SwRI® Proposal No. 20-64924

Proposal for

Uranium Study

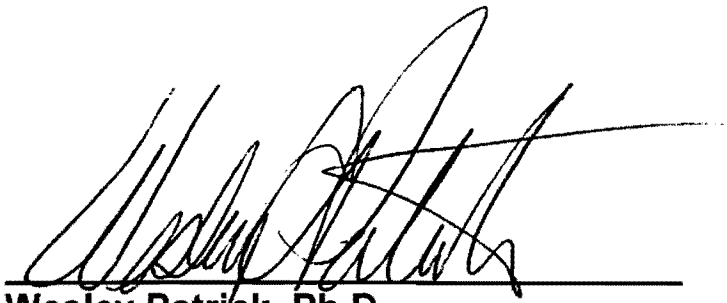
Prepared for

Commonwealth of Virginia
Department of Environmental Quality
RFP 12–06–PJ

Prepared by

Center for Nuclear Waste Regulatory Analyses
Geosciences and Engineering Division
Southwest Research Institute®
San Antonio, Texas

April 2012



Wesley Patrick, Ph.D.
Vice President
Geosciences and Engineering Division

TABLE OF CONTENTS

FIGURES

REQUEST FOR PROPOSALS
(RFP)

RFP # 12-06-PJ

Issue Date:	March 2, 2012
Title:	Uranium Study
Commodity Code:	91843
Issuing Agency:	Commonwealth of Virginia Department of Environmental Quality Attn: Patsy Jones, Contract Officer P. O. Box 1105 Richmond, VA 23218
Using Agency And/Or Location Where Work Will Be Performed:	Department of Environmental Quality Department of Mines, Minerals and Energy

Initial Period Of Contract: From Date of Award Through November 30, 2012.

Sealed Proposals Will Be Received Until 2:00 p.m. on April 3, 2012 For Furnishing The Services Described Herein.

All Inquiries For Information Should Be Directed To: Patsy Jones, Contract Officer, Phone: (804) 698-4335 or E-mail: Patricia.Jones@deq.virginia.gov. **Questions will be accepted until close of business on March 12, 2012.**

IF PROPOSALS ARE MAILED, SEND DIRECTLY TO THE ISSUING AGENCY SHOWN ABOVE. IF PROPOSALS ARE DELIVERED BY COURIER OR HAND DELIVERED, DELIVER TO: 1st Floor Receptionist Desk, Department of Environmental Quality, Attn: Patsy Jones, Contract Officer, 629 East Main Street, Richmond, VA, 23219.

In Compliance With This Request For Proposals And To All The Conditions Imposed Therein And Hereby Incorporated By Reference, The Undersigned Offers And Agrees To Furnish The Services In Accordance With The Attached Signed Proposal Or As Mutually Agreed Upon By Subsequent Negotiation.

Name And Address Of Firm:
Southwest Research Institute®
6220 Culebra Road
San Antonio, Texas Zip Code: 78238-5166
eVA Vendor ID or DUNS Number: 00-793-6482
Fax Number: (210 522-3559
E-mail Address: contract@swri.org

Date: April 2, 2012
By: [signature]
(Signature In Ink)
Name: R. B. Kalmbach
(Please Print)
Title: Executive Director, Contracts
Telephone Number: (210 522-2261

PREPROPOSAL CONFERENCE: A mandatory preproposal conference will be held at 9:30 a.m. on March 13, 2012 at the Department of Environmental Quality, 629 East Main Street, Richmond, VA, 23219. Reference: Section VII herein. NO ONE WILL BE ADMITTED AFTER 9:40 a.m. If special ADA accommodations are needed, please contact Patsy Jones at 804-698-4335 by March 9, 2012.

Note: This public body does not discriminate against faith-based organizations in accordance with the *Code of Virginia*, § 2.2-4343.1 or against an offeror because of race, religion, color, sex, national origin, age, disability, or any other basis prohibited by state law relating to discrimination in employment.

2 ATTACHMENT A: OFFEROR DATA SHEET

ATTACHMENT A

OFFEROR DATA SHEET

Note: The following information is required as part of your response to this solicitation. Failure to complete and provide this sheet may result in your proposal being scored lower.

1. Qualification: The vendor must have the capability and capacity in all respects to satisfy fully all of the contractual requirements.

2. Vendor's Primary Contact:

   Name: Joseph H. Marshall Phone: (210) 522-6510

3. Years in Business: Indicate the length of time you have been in business providing this type of good or service:

   65 Years _____ Months

4. Vendor Information:

   eVA Vendor ID or DUNS Number: 00-793-6842

5. Indicate below a listing of at least four (4) current or recent accounts, either commercial or governmental, that your company is servicing, has serviced, or has provided similar goods. Include the length of service and the name, address, and telephone number of the point of contact.

   A. Company:_____ Contact: _____

   Phone:(____)_____ Fax: (____)_____

   Project:_____

   Dates of Service: _____ $ Value: _____

   B. Company_____ Contact: _____

   Phone:(____)_____ Fax: (____)_____

   Project:_____

   Dates of Service: _____ $ Value: _____

   C. Company:_____ Contact: _____

   Phone:(____)_____ Fax:(____)_____

   Project:_____

   Dates of Service: _____ $ Value: _____

   D. Company:_____ Contact: _____

   Phone:(____)_____ Fax:(____)_____

   Project:_____

   Dates of Service: _____ $ Value: _____

SEE ATTACHED CREDIT REFERENCES

I certify the accuracy of this information.

Signed: Robert L. Wolfe Jr. Title: Procurement Specialist Date: March 28, 2012

SOUTHWEST RESEARCH INSTITUTE®

6220 CULEBRA RD. 78238-5166 • P.O. DRAWER 28510 78228-0510 • SAN ANTONIO, TEXAS, USA • (210) 684-5111 • WWW.SWRI.ORG

Date:

To:

BUSINESS AND CREDIT INFORMATION

DUNS: 00-793-6842

Location: San Antonio, TX; Houston, TX; Washington, DC; Detroit, MI

Officers: J.D. Bates, President
Beth Ann Rafferty, Chief Financial Officer, Vice President-Finance
Jack Fernandi, Treasurer

Accounts Payable: Karen A. Crow (210) 522-2911

A Not For Profit Texas Corporation
Texas Sales Tax Exemption Certificate is attached.
Federal Tax ID No. 74-1070544

CREDIT REFERENCES

Trade:

Wittigs Office Interiors
2013 Broadway
San Antonio, TX 78215
Accounts Receivable
Department
Attention: Eunice Myrick
Phone: 210-488-9621
Fax: 210-270-0118
eunice.myrick@wittigs.com

Fisher Scientific Company
2000 Park Lane
Pittsburgh, PA 15275
Phone: (412) 490-8308
Fax: (412) 490-5721
Attn: Kim Trauterman
Account No. 784214

W.W. Grainger, Inc.
4924 NW Loop 410
San Antonio, TX 78229
Phone: (847) 647-2060
Account No. 809690456

Matera Paper Company Inc
PO Box 200184
San Antonio, TX 78220-0184
Phone: (800) 580-8350
Fax: (210) 892-5162
Attn: Jenny Strunk/Steve Marshall

Arthur Fluid System Technologies
8341 Cross Park Drive
Austin, TX 78754
Fax: (512) 832-0063
Attn: Credit Department

Bank: Bank of America, N.A.
General credit inquiries should be faxed to 415-343-9301 and reference our name and account (001390004879).

Sincerely,

Joseph H. Marshall

Joseph H. Marshall
Purchasing Manager

HOUSTON, TEXAS (713) 977-1377 • WASHINGTON, DC (301) 881-0226

A. Company: U.S. Nuclear Regulatory Commission Contact: Valerie Whipple, Contracts Officer
Phone: (301) 492-3628 Fax (301) 492-3437
Project: Development of Supplemental EIS for Dewey Burdock In-situ Recovery Project-Task Order No. 1
Dates of Service: 10/1/09 9/28/12 $Value 589,976.00

B. Company: U.S. Nuclear Regulatory Commission Contact: Valerie Whipple, Contracts Officer
Phone: (301) 492-3628 Fax (301) 492-3437
Project: TA for the Development of a Standard Review Plan for Conventional Mill and Hap Leach Facilities Task Order No. 5
Dates of Service: 12/24/09—9/30/12 $Value 387,029.00

C. Company: U.S. Nuclear Regulatory Commission Contact: Valerie Whipple, Contracts Officer
Phone: (301) 492-3628 Fax (301) 492-3437
Project: Development of the Technical Basis for Revision of Regulatory Guide 8.30, "Health Physics Surveys in Uranium Recovery Facilities," Task Order No. 13
Dates of Service: 4/30/10—9/30/12 $Value 147,989.00

D. Company: U.S. Nuclear Regulatory Commission Contact: Valerie Whipple, Contracts Officer
Phone: (301) 492-3628 Fax (301) 492-3437
Project: Engineered Cover Support for Decommissioning and Uranium Recovery-Task Order No. 21
Dates of Service: 9/30/10—9/28/12 $Value 312,842.00

E. Company: U.S. Nuclear Regulatory Commission Contact: Valerie Whipple, Contracts Officer
Phone: (301) 492-3628 Fax (301) 492-3437
Project: Hydrogeologist Hydrologist to support Decommissioning and Uranium Recovery Activities—Phase 1
Dates of Service: 9/29/10—9/28/10 $Value 203,482.60

F. Company: U.S. Nuclear Regulatory Commission Contact: Valerie Whipple, Contracts Officer
Phone: (301) 492-3628 Fax (301) 492-3437
Project: Technical Assistance for the NRC/FSME Safety and Environmental Reviews of UR, Fuel, Cycle Facilities, Decommissioning Licensing and other NRC Licensing Support Activities
Dates of Service: $Value

G. Company: U.S. Nuclear Regulatory Commissio n Contact: Valerie Whipple, Contracts Officer
Phone: (301) 492-3628 Fax (301) 492-3437
Project: TA for the Development of a Supplemental EIS for the Ludeman In-Situ Recovery Project - Task Order No. 3
Dates of Service: 10/1/09—4/30/11 $Value 8,656.00

H. Company: U.S. Nuclear Regulatory Commissio n Contact: Valerie Whipple, Contracts Officer
Phone: (301) 492-3628 Fax (301) 492-3437
Project: "TA for the Developmental of a Final Supplemental Impact Statement for the Nichols Ranch I-Situ Uranium Recovery Project - Task Order No. 7"
Dates of Service: 10/1/09—2/11/11 $Value 374,322.00

I. Company: U.S. Nuclear Regulatory Commissio n Contact: Valerie Whipple, Contracts Officer
Phone: (301) 492-3628 Fax (301) 492-3437
Project: "TA for the Developmental of a Final Supplemental Impact Statement for the Lost Creek In-Situ Uranium Recovery Project - Task Order No. 8"
Dates of Service: 10/1/09—7/31/11 $Value 480,015.00

