiveness of fracking regulations. But both the official and the study itself declined to mention that Considine's close ties to the industry—and that his department had received nearly $6 million in donations from the oil and gas industry last year. Considine—whom one Pennsylvania newspaper called "the shale gas industry's go-to professor"—also helped write the controversial 2009 Penn State study and a 2010 expansion of it that was funded by the American Petroleum Institute.

University at Buffalo
The State University of New York

Office of the Provost

August 9, 2012

Professor James Holstun
Department of English
University at Buffalo
306 Clemens Hall
Buffalo, NY 14260-4610

Dear Professor Holstun:

Thank you for your email expressing concern for the integrity of university scholarship. I have shared your concerns with Dean Bruce Pitman, to whom the Shale Resources and Society Institute reports.

Universities are the home of academic freedom. In granting this freedom, we encourage scholars to explore the truth. As a major research university, UB is one of the few places in our society where this debate can occur.

As you know, after a piece of scholarship has been unveiled, scholars may disagree with the conclusions drawn or the method of presentation of the results. This is right and proper.

Sources of funding and potential conflicts must be reported in line with our policies and practices, and we should periodically review those policies. In the case of the first report of SRSI, these UB policies and practices were followed.

If there are questions about a piece of scholarship, the academy creates understanding through discussion of the data, their interpretation, and the conclusions drawn. Little progress is made in personalizing the debate.

As with any subject of scholarship undertaken at UB, in a debate of the role of oil shale in producing energy and the building of a social consensus on the use of this resource, my role is to ensure that we have effective policies and practices in place, that these policies and practices are followed and that infringement of expression of ideas as embedded in academic freedom does not occur. As a result, I encourage the debate shift to the data related to extracting resources from oil shale and their interpretation.

Sincerely yours,

Charles F. Zukoski
Provost and Executive Vice President for Academic Affairs
University at Buffalo

cc: President Satish Tripathi
Dean Bruce Pitman

562 Capen Hall, Buffalo, NY 14260-1606
Tel: (716) 645-2992 Fax: (716) 645-3685 Web: http://www.buffalo.edu/provost

Attachment – H

Provost Charles Zukoski's 9/12/12 Letter

To the University at Buffalo Community

Regarding Research Policy and Practice at UB

About the Provost
From the Provost
Schools & Colleges
Administrative Units, Centers & Institutes
Accreditation & Assessment
Commission on Academic Excellence & Equity
Programs, Policies & Resources
Contact

Published September 12, 2012

Research Policies and Practices at UB

Dear University Community,

As a major research university, UB is one of the few places in our society where honest and open debates about any topic, including controversial subjects, can occur. As Provost, one of my most important duties is to protect the academic freedom of all of our faculty to explore important topics irrespective of whether or not they are considered controversial.

Heightened sensitivities have emerged on management of conflict of interest giving rise to legitimate concerns regarding how faculty research is supported, conducted and reported. As an example, last month, the US Public Health Service (PHS) issued new conflict guidelines for PHS-funded university research, which UB has adopted. This action takes place amidst a growing conversation in the academic community nationally regarding the role of industry funding to support university research.

It is right and proper for UB faculty to seek and the University to accept private sector funding in support of scholarly activities. To ensure transparency and adherence to rigorous standards of academic integrity, UB investigators are required by university policy to disclose annually conflicts of interest and conflicts of commitment. If the conflicts are determined to be unmanageable, UB will not accept the funding.

Research involving shale gas is an excellent example of a controversial, important and timely topic. Almost immediately upon my arrival at UB, I became aware of concerns about the university's involvement in shale gas research. I have been following the communications around the Shale Research and Society Institute (SRSI) carefully. I have spent time learning about the origins of SRSI, reading its first report, and reviewing specific UB policies related to the establishment of UB centers and institutes and share with you the following:

The concept of SRSI was created by faculty from the Department of Geology. Dean E. Bruce Pitman established SRSI to provide objective scientific research and informed analysis of policies, practices and the science related to shale gas and hydraulic fracturing.

> No policies were broken in the establishment of SRSI as a decanal center within the College of Arts and Sciences.
>
> All funding for SRSI has been paid entirely by the College of Arts and Sciences through discretionary funds, which include indirect cost recovery from research grants, investment income and unrestricted gifts. UB has received no industry funding for SRSI.
>
> With regard to the first report of SRSI, Co-Director John Martin did not receive industry funding for his work on the report. If the non-UB authors received industry funding for their work on the report, sound academic practice would dictate that they disclose it in the report.

The controversy that has arisen over the first report of SRSI exposes sensitivities we have to the integrity of research conducted at UB. The result cannot be that we avoid undertaking and discussing topics that are current and where there is polarization of opinion. Instead, we must develop policies and practices in which we have confidence that, when followed, assure us that scholarship is undertaken without inappropriate conflicts influencing the results.

The University neither dictates the conclusions drawn by faculty from their research nor reviews faculty research before it is published. Standards of academic conduct are monitored within our policies related to research integrity and conflict of interest and commitment. When allegations of research misconduct are made, UB has robust practices for responding to such allegations.

As the world changes, we are continuously exposed to complex issues and events that challenge our policies and practices. With that in mind, I have asked Vice President for Research and Economic Development, Alexander Cartwright and Faculty Senate Chair, Ezra Zubrow to establish a joint committee to review university policies and practices related to research, scholarship and publication practices across the disciplines, with the goal of offering recommendations to develop and strengthen our policies in these areas. The Faculty Senate is the appropriate place for such a policy debate to occur and I am confident that, with this approach, any modifications to existing policies will be made in a thoughtful and careful manner.

We attract and retain the world-class scholars of UB by sustaining extraordinary standards of excellence. I look forward to working with Vice President Cartwright, Faculty Senate Chair Zubrow and all UB faculty to ensure our principles and policies remain anchored in our commitment to intellectual honesty and academic excellence.

Sincerely,