J. Company: U.S. Nuclear Regulatory Commissio n Contact: Valerie Whipple, Contracts Officer
Phone: (301) 492-3628 Fax (301) 492-3437
Project: TA for the Development of a Final Supplemental Environmental Impact Statement for the Moore Ranch In-Situ Uranium Recovery Project Task Order No. 9
Dates of Service: 10/1/09—10/1/10 $Value 265,394.00

K. Company: U.S. Nuclear Regulatory Commission Contact: Valerie Whipple, Contracts Officer
Phone: (301) 492-3628 Fax (301) 492-3437
Project: Revision of Statistical Methods for Evaluation of Water Quality in the Standard Review Plan for In Situ Recovery Uranium Extraction Applications, NUREG 1568 - Task Order No. 11
Dates of Service: 4/12/10 10/11/10 $Value 31,171.80

L. Company: U.S. Nuclear Regulatory Commission Contact: Valerie Whipple, Contracts Officer
Phone: (301) 492-3628 Fax (301) 492-3437
Project: Development of Fact Sheets for Uranium Recovery Facilities - Task Order No. 12
Dates of Service: 3/22/10 - 10/31/10 $Value 112,710.00

M. Company: U.S. Nuclear Regulatory Commission Contact: Valerie Whipple, Contracts Officer
Phone: (301) 492-3628 Fax (301) 492-3437
Project: "Evaluation of Land Application as Appropriate Method for Disposal of Liquid Wastes at Uranium In-Situ Recovery Facilities – Task Order No. 15"
Dates of Service: 4/8/10 9/15/10 $Value 69,953.00

N. Company: U.S. Nuclear Regulatory Commission Contact: Valerie Whipple, Contracts Officer
Phone: (301) 492-3628 Fax (301) 492-3437
Project: Hydrogeologist/Hydrologist to Support Decommissioning and Uranium Recovery Activities - Task Order No. 22
Dates of Service: 9/29/10 9/28/12 $Value 65.40

O. Company: U.S. Nuclear Regulatory Commission Contact: Valerie Whipple, Contracts Officer
Phone: (301) 492-3628 Fax (301) 492-3437
Project: Technical Assistance in Support of Engineered Systems Working Session in Hanford, WA -Task Order No. 18
Dates of Service: 7/9/10—9/30/10 $Value 40,000.00

P. Company: U.S. Nuclear Regulatory Commission Contact: Valerie Whipple, Contracts Officer
Phone: (301) 492-3628 Fax (301) 492-3437
Project: Technical Assistance for the Identification of References and Development of an Outline for an Environmental Topical Report on Reprocessing Facilities-Task Order No. 19
Dates of Service: 7/16/10—1/15/11 $Value 272,598.00

Q. Company: U.S. Nuclear Regulatory Commission Contact: Valerie Whipple, Contracts Officer
Phone: (301) 492-3628 Fax (301) 492-3437
Project: "Technical Safety Review of Crow Butte Resources, Inc. License Amendment Application for the Three Crow Project Task Order No. 20"
Dates of Service: 9/9/10 - 9/30/11 $Value 60,000

R. Company: U.S. Nuclear Regulatory Commission Contact: Valerie Whipple, Contracts Officer
Phone: (301) 492-3628 Fax (301) 492-3437
Project: Hydrogeologist/Hydrologist to Support Decommissioning and Uranium Recovery Activities - Phase 003
Dates of Service: 9/29/10 - 9/28/12 $Value 6,101.45

S. Company: U.S. Nuclear Regulatory Commission Contact: Valerie Whipple, Contracts Officer
Phone: (301) 492-3628 Fax (301) 492-3437
Project: Development of Fact Sheets for Reactor and Complex Materials Facilities Undergoing Decommissioning
Dates of Service: 9/23/11—9/28/12 $Value 236,735.00

T. Company: U.S. Nuclear Regulatory Commission Contact: Valerie Whipple, Contracts Officer
Phone: (301) 492-3628 Fax (301) 492-3437
Project: Titan Uranium Heap Leach Safety Review
Dates of Service: 9/23/11—3/31/12 $Value 84,000

U. Company: U.S. Nuclear Regulatory Commission Contact: Valerie Whipple, Contracts Officer
Phone: (301) 492-3628 Fax (301) 492-3437
Project: Titan Heap Leach Environmental Review
Dates of Service: 9/23/11—3/31/12 $Value 45,000.00

V. Company: _____ Contact: _____
Phone: ( ) _____ Fax ( ) _____
Project: _____
Dates of Service: _____ $Value _____

W. Company:_____ Contact:_____

Phone: ( )_____ Fax ( )_____

Project:_____

Dates of Service:_____ $Value _____

X. Company:_____ Contact:_____

Phone: ( )_____ Fax ( )_____

Project:_____

Dates of Service:_____ $Value _____

Y. Company:_____ Contact:_____

Phone: ( )_____ Fax ( )_____

Project:_____

Dates of Service:_____ $Value _____

Z.

3.a Experience

Southwest Research Institute® (SwRI®) has been performing work related to the nuclear fuel cycle, including uranium mining, milling, and waste management since 1987 through the Center for Nuclear Waste Regulatory Analyses (CNWRA®). CNWRA is a federally funded research and development center (FFRDC) chartered by the U.S. Nuclear Regulatory Commission (NRC) and is part of the Geosciences and Engineering Division (GED) at SwRI. In addition to assisting NRC, CNWRA conducts research and development for non-Federal governmental organizations and commercial clients throughout the United States and abroad. Our professional staff of 61 scientists and engineers covers the following disciplines:

Figure 3-1. The Center for Nuclear Waste Regulatory Analyses Offices in San Antonio, Texas

- Hydrology and Hydrogeology
- Geochemistry
- Geology and Geophysics
- Corrosion Science and Process Engineering
- Mining, Geotechnical, and Facility Engineering
- Performance Assessment
- Environmental Assessment
- Regulatory Analysis

Although CNWRA's main office (Figure 3-1) is in San Antonio, Texas, we also maintain an office in Rockville, Maryland to support NRC and our other clients on the East Coast.

CNWRA is particularly strong in the area of risk assessment related to the nuclear fuel cycle including probabilistic assessment of natural hazards to engineered structures, and fate and transport of radioactive and chemical contaminants in air, soil, and water (Figure 3-2).

Assisting CNWRA in the Department of Environmental Quality Uranium Study will be Clear Creek Associates (Clear Creek) and Chmura Economics & Analytics (Chmura), both small business enterprises certified with the State of Virginia. Clear Creek has extensive experience in hydrology and hydrogeology related to hard rock mine development, operation, and management of environmental impacts. Chmura will be assisting CNWRA in the area of financial assurance financing vehicles.

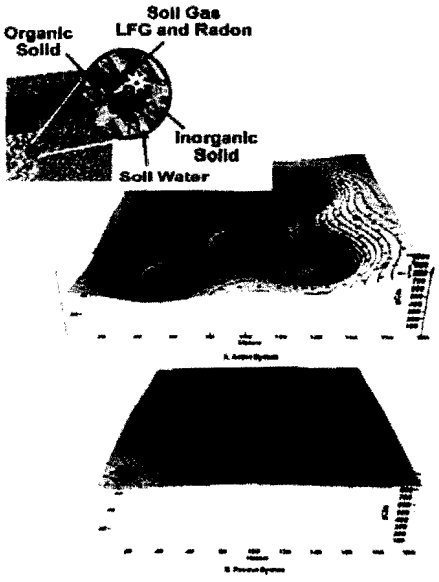


Figure 3-2. Processes Controlling Radon Emissions in a Landfill and Simulated Radon Surface Fluxes

Experience of CNWRA in Uranium Mining, Milling, and Waste Management

CNWRA has provided support to NRC related to the uranium fuel cycle through scientific research and development of assistance in developing regulations and regulatory guidance for uranium milling and waste disposal. Although NRC does not have regulatory authority for uranium mining per se, NRC does regulate uranium extraction in the form of *in-situ* leaching as well as conventional milling, and disposal of residuals from these processes in the form of tailings impoundments and ponds. CNWRA has also provided extensive support to NRC for environmental assessments of uranium recovery projects. Specific projects that CNRWA has performed related to uranium mining, milling, and waste management are listed in our offerors data sheet, RFP Attachment A.

Independence of Southwest Research Institute®

Since it was established in 1947, SwRI has been a source of independent research and development benefiting government, industry, and the public. This independence extends to CNWRA, a federally funded research and development center operated by SwRI under sponsorship from NRC. As explained more fully in the following discussion, the demonstrated independence of SwRI and CNWRA has a solid foundation in regulation, policy, organization, operational considerations, and practice.

SwRI is organized and operated in accordance with section 501(c)3 of the U.S. Internal Revenue Code. This establishes SwRI and each of its operating units as non-profit entities. Because it lacks any profit motive, SwRI can withstand—and for decades has demonstrated its ability to resist—undue outside influences and render sound and unbiased technical advice. The executive and division management of SwRI reports to an independent Board of Directors. The statement of purpose in the SwRI corporate by-laws reinforces the independence of the organization, stating that it is "to provide charitable, scientific testing for public safety, literary, or educational benefits in the public interest..." Operationally and practically, independence of SwRI is ensured by the fact that it works for such a broad spectrum of public and private entities on such a large number of projects (several thousands in any given year) that it does not depend on any one or a few organizations for financial support.

Within SwRI, CNWRA is organized as a FFRDC. The regulations (see 48 CFR 35.017) are clear that any FFRDC must be established and operated in a manner that fosters and assures that independent advice and counsel are provided to the sponsoring agency. Specifically, it must "...conduct its business in a manner befitting its special relationship with the Government, to operate in the public interest with objectivity and independence, to be free from organizational conflicts of interest, and to have full disclosure of its affairs..." To fulfill these requirements, an FFRDC must be a non-profit entity and, even if it is operated by a non-profit (which is the case for CNWRA) another level of independence is required by regulation, which mandates that the FFRDC be operated as "an identifiably separate operating unit..." within the parent organization.

CNWRA provides technical assistance and research support to NRC on matters related to uranium extraction, within the above framework of independence. Over the years, CNWRA has provided assistance in developing standard review plans for guiding reviews of uranium extraction license applications, reviewing safety aspects of license renewals and amendments, evaluating mine/mill tailings impoundments, analyzing proposed alternative concentration limits, and assessing and reviewing environmental impacts related to uranium extraction operations. Regulatory guidance documents serve the dual purposes of providing instructions to staff

conducting the reviews and informing potential applicants about what is needed in license applications to meet regulatory requirements. The charter and contract for operation of CNWRA explicitly speak to its responsibility to provide independent advice and counsel, including in areas where it is not currently tasked. In addition, under this award-fee contract, one of the evaluation criteria deals with the degree to which CNWRA provides independent products and services. Furthermore, CNWRA conducts a large number of projects for various clients, which further ensures its independence from outside influence.

Finally, both SwRI and CNWRA have formal processes for evaluating potential for organizational and individual conflicts of interest (COI) to ensure the independence of its work. At the corporate level, the SwRI Central Proposal Office evaluates potential for COI before any proposal is developed and submitted. This evaluation is led by the SwRI Executive Vice President, and participated in by the Chief Financial Officer, Vice President Legal and General Counsel, and Executive Director Contracts. At the division level, CNWRA evaluates and documents the independence and freedom from COI of each staff member, consultant, and subcontractor used on each project its conducts. These policies, procedures, and practices have been effective for decades, and will be applied to the proposed program. Our analysis concludes that CNWRA undertaking the proposed work for the State of Virginia will not give rise to any organizational or individual conflict of interest.

Background on SwRI

SwRI, headquartered in San Antonio, Texas (Figure 3-3), is one of the oldest and largest independent, nonprofit, applied research and development (R&D) organizations in the United States. Founded in 1947, SwRI provides contract research and development services to industrial and government clients in the United States and abroad.

SwRI offers multidisciplinary, problem-solving services in a variety of areas in engineering and the physical sciences. Historically, more than 4,000 projects are open at the Institute at any one time. These projects are funded almost equally between the government and commercial sectors. SwRI's total revenue for fiscal year 2011 was $581 million. In 2011, SwRI funded $6.1 million to its internally sponsored R&D program, which is designed to encourage new ideas and innovative technologies.

SwRI's headquarters occupies more than 2 million square feet of office and laboratory space on more than 1,200 acres in San Antonio. The Institute has business offices in Houston and Washington and technical offices and laboratories in

Ann Arbor, Michigan
Atlanta, Georgia
Beijing, China
Boulder, Colorado
Hill Air Force Base, Utah
Hanover, Maryland
Layton, Utah
Lorton, Virginia
Minneapolis, Minnesota
Oklahoma City, Oklahoma
Rockville, Maryland
Warner Robins, Georgia

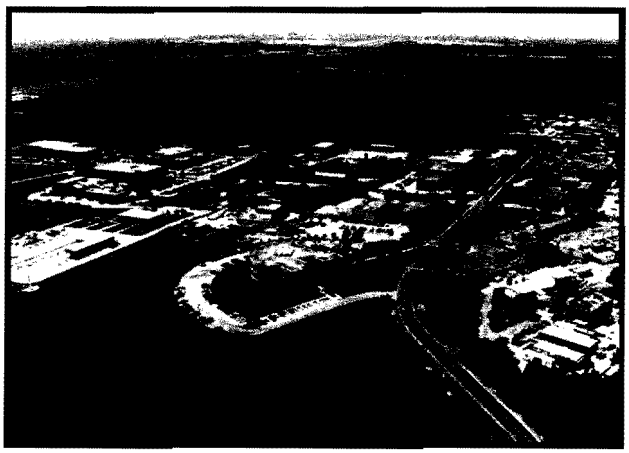


Figure 3-3. Southwest Research Institute® Campus in San Antonio, Texas

In addition, SwRI provides environmental monitoring expertise at munitions disposal sites at the Umatilla Army Depot in Hermiston, Oregon and the Pine Bluff Chemical Depot in Pine Bluff, Arkansas.

At the close of fiscal year 2011, SwRI staff numbered 3,046, including 275 professionals with doctorate-level degrees and 499 with master's level degrees. In 2011, staff members published 507 papers in the technical literature; made 500 presentations at technical conferences, seminars and symposia around the world; submitted 66 invention disclosures; filed 65 patent applications; and received 34 U.S. patent awards.

Background on Clear Creek Associates

Clear Creek Associates is a groundwater consulting firm that specializes in hydrogeologic studies, environmental investigations, and groundwater modeling. Clear Creek supports both municipal and industrial clients, and has a particular expertise in understanding the hydrologic effects of large-scale mining operations and managing groundwater resource and hydrogeologic investigations in fractured bedrock settings.

Founded in Scottsdale, Arizona in 1999, Clear Creek has expanded to include offices in Tucson, Arizona; Claremont, California; and, in 2009, Leesburg, Virginia. Clear Creek is a growing business and plans to continue to develop and grow in Virginia. In fiscal year 2011, the company's total revenue was $5.5M. Clear Creek is certified as a Virginia Small Business (#697428) under the categories of Environmental Consulting and Groundwater Consulting.

At present, Clear Creek has 32 staff members consisting of highly-qualified geologists, hydrologists, engineers, and legal and business-management professionals, with most individuals having at least fifteen years of professional experience. Clear Creek's staff is highly regarded and includes the National Groundwater Association's (NGWA) 2012 McElhiney Lecturer (Mr. Marvin Glotfelty), the 2012 national president of the American Institute of Professional Geologists (AIPG)(Ms. Barbara Murphy), as well as 16 staff members who are professionally licensed, and are active in national or regional professional societies.

Some of Clear Creek's mining experience is described in the following.

Sierrita Mitigation Order Investigation and Feasibility Study—Green Valley, Arizona

Clear Creek provides environmental consulting services for investigation of a groundwater sulfate plume and remedial actions conducted pursuant to a Mitigation Order on Consent between the Arizona Department of Environmental Quality and Freeport-McMoRan Sierrita, Inc. The sulfate plume has migrated beneath the developed area of Green Valley and impacted drinking water supplies. Clear Creek project components include

- Groundwater Monitoring—Responsible for groundwater monitoring and preparation of groundwater monitoring reports for agency submittal.

- Remedial Design—Clear Creek developed the final conceptual wellfield design for a groundwater pumping system consisting of 18 wells capable of pumping a total of 14,000 gallons per minute. The design was developed based on the conceptual hydrogeologic model. Clear Creek used groundwater flow and chemical transport numerical modeling to optimize well placement and pumping rates, and to predict future migration of a sulfate plume.

- Wellfield Design—Clear Creek developed designs and technical specifications for eight production wells being installed for plume control. The well specifications provide detailed requirements for drilling and well construction needed to protect Sierrita's investment.

- Interceptor Well Construction Oversight and Testing—Clear Creek provided construction management and oversight during the installation of four of the groundwater interceptor wells. Well depths ranged from approximately 500 to 700 feet and required detailed hydrogeologic analysis and testing.

Pinal Creek Water Quality Revolving Fund Site—Miami, Arizona

Clear Creek provides hydrogeologic and water management consulting services to support the remediation conducted by Miami at the Pinal Creek Water Quality Assurance Revolving Fund Site. Releases of contaminants and hazardous substances have occurred from the mining and processing facilities, including: process solution impoundments, tailings piles, leach dumps, waste rock piles, spills, and as storm water runoff. Erosion of waste piles, especially tailings piles, has also resulted in the release of contaminants to water courses. Particulate fallout of wind-blown tailings and from copper smelters in the area has also contributed to the spread of contamination. Selected project components include

- Remedial Design—Clear Creek compiles and evaluates water quality, water level, and operational data for the remediation facilities for periodic assessment of facility performance and optimization of operating plans. Clear Creek supports Miami in the development of a long-term strategic plan for coordination of remediation, source control, and closure activities. Examples of work in progress includes field and laboratory studies to quantify the acidity and metals contained by aquifer solids and evaluate approaches to attenuate them, evaluation of recharge technologies for water management and enhancement of groundwater cleanup, and assessment of seepage from tailing impoundments into a shallow alluvial aquifer.

- Hydrogeology and Wellfield Design—The Kiser Basin and LPC wellfields are key remediation facilities. Evaluation of these wellfields is ongoing by Clear Creek because of our expertise in hydrogeology and knowledge of the wellfield designs. Clear Creek supervised the drilling and installation of over 20 domestic drinking water supply wells and three large-diameter supply wells as part of the response to address water supplies impacted by poor quality water.

- Groundwater and Surface Water Monitoring—Clear Creek revised the monitoring plan for the site based on an evaluation of data collected under the current plan and expectation of future data needs. The revised plan eliminated or reduced monitoring requirement at noncritical facilities and strengthened monitoring at critical facilities.

Cyprus Tohono Mine Site Groundwater Remedial Investigation/Feasibility Study—Casa Grande, Arizona

Since 1999, Clear Creek has provided hydrogeological consulting services to support investigation of groundwater impacts at the Cyprus Tohono Corporation Mine Site, south of Casa Grande, Arizona. In 2009, Freeport McMoRan Corporation and Cyprus Tohono Corporation entered into a Settlement Agreement with the U.S. Environmental Protection Agency (EPA) to conduct a groundwater Remedial Investigation/Feasibility Study at the Site.

A primary component of this characterization and remediation project involves an evaluation of the generation, fate, and transport of radionuclides, including uranium and its decay elements, in mine materials, soil, and groundwater. Clear Creek performed groundwater and contaminant transport modeling to simulate radionuclide transport at the site.

Additionally, Clear Creek has coordinated and overseen installation of over sixty new monitor wells to characterize groundwater conditions over a 30 square mile area. Clear Creek was responsible for preparing the overall Conceptual Site Model (CSM), which describes site hydrogeology, contaminant transport pathways, and the nature and extent of groundwater impacts at the site. One key component of the CSM involved investigating and characterizing transport pathways in the vicinity of a mill tailings impoundment and former evaporation ponds. Clear Creek coordinated the installation and testing of 10 monitor wells in this area and used borehole logging and depth-specific sampling techniques to better evaluate the relationship between infiltration, seepage, and geology. A key finding was the recognition that seepage was migrating along the basin-fill/bedrock contact through paleo-channels in the bedrock surface. This finding supported the siting of additional monitor wells and will be used to focus the analysis of remedial alternatives. In another area of the site, Clear Creek used water levels and site specific conditions to demonstrate the existence of a hydraulic capture zone in the area of the underground workings and mine pit. This demonstration was summarized in the CSM Report. The presence of the hydraulic capture zone is a critical consideration regarding future remedial alternatives for affected groundwater in this area. Clear Creek developed a numerical groundwater flow model to support the demonstration of the current and future passive containment capture zone created by the CTC open pit.

Asarco Hayden Mill and Smelter Complex—Mill Tailings Seepage Analysis

Clear Creek evaluated the seepage generated by tailing impoundments totaling about 1,300 acres immediately adjacent to the Gila River at the Hayden Smelter complex near Winkelman, Arizona. Using the HELP Model (1997, Environmental Laboratory USAE Waterways Experiment Station; Version 3.07), Clear Creek simulated the infiltration of natural precipitation through the tailings and into the underlying groundwater system. Several scenarios were developed including scenarios with and without a 4-foot thick layered low-permeability cap. Sieve analyses of the tailings collected by Asarco staff were used to characterize the soil properties of the tailings for input to the model.

Since completion of this project, Clear Creek has been retained to manage the development of Best Available Demonstrated Control Technologies (BADCT) for dozens of facilities at the Smelter Complex. This work is on-going.

Phelps Dodge Bagdad Mine—Mine Pit Dewatering Study

Clear Creek completed an assessment of current and future pit dewatering activities at the Bagdad Mine, including a review of the effectiveness of in-pit drain-holes and pumping from adjacent dewatering wells. The study relied on a review of existing geologic and hydrologic data and included field tasks to address key data gaps. Field tasks included reconnaissance-level geologic mapping, borehole/drain-hole pressure/water level measurements, falling-head permeability testing, and water quality sample collection. Clear Creek analyzed the data focusing specifically on hydraulic conditions in the vicinity of the pit, such as hydraulic conductivity and the connectivity of various geologic structures. The results of the analysis were used to develop a conceptual understanding of groundwater flow in the vicinity of the pit. A preliminary numerical MODFLOW flow model of the pit was developed and used to evaluate

current and alternative pit dewatering strategies subject to various pit development scenarios. The model was also used to estimate dewatering volumes required for future pit geometries.

Freeport-McMoRan Safford Dos Pobres—Mine Pit Dewatering Study

Clear Creek evaluated future pit dewatering needs for the Dos Pobres Open Pit mine in Safford, Arizona. The Dos Pobres pit currently extends to a depth of about 900 feet which is at or below the regional water table. Further deepening of the pit will result in groundwater flow into the pit. The hydrogeology of the pit area is complex as it is affected by a major fault that crosses the pit. To assess future pit dewatering needs, Clear Creek developed a cost-effective spreadsheet evaluation of groundwater flow that can be modified by mine engineers as conditions and mine plans change over time. The spreadsheet, which is based on Darcy's Law, takes into account the differences in hydrogeologic conditions on either side of the fault and uses groundwater monitor well data to compute potential pit inflow values. Complex fracture flow modeling was rejected because of the high cost and because so little information was available regarding individual fractures. Clear Creek's approach was designed to provide a tool that site mine engineers could easily and cost-effectively use in the future to evaluate pit dewatering.

Background on Chmura Economics & Analytics

Chmura Economics & Analytics was founded by Christine Chmura in 1999. The firm is a women- and minority-owned small business[1] (LLC) with headquarters in Richmond, Virginia. Chmura currently has nine professional staff members plus temporary support staff. A branch office was opened in Cleveland, Ohio in 2005. The firm specializes in applied economic consulting, quantitative research, and software solutions requiring the integration of advanced economic analysis. Chmura's work has included workforce and economic development, site selection, and impact analysis. Chmura publishes Virginia Economic Trends, now in its tenth year, and additional electronic publications, custom publications, and forecasts are available via www.chmuraecon.com. Chmura's software products include our EQ suite featuring JobsEQ®, the premier workforce modeling software, which is currently in widespread use by economic development agencies and workforce boards throughout Virginia and the nation.

Chmura's multi-state client base includes economic developers, workforce practitioners, education reformers, firms seeking information and data to make sound decisions, governors and secretariats, chambers of commerce, lobbyists, developers, target marketers, counties and localities, firms and corporations seeking fiscal analysis for project and incentive-based discussions, as well as many other public and private entities with needs for credible information on a timely basis. Chmura served over 100 clients during the past two years with projects and services spanning a multitude of public and private entities. Furthermore, Chmura's online products currently serve over 9,000 international users and as many subscribers across the nation receive Chmura's weekly and quarterly publications.

Chmura has been involved in the analysis of Virginia's uranium assets since the revival of interest in 2007. In 2011, Chmura completed the first comprehensive socioeconomic impact analysis of the uranium industry in Virginia's history. Chmura's holistic approach to the economic implications of a potential uranium mine and mill has stood the test of time and is widely regarded as a balanced, objective, and thorough analysis of such an industrial complex.

[1]SWAM Number S–9700

Team Experience to Address the Statement of Needs

The following are brief descriptions of the team's experience to address the Statement of Needs for the Uranium Study for the Department of Environmental Quality.

III. A. Statement of Needs—Initial Literature Review and Recommendations

> • *Virginia & Other Relevant Studies: Utilizes summaries prepared by the Workgroup of existing Virginia uranium mining studies (National Academy of Sciences/National Academies Press [NAS/NAP], Virginia Beach, Fairfax, Roanoke River Basin Association, Chmura Economics and Analytics, and RTI International, and the 1984 Senes Assessment of Risk and associated Uranium Task Force Report), as well as other relevant studies, and makes recommendations concerning findings of these studies that are relevant to Virginia's existing regulatory framework that would apply to uranium mining and milling*
>
> • *Existing Regulatory Programs: Compares existing uranium mining and milling regulatory programs including Nuclear Regulatory Commission (NRC), any agreement state programs, and international programs (such as Australia, Canada and France), and recommends provisions from within those regulatory programs that are relevant to the Commonwealth and would be effective in Virginia.*
>
> • *International Emerging Standards: Summarizes pertinent information and studies from such groups as the International Atomic Energy Agency, the World Nuclear Association, etc. and provides recommendations based on this review that are relevant to the Commonwealth's regulation of the life span of uranium mining and milling including recommendations regarding modem best international practices and other emerging standards and technologies. Identify internationally accepted best practices that can be implemented to mitigate the risk of radioactive releases, discussing technologies available to reduce emissions and maintain a focus on pollution prevention and reduction.*

CNWRA routinely utilizes reports, especially summaries of reports, to provide recommendations for developing and revising regulatory frameworks. With regard to uranium milling, CNWRA has reviewed reports and developed recommendations for NRC to consider when developing regulatory guidance on conventional milling and *in-situ* recovery uranium milling. Projects CNWRA has completed include:

- Revision of standard review plan for *in-situ* leach uranium extraction license applications, NUREG–1569
- Development of standard review plan for conventional mill and heap leach facilities

In addition, CNWRA reviewed reports, including international standards, to recommend regulatory guidance for land disposal of liquid wastes at *in-situ* uranium recovery facilities. Examples are

- Evaluation of land application as an appropriate method for disposal of liquid wastes at uranium *in-situ* recovery facilities.
- Revision of statistical methods for evaluation of water quality in the standard review plan for *in-situ* recovery uranium extraction applications, NUREG–1569.

The following are some specific projects that CNWRA has completed that are particularly relevant to this Statement of Needs.

1) Technical and regulatory analysis to support development of a new NRC regulation governing uranium mining and recovery.

This project assisted NRC in establishing regulations specifically for application to all uranium recovery facilities. Existing NRC regulations at 10 CFR Part 40, "Domestic Licensing of Source Material," apply broadly to all facilities receiving title to, receiving, possessing, using, transferring, or delivering source and byproduct materials. These regulations have been used for uranium recovery licensing but do not address *in-situ* leaching facilities, which comprise the majority of current uranium extraction operations in the United States. In addition, NRC wished to address use of uranium mill tailings impoundments as a potentially cost-effective location to dispose of materials from reclamation and cleanup of other fuel cycle facilities and to resolve inconsistencies, inadequacies, and operational problems identified during application of 10 CFR Part 40 and other NRC regulations to uranium mining and extraction facilities, resulting in a stand-alone regulation for these facilities.

CNWRA activities that were completed under the task included development of a report identifying issues to be addressed in 10 CFR Part 41 including (i) clarifications or improvements to existing regulatory requirements, (ii) inconsistencies or conflicts within or among existing regulations, (iii) operational problems identified during implementation of existing regulations, (iv) requirements necessary for regulating *in-situ* leaching facilities, (v) incorporation of NRC decisions and policies that have been effected since the completion of 10 CFR Part 40, and (vi) criteria for disposing of materials from reclamation and cleanup of other fuel cycle facilities. CNWRA also prepared the Regulatory Analysis, including the Small Business Regulatory Enforcement Fairness Act Analysis.

The final report from this project included text for a proposed new NRC regulation that included specific recommendations for acceptable contaminant concentrations and radioactivity levels.

2) Prepared a baseline risk-Informed, performance-based approach for *in-situ* leach uranium extraction licensees.

This project drew upon extensive CNWRA involvement in regulation of *In-Situ* leach Uranium Recovery facilities and processes for the NRC. The report was published as an NRC NUREG series document and remains in wide use by NRC and Uranium Recovery licensees. The report included a description of *in-situ* leach facilities operations including plant operation; aquifer restoration; instrumentation; waste management; reclamation, decontamination, and decommissioning; management controls and operating procedures; radiation safety controls and monitoring; respiratory protection program; bioassay program; contamination control programs; groundwater and surface water monitoring programs; management audit and control program; and reporting requirements.

The report also included (i) an approach to risk assessment that addressed surface environment chemical hazards, surface environment radiological hazards, groundwater chemical and radiological contamination hazards and (ii) consequence analyses that included chemical hazard consequence analyze for a variety of relevant chemicals, radiological hazard consequence analyses for a variety of substances and operations, groundwater contamination hazard consequence analyses, pregnant lixiviant field spill hazard consequence analysis, transportation hazard risk analysis, tornado hazard and consequence

analysis, seismic hazard and consequence analysis, and performance measures. The report concluded with risk insights and recommendations for each of the areas for which consequence analyses had been conducted.

3) Updated NRC Regulatory Guides.

CNWRA has contributed to updates and revisions to NRC regulatory guides addressing the following topics:

- Radiological Effluent and Environmental Monitoring at Uranium Mills
- Quality Assurance for Radiological Monitoring Programs (Inception through Normal Operations to License Termination)
- Bioassay of Effluent Streams and the Environment at Uranium Mills
- Standard Format and Content of License Applications for Uranium Mills
- General Guidance for Designing, Testing, Operating, and Maintaining Emission Control Devices at Uranium Mills
- Design, Construction, and Inspection of Embankment Retention Systems at Uranium Recovery Facilities
- Operational Inspection and Surveillance of Embankment Retention Systems for Uranium Mill Tailings
- Methods for Estimating Radioactive and Toxic Airborne Source Terms for Uranium Milling Operations
- Onsite Meteorological Measurement Program for Uranium Recovery Facilities—Data Acquisition and Reporting
- Calculation of Radon Flux Attenuation by Earthen Uranium Mill Tailings Covers
- Standard Format and Content of Decommissioning Plans for Materials Licensees

4) Updates to and revision of NRC Standard Review Plans for Uranium Recovery Facilities.

This tasking included updates or revisions to NRC standard review plans for licensing actions under requirements of both Title I and Title II of the Uranium Mill Tailings Radiation Control Act.

III. B. Statement of Needs—Coordination With Workgroup

> *1. Coordinate with the Workgroup through at least monthly progress meetings to develop analyses of the following items and to develop and provide a final report. The contractor must be available to meet with the Workgroup, either face-to-face or via conference calls, as needed to develop interim deliverables and the final report that:*

a. Compares recommendations in the initial report (referenced in A. above) to the statutory jurisdictions of the DEQ and DMME;

b. Identifies areas where regulatory coverage might need to be created, modified or expanded to ensure protection of public health and the environment with respect to the lifespan of mining and milling projects in Virginia and long-term site monitoring requirements;

c. Recommends changes (including statutory changes) to meet these needs.

CNWRA routinely coordinates with NRC in the development of new regulations and guidance related to the nuclear fuel cycle, and uranium processing and waste disposal. Commonly, coordination is conducted for financial and programmatic items as well as technical items. These meetings can consist of a diverse group of individuals with different viewpoints. CNWRA has experience working in small and large groups to achieve general and specific work objectives. Because NRC is a regulator and a principal client, CNWRA is very familiar with issues associated with statutory jurisdictions, developing regulations that are protective of public health and the environment, and revising regulations where necessary. In addition, CNWRA has experience ensuring that uranium milling applicants meet regulations established by NRC and EPA. This experience has come from reviewing the new, renewal, and amendment uranium milling license applications for NRC listed below:

- Crow Butte Resources, Inc. license renewal application;
- Health physics review of Uranerz Energy Corporation license application for Nichols Ranch *in-situ* uranium recovery;
- Revision of standard review plan for *in-situ* leach uranium extraction license applications, NUREG–1569;
- Technical assistance for the development of supplemental environmental impact statement for the Dewey Burdock *In-Situ* Recovery Project;
- Development of standard review plan for conventional mill and heap leach facilities;
- Technical assistance for the development of a final supplemental environmental impact statement for the Nichols Ranch *In-Situ* Uranium Recovery Project; and
- Development of the technical basis for revision of Regulatory Guide 8.30, "Health Physics Surveys In Uranium Recovery Facilities.

CNWRA staff also participated with NRC in public meetings conducted with respect to development of 10 CFR Part 63 and the Yucca Mountain Review Plan.

III. B. 2. a. Statement of Needs—Water Quality Monitoring for Surface Water

(1) Ecological risks associated with radiological toxicity and radiation exposure;
(2) Impacts of mine dewatering activities;
(3) Tracking and minimizing the impacts of elevated concentrations of trace elements;
(4) Impacts of land disturbance activities and surface water run-off; and,
(5) Potential for long-term water quality degradation.

CNWRA has conducted multiple projects that involved the evaluation of uranium mining and processing impacts on surface water, and has conducted similar evaluations of potential impacts of other sites contaminated with radioactive materials. The following is a list of projects involving such evaluations:

- Umetco Gas Hills Mining Company Above Grade Tailings Impoundment Technical Evaluation Report
- Technical Evaluation Report for the Plateau Resources Limited Shootaring Canyon, UT Reclamation Plan
- Technical Evaluation Report for the Kennecott Uranium Co. Sweetwater Uranium Project Reclamation Plan
- Technical Evaluation Report for the Pathfinder Mines Shirley Basin Reclamation Plan
- Review of the White Mesa, Blanding, UT, Reclamation Plan
- Completion of the Crowe Butte Environmental Assessment and Technical Evaluation Report
- Preparation of the Safety Evaluation Reports for the Cogema Christensen and Irigaray *In-Situ* Leach Facilities

In addition, Clear Creek is currently conducting monitoring and evaluation of surface water impacts from historical copper mining activities for the Pinal Creek Water Quality Assurance Revolving Fund site in central Arizona, a state "Superfund" site.

III. B. 2. b. Statement of Needs—Water Quality Monitoring for Groundwater

> *(1) The potential impacts on groundwater associated with the construction, operation and decommissioning of a mine, mill and tailings facility;*
>
> *(2) The threats to groundwater quality related to failure of structures designed to limit movement of contaminants from the tailings into surrounding groundwater and issues associated with inadequate hydraulic isolation in below grade disposal facilities;*
>
> *(3) Effects of mine dewatering on groundwater quality and quantity;*
>
> *(4) Effects of mine flooding on groundwater quality and quantity; and,*
>
> *(5) Effects of exploratory bore holes on groundwater quality.*

Most of CNWRA's projects involving the assessment of potential impacts from uranium mining and processing have also required evaluation of potential impact to groundwater. The following is a list of such projects:

- Technical Evaluation Report for the Plateau Resources Limited Shootaring Canyon, UT Reclamation Plan

- Technical Evaluation Report for the Kennecott Uranium Co. Sweetwater Uranium Project Reclamation Plan
- Technical Evaluation Plan for the Pathfinder Mines Shirley Basin Reclamation Plan
- Review of the White Mesa, Blanding, UT, Reclamation Plan
- Completion of the Crowe Butte Environmental Assessment and Technical Evaluation Report
- Preparation of the Safety Evaluation Reports for the Cogema Christensen and Irigaray *In-Situ* Leach Facilities
- Technical Review of Values of Partition Coefficient and Solubility Used in the West Valley New York Demonstration Project Environmental Impact Statement
- Report of Infiltration, Seepage, and Groundwater Contamination for the Atlas Corp. Uranium Mill Tailings Pile Near Moab, Utah
- Limit Request for the Petrotomics Corp. Shirley Basin Site

In addition, Clear Creek is currently conducting monitoring and evaluation of groundwater impacts from historical copper mining activities for the Pinal Creek Water Quality Assurance Revolving Fund site in central Arizona, a state "Superfund" site, and four other mining sites in Arizona with groundwater impacted by historical mining, milling, and ore processing

III. B. 2. c. Statement of Needs—Air Quality Monitoring Plan

(1) Evaluation of technologies;

(2) Release of particulate matter from wind erosion of ore stockpiles, waste rock, mine tailings, processing facilities, and mine blasting;

(3) Mobilization of contaminants;

(4) Adequacy of the U.S. Environmental Protection Agency's National Emissions Standards for Hazardous Air Pollutants (NESHAP) for radon;

(5) The emission of radon from waste rock piles, ore stockpiles and windblown particulates;

(6) The potential for the release of radon from evaporation ponds and tailings impoundments; and,

(7) The release of radon during dewatering activities

CNWRA's work on environmental assessments and impact statements for uranium mining and milling projects has involved analysis of the potential impacts of releases of radionuclides and other air pollutants to the atmosphere. Dr. Durham, Principal Investigator for this topic has extensive experience with techniques for monitoring atmospheric releases of radionuclides, as described in his resume.

CNWRA also assisted NRC in developing the following regulatory guides related to air emissions from uranium recovery and waste management sites:

- Regulatory Guide 4.14, Radiological Effluent and Environmental Monitoring at Uranium Recovery Facilities

- Proposed Revisions to Uranium Recovery Regulatory Guidance Documents, Draft Regulatory Guide 3.64, Calculation of Radon Flux Attenuation by Earthen Uranium Mill Tailings Covers and Report of Milestone Completion

- Proposed Revisions to Uranium Recovery Regulatory Guidance Documents, Draft Regulatory Guide 3.63, Onsite Meteorological Measurement Program for Uranium Recovery Facilities-Data Acquisition and Reporting

- Proposed Revisions to Uranium Recovery Regulatory Guidance Documents, Draft Regulatory Guide 3.59, Methods for Estimating Radioactive and Toxic Airborne Source Terms for Uranium Recovery Operations

- Final Proposed Revisions to Uranium Recovery Regulatory Guidance Documents--Draft Regulatory Guide 4.15, Quality Assurance for Radiological Monitoring Programs (Normal Operations)--Effluent Streams and the Environment

III. B. 2. d. Statement of Needs—Adequacy of Virginia's Water Quality Standards

> *(1) Water-soluble radionuclides or absorbed chemicals;*
>
> *(2) The potential for the increase in radioactivity concentrations in a river/reservoir system and the exceedance of the Maximum Contaminant Level (MCL) established for radiological contaminants for drinking water, recreational use, irrigation, agricultural use, and other non-potable uses;*
>
> *(3) A sampling protocol and regulatory oversight for radiological contaminants in surface water and groundwater;*
>
> *(4) The potential for undiluted tailings liquids to exceed existing Safe Drinking Water Act standards for uranium; and,*
>
> *(5) Identify additional water quality criteria if needed.*

CNWRA has completed the following projects that required evaluation of the appropriateness of state and federal water quality standards with respect to potential releases of contaminants from uranium mining and milling on surface water and groundwater

- Technical Evaluation Report for Alternate Concentration Limit Request for the Petrotomics Corp. Shirley Basin Site

- Technical and regulatory analysis to support development of a new NRC regulation governing uranium mining and recovery

- Update and revision of NRC Standard Review Plan for Uranium Recovery Facilities

In addition, Clear Creek has evaluated the applicability of surface water and groundwater standards controlling remediation of historical copper mining activities for the Pinal Creek Water Quality Assurance Revolving Fund site in central Arizona, a state "Superfund" site.

III. B. 2. e. Statement of Needs—Standards for Safe Disposal of Mine Waste

> *(1) The potential of serious environmental problems resulting from acid mine drainage or other leachate from mine waste;*
>
> *(2) Segregation and safe disposal of sub-ore grade waste rock;*
>
> *(3) The safe control and disposal of uranium tailings;*
>
> *(4) Mitigation of contaminants from existing sources (e.g., tailings, ore stock piles and waste rock piles) to both groundwater and surface water; and,*
>
> *(5) To address on-site workers health and safety.*

CNWRA has evaluated the safety of uranium mill tailings piles and impoundments as part of its uranium recovery licensing assistance to NRC and has assisted NRC in developing Regulatory Guide 3.11.1, Operational Inspection and Surveillance of Embankment Retention Systems for Uranium Mill Tailings.

Clear Creek led the investigation and remediation of acid mine drainage originating from copper ore processing and former tailings impoundments at the Pinal Creek Water Quality Assurance Revolving Fund site in central Arizona and four other mining sites in Arizona with groundwater impacted by historical mining, milling, and ore processing.

III. B. 2. f. Statement of Needs—Engineering Designs and Best Management Practices

> *(1) Minimizing the ecological risks from the loading and transportation of the uranium product and chemicals used in the processing operation;*
>
> *(2) Minimizing the impacts of accidents or natural disasters or management oversight failures that impair the normal operations of the mining, processing, tailings management, or water treatment facilities;*
>
> *(3) Minimizing the exposures to humans and populations of aquatic and terrestrial biota to elevated levels of radionuclides and other hazardous substances;*
>
> *(4) Minimizing the exposures of the public to elevated levels of radionuclides and other hazardous substances; and,*
>
> *(5) Determining if an effective hydrogeological model is available for use at potential sites.*

In the use of engineering design and best management practices to minimize the impacts of uranium mining activities, CNWRA has supported NRC in developing regulatory guidance for:

- General Guidance for Designing, Testing, Operating, and Maintaining Emission Control Devices at Uranium Mills

- Design, Construction, and Inspection of Embankment Retention Systems at Uranium Recovery Facilities

- Operational Inspection and Surveillance of Embankment Retention Systems for Uranium Mill Tailings

In addition, CNWRA's proposed Subject Matter Experts, Dr. Ghosh and Dr. Hsiung are mining engineers with extensive experience in design of mining projects in general.

III. B. 2. g. Statement of Needs—Necessary Components of a Full Environmental Impact Analysis

> *(1) Timing of the environmental impact analysis;*
> *(2) Required components, including baseline and characterization data needed; and,*
> *(3) Legal requirements.*

CNWRA is well-qualified to advise the Workgroup on matters related the need for and scope of environmental analyses as exemplified by developing two short courses on the National Environmental Policy Act (NEPA) requirements for environmental assessments and impact statements. CNWRA assisted NRC in preparation of the Generic Environmental Impact Statement for *In-Situ* Leach Uranium Milling Facilities (NUREG–1910) addressing potential environmental imprints of *in-situ* uranium mining in the western United States. In addition, CNWRA has assisted NRC in preparing site specific environmental assessments for:

- Nichols Ranch *In-Situ* Uranium Recovery (ISR) Project
- Lost Creek *In-Situ* Uranium Recovery (ISR) Project
- Moore Ranch *In-Situ* Uranium Recovery (ISR) Project
- Dewey Burdock *In-Situ* Uranium Recovery (ISR)

III. B. 2. h. Statement of Needs—Methods for Incorporating ALARA Standards

> *Methods for incorporating "As Low As Reasonably Achievable" (ALARA) standards into Commonwealth regulations of uranium mining and milling.*

CNWRA staff incorporates ALARA guidance into most of our projects that involve radioactive work. Specifically, CNWRA incorporated ALARA concepts and principles into a project to update NUREG–1569, "Standard Review Plan for *In-Situ* Leach Uranium Extraction License Applications," and a new NUREG that will be entitled "Standard Review Plan for Conventional and Heap Leach Milling License Applications."

CNWRA staff also reviewed the DOE's approach to ALARA in its License Application for Yucca Mountain.

III. B. 2. i. Statement of Needs—Methods for Addressing Risk of Catastrophic Events

> *(1) Assessment of risks;*
>
> *(2) Vulnerability Analysis for security events;*

(3) Risk Analysis for natural disasters (including extreme weather events such as tornadoes, hurricanes, etc.);

(4) Minimization of both long-term and short-term environmental effects of the failure of a waste containment facility or a temporary storage area;

(5) The potential for extreme flooding events;

(6) The potential for landslides and debris flows;

(7) The potential for seismic events; and,

(8) Addressing the potential impact of failures of on-site storage facilities or accidents in the loading and transportation of chemicals on groundwater quality.

CNWRA has performed extensive work evaluating the potential impacts and risks associated with natural hazards to facilities handling and storing radioactive materials. This work has include evaluating the potential impacts of flooding, ground movement, and seismic events. Specific projects that CNWRA has conducted related to the impact and risk of natural hazards to nuclear facilities include

- Long-Term Integrity Assessment of Dry Storage Of Spent Nuclear Fuel Report to Korea Atomic Energy Research Institute
- Final Topical Report on the Effects of Potential Natural Phenomena and Aviation Accidents at the Proposed Pa'ina Hawaii, LLC, Irradiator Facility
- Humboldt Bay Independent Spent Fuel Storage Installation Safety Evaluation Report
- Extreme Wind/Tornado/Tornado Missile Hazard Analysis. (CNWRA Report to NRC)
- Development of a Hazard Identification Database for Nearby Military and Industrial Facilities of the Proposed Repository at Yucca Mountain. (CNWRA Report to NRC)
- Seismic Response of Rock Joints and Jointed Rock Mass. (NUREG/CR-6388)

III. B. 2. j. Statement of Needs—Identification of Life Span Financial Assurance Mechanisms

(1) Providing for modem mining practices for continuous rehabilitation during the life of the mining and milling operation;

(2) Ensuring that life cycle costs as well as long-term stewardship are reflected in the type of and amount of financial surety;

(3) Providing for minimization of long-ten impacts to water resources;

(4) The potential financial impact on municipal and critical infrastructure related to catastrophic or operational events; and,

(5) Liability provisions for catastrophic events.

CNWRA assisted NRC in development of a surety estimation methodology for Groundwater Corrective Actions at Title II Conventional Mills. This project resulted in a report that addressed technical and financial regulatory requirements, characteristics of uranium mill tailings, groundwater contamination and cleanup, the influence of geochemistry on hazardous constituent migration, development of a cost estimation methodology to assess the adequacy of surety funds, the linkage between cost estimation methodology and the groundwater corrective action plan, and a proposed review plan to address the technical adequacy of the groundwater corrective actions plans and cleanup times. The cost estimation methodology proposed in this report included capital costs, operation and maintenance costs, periodic costs, dismantling costs, contingency allowance, present value analysis, and computation of total costs.

Chmura will complement the risk assessment and engineering expertise of CNRWA by providing economic modeling to evaluate the feasibility of various financial instruments addressing long-term and catastrophic risk.

III. B. 2. k. Statement of Needs—Evaluation of Validity of Site-specific Data

Evaluation of validity and reliability of site-specific data provided by Virginia Uranium, Inc. and its contractors, and analysis of these baseline conditions at the Coles Hill site with regard to the air, water, soil, ore and waste rock, and biota issues that the Commonwealth's uranium mining and milling regulations should be expected to address. Gap analysis of site-specific data available and what is necessary for overall understanding of issues related to statutory and regulatory framework for the protection of human health and the environment.

CNWRA's experience cited previously in performing technical reviews for multiple uranium recovery sites and other sites using or storing radioactive materials substantiates its ability to successfully complete this task. Clear Creek also has extensive experience in hydrologic site characterization related to mining projects. This experience includes

- Remedial investigation and feasibility study for the Bisbee Copper Queen Mine, Arizona
- Remedial investigation and feasibility study for the Tohono Mine, Arizona

3.b Key Staff Qualifications

CNWRA has assembled a highly experienced in-house team of subject matter experts and subcontractors to meet the needs of the Workgroup under the tight time constraints of this project. Figure 3-4 shows the proposed team organization and individual assignments based on the Statement of Needs. Resumes of key staff are provided in Section 3.c.

Mr. Patrick Mackin will act as Project Manager. Mr. Mackin's contact information is:

Mr. Patrick Mackin
pmackin@cnwra.swri.edu
210-522-5054

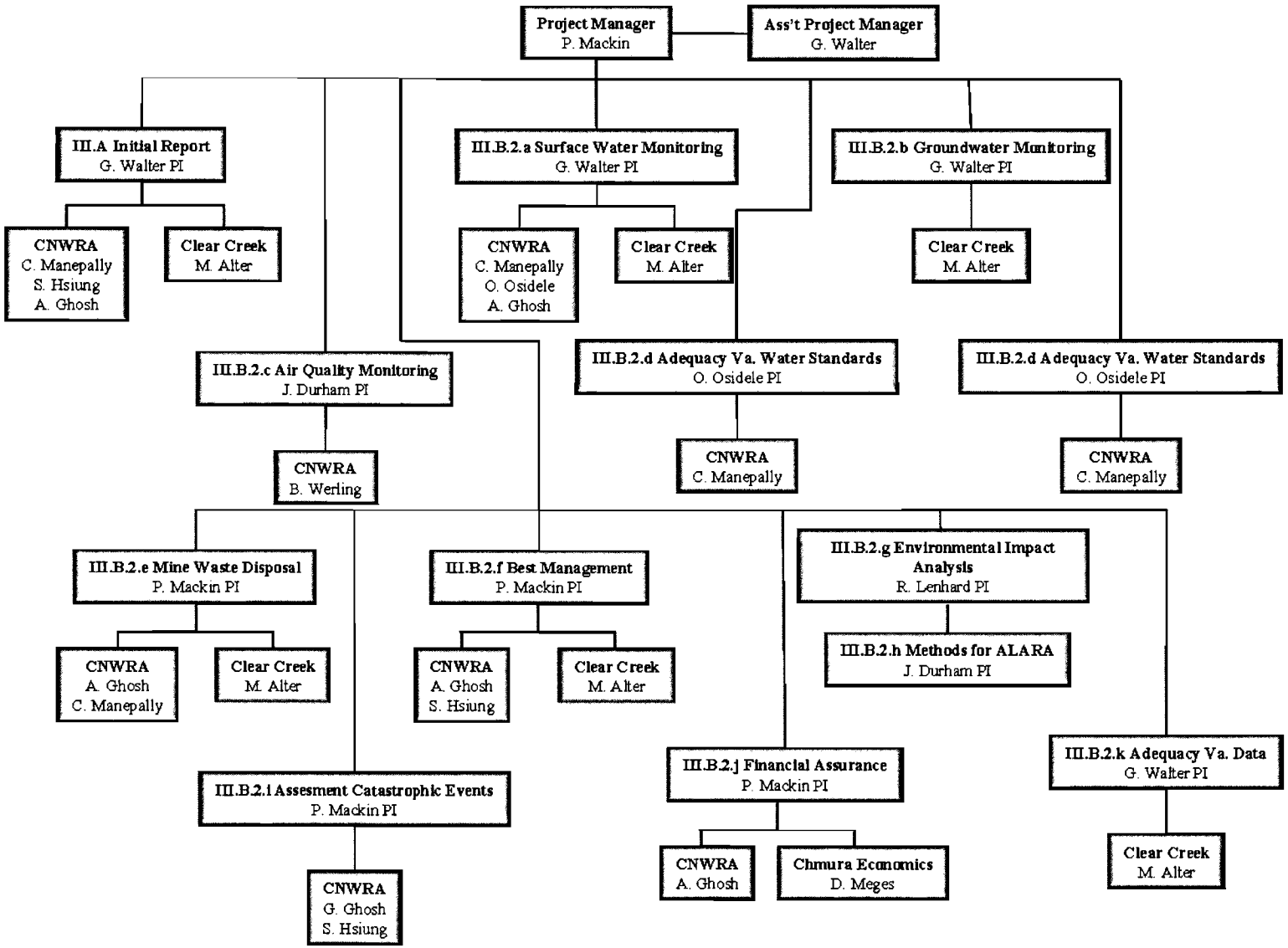


Figure 3-4. Proposed Team Organization and Individual Assignments

Mr. Mackin is Director of Administration and Manager of CNWRA Operations. In addition to his administrative responsibilities, Mr. Mackin is an active project manager. As a Director of CNWRA, he is well-positioned to coordinate staff assignments. He also makes frequent visits to our Rockville, Maryland office which will allow him to coordinate travel to meet with the Workgroup.

Mr. Mackin has a wide range of technical and project management experience applicable to uranium mining. This experience includes managing contracts with NRC for uranium mining facility licensing. Activities covered by these contracts included reviewing and evaluating license applications, groundwater remediation plans, and surface reclamation plans; performing site compliance inspections; developing environmental assessments, environmental impact statements, safety evaluation reports, regulatory guidance documents and regulations; preparing slope stability and risk assessments; and applying decontamination and decommissioning criteria. Mr. Mackin prepared regulatory analyses for development and revision of NRC regulations applicable to uranium mining.

Previously, as Assistant Director, Systems Engineering and Integration, Mr. Mackin was responsible for the application of systems engineering principles to streamline the NRC licensing program for a proposed mined geologic repository for the disposal of high-level radioactive waste, including process refinement, procedure development, and training. He was the CNWRA project manager for development of the Yucca Mountain Review Plan, which has been used by NRC to review a license application for a high-level waste geologic repository. He also directed the assessment of the environmental impact statement for the proposed repository. Mr. Mackin has assessed the classification of radioactive waste in tanks at the Hanford and Savannah River sites. He coordinated the activities of hydrologists, geochemists, geotechnical engineers, health physicists, materials scientists, and performance and risk assessment staff in carrying out these responsibilities.

In addition to acting as Project Manager, he will be the Principal Investigator and Subject Matter Expert for the following topics in the Statement of Needs:

- III.B.1 Coordination with Workgroup
- III.B.2.e Standards for Safe Disposal of Mine Waste
- III.B.2.f Engineering Designs and Best Management Practices
- III.B.2.i Methods for Addressing Risk of Catastrophic Events
- III.B.2.j Identification of Life Span Financial Assurance Mechanisms

Dr. Gary R. Walter will serve as Assistant Project Manager and Principal Investigator/Subject Matter Expert for the following topics in the Statement of Needs:

- III.A Initial Literature Review and Recommendations
- III.B.2.a Water Quality Monitoring for Surface Water
- III.B.2.b Water Quality Monitoring for Groundwater
- III.B.2.k Evaluation of Validity of Site-specific Data.

Dr. Walter is Manager of the Department of Earth, Material, and Planetary Sciences in the Geosciences and Engineering Division of SwRI of which CNWRA is also a part. Dr. Walter has a Ph.D. in Hydrology from the University of Arizona and more than 30 years experience managing projects on soil and groundwater contamination including remediation of acid mine drainage and other impacts of mining operations such as seepage from tailings impoundments

and evaporation ponds. Dr. Walter was a subject matter expert in the development of the Generic Environmental Impact Statement for *In-Situ* Leach Uranium Milling Facilities[2]. He has also conducted evaluations of the performance of uranium mill tailings impoundments for NRC and the performance of cover designs for defense radioactive waste isolation.

As Assistant Project Manager, Dr. Walter will work in close association with Mr. Mackin to assure continuity of coordination with the Workgroup.

Additional key staff include

- Dr. Amit Ghosh (CNWRA)
- Dr. Sui-min "Simon" Hsiung (CNWRA)
- Ms. Chandrika Manepally (CNWRA)
- Dr. Robert Lenhard (CNWRA)
- Dr. James Durham (CNWRA)
- Dr. Olufemi Osidele (CNWRA)
- Mr. Bradley Werling (CNWRA)
- Mr. Michael Alter (Clear Creek Associates)
- Mr. Daniel Meges (Chmura Economics & Analytics)

The specific roles and experience of these staff are described as follows.

Dr. Amitava Ghosh will be a Subject Matter Expert for the following Statement of Needs topics

- III.A Initial Literature Review and Recommendations
- III.B.2.a Water Quality Monitoring for Surface Water
- III.B.2.e Standards for Safe Disposal of Mine Waste
- III.B.2.f Engineering Designs and Best Management Practices
- III.B.2.i Methods for Addressing Risk of Catastrophic Events

Dr. Ghosh is a Staff Engineer at CNWRA. He has a Ph.D. in Mining Engineering from the University of Arizona and more than 25 years of consulting and research experience in mining engineering and geological engineering with specialization in rock mechanics/rock engineering and performing reliability/risk assessments. He specializes in applications of numerical simulations, probabilistic methods and risk assessment methodologies, field and laboratory experiments, blasting, rock fracture mechanics, and fractal geometry. Dr. Ghosh developed the geotechnical portion of NRC's Standard Review Plan for reviewing the reclamation plans of uranium mill tailings sites under Title II of the Uranium Mill Tailings Radiation Control Act (NUREG–1620). He has also developed the geotechnical portion of a new standard review plan for conventional uranium mill and heap leach facilities. The review methods in the geotechnical section of this SRP include use of probabilistic methods to demonstrate safety of a uranium facility. Dr. Ghosh conducted independent confirmatory analyses and developed the safety evaluation report for several uranium mill tailings facilities. He also inspected a uranium reclamation facility, as a part of the Nuclear Regulatory Commission team, for activities associated with construction of mill tailings disposal cells.

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[2]NRC. NUREG–1910, "Generic Environment Impact Statement for *In-Situ* Leach Uranium Milling Facilities." Washington, DC: U.S. Nuclear Regulatory Commission. 2009.

Dr. Simon Hsiung is a Staff Engineer at CNWRA and will serve as a Subject Matter Expert for the following topics of the Statement of Needs:

- III.A Initial Literature Review and Recommendations
- III.B.2.f Engineering Designs and Best Management Practices
- III.B.2.i Methods for Addressing Risk of Catastrophic Events
- III.B.2.j Identification of Life Span Financial Assurance Mechanisms

Dr. Hsiung is a mining engineer with a broad range of experience in geotechnical engineering and integrated safety analysis. He has more than 35 years of research and consulting experience in the disciplines of mining engineering and rock mechanics. Dr. Hsiung has conducted research and provided technical assistance in rock mechanics, geotechnical engineering, and natural phenomena and human-induced hazard assessment to NRC and other clients. He has developed technical evaluation reports for uranium tailings, reclamation plans for source material licenses in areas related to dynamic and static stability of slopes, potential liquefaction of foundation soils, settlement effects on radon barrier integrity, and integrated safety analyses for NRC-licensed nuclear fuel fabrication facilities. His recent experience includes (i) reviewing structural designs for mixed oxide and gas centrifuge facilities; (ii) developing safety evaluation reports for NRC on several license applications for mixed oxide, gas centrifuge, laser enrichment, and independent spent fuel storage installation facilities with focuses on tornado and high-wind evaluation; slope stability, liquefaction potential, aircraft crash, snow, and hurricane hazard characterization, tornado and human-made missile impact assessments, settlement and soil bearing capacity determination; (iii) performing final structural design review (including foundation design and soil-structure interaction analysis) and construction inspections on gas centrifuge facilities; and (iv) reviewing the U.S. Department of Energy license application for a high-level nuclear waste geologic repository at Yucca Mountain, Nevada.

Ms. Chandrika Manepally is a Senior Research Engineer in CNWRA and will serve as Subject Matter Expert for the following topics of the Statement of Needs:

- III.A Initial Literature Review and Recommendations
- III.B.2.a Water Quality Monitoring for Surface Water
- III.B.2.d Adequacy of Virginia's Water Quality Standards
- III.B.2.e Standards for Safe Disposal of Mine Waste

Ms. Manepally is a hydrologist with expertise in unsaturated and saturated flow and transport. She has been the technical lead for several projects related to providing input to the safety assessment of *in-situ* uranium recovery sites. She also is involved in projects related to preparing and reviewing environmental assessments and environmental impacts statements under the requirements of the National Environmental Policy Act. She is also the principal investigator in projects that provide technical support in licensing reviews related to disposal, long-term stabilization, and control of uranium mill tailings under the requirements of the Uranium Mill Tailings Radiation Control Act. Ms. Manepally has an M.S. in Civil Engineering from the University of Toledo.

Dr. James Durham will be Principal Investigator for topics III.B.2.c Air Quality Monitoring Plan and III.B.2.h Methods for Incorporating ALARA Standards. Dr. Durham is a Principal Engineer at CNWRA and has a Ph.D. in Nuclear Engineering from the University of Illinois-Urbana. He was a major contributor to two standard review plans for uranium recovery licensing reviews

and he was the principal investigator for a project that collected air samples to evaluate the adequacy of the airborne effluent system at a licensee's facility. He developed VARSKIN 3, a skin dose calculation tool and the associated user's manual for NRC. He was the principal investigator evaluating the effects of potential natural phenomena and aviation accidents at the proposed Pa'ina Hawaii, LLC, irradiator facility for the NRC. He was also a major contributor to the environmental review conducted as part of the Nuclear Fuel Services, Inc., license renewal. Before joining GED, Dr. Durham was an assistant professor in the Department of Environmental and Radiological Health Sciences at Colorado State University. He taught lectures and laboratories in radiation physics, internal and external dosimetry instrumentation, and waste management. He served 5 years as chair of the university's Radiation Safety Committee and advised five Master of Science candidates.

Dr. Olufemi Osidele is a Senior Research Engineer in CNWRA. He will be Principal Investigator for Statement of Needs topic III.B.2.d Adequacy of Virginia's Water Quality Standards and Subject Matter Expert for III.B.2.a Water Quality Monitoring for Surface Water. Dr. Osidele has over 20 years experience in engineering hydrology and environmental systems analysis. He holds a Ph.D. in Environmental Systems Analysis from the University of Georgia. He specializes in watershed hydrologic modeling, water quality management, integrated systems modeling, uncertainty analysis, environmental risk assessment, and stakeholder–science integration. Dr. Osidele has reviewed system risk assessments to support regulatory analyses of geologic radioactive waste disposal facilities, including hydrologic models of flood protection measures for surface facilities. He has evaluated impacts to surface water quality to support licensing reviews for conventional and *in-situ* uranium mining and milling facilities in Wyoming. Prior to joining SwRI, he developed computational methods for uncertainty and sensitivity analyses in a multimedia risk assessment model for EPA hazardous waste program. He also applied these methods in examining surface water hydrology and water quality models supporting EPA's Total Maximum Daily Load watershed management program.

Mr. Bradley Werling will serve as a Subject Matter Expert for Statement of Needs topic III.B.2.c Air Quality Monitoring Plan. Mr. Werling is a Research Scientist at CNWRA. He has 18 years' experience in environmental science and chemistry. Mr. Werling has conducted environmental impact assessment activities both reviewing and preparing National Environmental Policy Act (NEPA) documents. Mr. Werling contributed to many environmental assessments for various Nuclear Regulatory Commission-regulated sites including several uranium recovery environmental impact statements. He has provided technical input for NEPA documents in several resource areas including air quality, land use, socioeconomics, and noise. In 2007, Mr. Werling has an M.S. in Environmental Science from the University of Texas at San Antonio and completed the NEPA certificate program as part of the Duke University Environmental Leadership Program cosponsored by the Council on Environmental Quality.

Dr. Robert Lenhard will be Principal Investigator for Statement of Needs topic III.2.g Necessary Components of a Full Environmental Impact Analysis. Dr. Lenhard is Program Manager for Environmental Protection and Waste Management for Non-High Level Waste at CNWRA. In this capacity he manages all of CNWRA's work related to uranium recovery and waste management. He is also responsible for scoping and managing CNWRA's environmental assessment projects under NEPA. Dr. Lenhard has a Ph.D. in Soil Physics from Oregon State University.

Mr. Michael Alter is a Principal Hydrogeologist based in the Leesburg, Virginia office of Clear Creek Associates. He will serve as a Subject Matter Expert for the following topics of the Statement of Needs:

- III.A Initial Literature Review and Recommendations
- III.B.2.a Water Quality Monitoring for Surface Water
- III.B.2.b Water Quality Monitoring for Groundwater
- III.B.2.e Standards for Safe Disposal of Mine Waste
- III.B.2.f Engineering Designs and Best Management Practices
- III.B.2.k Evaluation of Validity of Site-specific Data

Mr. Alter has worked on mine water management and hydrogeologic studies at various North American mining sites since 1995. His recent focus has been characterization and remediation of radionuclide contamination associated with legacy hard rock mining operations. Mr. Alter understands mine water management challenges associated with mining and mineral processing and has been responsible for preparing groundwater/aquifer protection permits and discharge permits for mines and mine facilities, including mill tailing impoundments, leach stockpiles, waste-rock stockpiles, and process water conveyances and collection impoundments. His related expertise includes geochemistry of mine materials and solutions, mine facility siting, chemistry of closed underground mines, *in-situ* leaching operations, mine pit hydrology and pit lake geochemistry, regulatory guidance for mining projects, permit acquisition, and mine contaminant transport in bedrock and basin-fill settings.

Mr. Alter has a M.Sc. in Geology from Arizona State University and is a Professional/Registered Geologist in Virginia, Pennsylvania, and Arizona.

Mr. Daniel Meges will assist CNWRA and the Department of Environmental Quality in identifying financial assurance requirements and instruments for mitigating the impacts of uranium mining, milling, and waste management for Statement of Needs topic III.B.2.j. Mr. Meges is an economist and business development manager for Chmura Economics & Analytics. He is familiar with the issues related to possible uranium mining in Virginia having worked on the socioeconomic impacts study for the Chatham Labor Shed. Prior to joining the Chmura team, Daniel worked eight years as an economist for the U.S. government, specializing in economic development, international assistance, and trade policy. In this capacity he travelled widely in Europe while advancing U.S. foreign policy and serving as a special advisor for political affairs for two U.S. ambassadors. Mr. Meges also has deep experience in industrial and labor relations, having worked several years in the auto and steel industries as a human resources/labor relations manager. He has B.S. from Cornell University, an M.A. from the University of Chicago, and an M.B.A. from Loyola University Chicago.

3.c Resumes of Key Staff

PATRICK C. MACKIN

Current Position:

Director of Administration
Manager of CNWRA® Operations and Information Management Systems
Geosciences and Engineering Division
Southwest Research Institute®

Experience:

Mr. Mackin has a wide range of technical and project management experience applicable to uranium mining. This experience includes managing contracts with NRC for uranium mining facility licensing. Activities covered by these contracts included reviewing and evaluating license applications, groundwater remediation plans, and surface reclamation plans; performing site compliance inspections; developing environmental assessments, environmental impact statements, safety evaluation reports, regulatory guidance documents and regulations; preparing slope stability and risk assessments; and applying decontamination and decommissioning criteria. Mr. Mackin prepared regulatory analyses for development and revision of NRC regulations applicable to uranium mining.

Mr. Mackin's current responsibilities as director of administration include planning, cost, and schedule; fiscal and administrative interface with clients; coordination of business, legal, human, and communications resources; records control; and information technology (IT) systems management. Mr. Mackin also prepares and contributes to a variety of technical, regulatory, management, and planning reports for NRC, GED's primary client.

Mr. Mackin led a successful and complex effort to establish a Federal Information Security Management Act (FISMA) Certification and Accreditation for GED local area network and wide area network. In completing this activity, Mr. Mackin developed a broad knowledge of IT system security requirements, operating policies and procedures, and management techniques.

Previously, as Assistant Director, Systems Engineering and Integration, Mr. Mackin was responsible for the application of systems engineering principles to streamline the NRC licensing program for a proposed mined geologic repository for the disposal of high-level radioactive waste, including process refinement, procedure development, and training. He was the GED project manager for development of the Yucca Mountain Review Plan, which has been used by NRC to review a license application for a high-level waste repository. He also directed the assessment of the environmental impact statement for the proposed repository. Mr. Mackin has assessed the classification of radioactive waste in tanks at the Hanford and Savannah River sites. He coordinated the activities of hydrologists, geochemists, geotechnical engineers, health physicists, materials scientists, and performance and risk assessment staff in carrying out these responsibilities.

Mr. Mackin was an officer in the U.S. Navy from 1970 to 1990. He commanded a naval warship and served as Pacific Theater War Planner on the staff of the Chairman, Joint Chiefs of Staff. He instructed seminars on strategic planning at the Army War College and the National

Defense University. His primary area of expertise was operation and maintenance of nuclear-powered ships. He was chief engineer for a nuclear-powered aircraft carrier. Mr. Mackin coordinated integrated systems testing and startup for an eight-reactor shipboard complex following a three-year overhaul. He also has significant experience in a wide range of planning, management, training, and systems engineering assignments. He directed research and development projects for advanced marine vehicles (surface effect ships), including major structural modifications; sensor development; and design of vessel command, control, and communications systems.

Special Expertise:

In a professional career spanning more than 40 years, Mr. Mackin has a broad record of success in leading multidisciplinary teams in completing complex tasks. He is particularly skilled in forming teams from individuals with diverse interests and areas of expertise and then motivating those people to achieve common goals. In recent years, Mr. Mackin has developed special expertise in integrating IT systems and software with records management requirements.

Mr. Mackin is an unusually effective speaker and presenter. He has made presentations to a wide variety of individuals and forums including the Secretary of Defense, the Chairman of the Joint Chiefs of Staff, senior Southwest Research Institute and NRC managers, professional societies, and the National War College. He has taught statistics and professional writing as an adjunct professor at the college undergraduate level.

Education:

1980 M.S., Systems Management, University of Southern California
1970 B.S., Mathematics, U.S. Naval Academy

Previous Positions:

Assistant Director, Systems Engineering and Integration, Center for Nuclear Waste Regulatory Analyses, Southwest Research Institute; 1994-2003.

Manager, Systems Engineering and Integration Element, Center for Nuclear Waste Regulatory Analyses, Southwest Research Institute; 1993-1994.

Principal Engineer, Systems Engineering and Integration Element, Center for Nuclear Waste Regulatory Analyses, Southwest Research Institute; 1990-1993.

Officer, U.S. Navy; 1970-1990.

Professional Registrations and Affiliations:

American Nuclear Society
Southwest Research Institute Advisory Committee on Quality and Environmental Improvement

Publications and Presentations:

A summary, by category, of Mr. Mackin's publications and presentations while employed by SwRI follows:

- Approximately 15 operating and technical procedures.
- Approximately 20 environmental assessments and environmental impact statements.
- Approximately 25 safety evaluation reports and associated requests for additional information.
- Approximately 50 technical reports including slope stability assessments, site technical evaluation reports, surety assessments, and inspection reports.
- Approximately 40 regulatory guidance documents including standard review plans and regulatory guides. Mr. Mackin was the project manager for the development of the Yucca Mountain Review Plan that has been used to guide the NRC licensing review for a potential repository for high-level radioactive waste.
- More than 30 management and operations plans including training plans, records management plans and procedures, computer security plans and assessments, and facilities maintenance and management plans.
- More than 15 technical presentations and papers covering a wide range of subjects.

Specific documents will be provided on request.

GARY R. WALTER, Ph.D., P.G.

Current Position:

Manager
Technical Resources
Department of Earth, Material, and Planetary Sciences
Geosciences and Engineering Division
Southwest Research Institute®

Experience:

Dr. Walter has more than 30 years' experience in the fields of hydrogeology and environmental remediation. While at Southwest Research Institute, Dr. Walter has managed programs for the characterization of cementitious materials for use in radioactive waste disposal and been a consultant to NRC on projects related to the environmental impacts of *in-situ* uranium recovery and performance of engineered covers for uranium mill tailings. He has conducted independent research on the effect of gas generation on radon emissions from landfills receiving radium-bearing waste. He has also managed projects related to alternative transportation fuel production and environmental impacts under the Hydrogen Technology Information Service and is a key participant in the Institute's program on carbon capture, conversion, and sequestration. This work included participating in the development of a risk assessment technique for evaluating the impacts of permafrost thawing due to climate change.

He specializes in applying numerical models to environmental and water supply problems. Dr. Walter has developed and applied computer programs to simulate groundwater flow and transport of reactive chemical constituents, as well as vapor-phase transport and the analysis of complex well hydraulics problems. He has managed environmental and water resource investigations throughout the United States, and in the England, Venezuela, and Japan.

Special Expertise:

Dr. Walter is skilled in the use of numerical models for simulating groundwater flow and transport under saturated and unsaturated conditions. He has also managed investigation of the properties controlled low-strength materials for waste isolation applications.

Education:

Ph.D., Hydrology, University of Arizona, 1985
M.A., Geology, University of Missouri, Columbia, 1974
B.A., Chinese and Sociology, University of Kansas, 1969

Previous Positions:

President of Hydro Geo Chem, Inc. 1999 to 2002

Professional Registrations and Affiliations:

Registered Geologist in Wyoming, No. PG-2748

American Geophysical Union, National Ground Water Association, Society of Petroleum Engineers

Refereed Publications:

Walter, G.R., R. R. Benke, and D. A. Pickett. In Review. Effect of Biogas Generation on Radon Emissions from Landfills Receiving Radium-Bearing Waste from Shale Gas Development. Submitted to Journal of the Air & Waste Management Association.

Walter, G.R., M. Necsoiu, and R. McGinnis. 2012. Estimating Aquifer Channel Recharge Using Optical Data Interpretation. Ground Water, 50(1), 68–76.

Necsoiu, M., S. Leprince, D.M. Hooper, C.L. Dinwiddie, R.N. McGinnis, and G.R. Walter. 2009. Monitoring migration rates of an active subarctic dune field using optical imagery. Remote Sensing of Environments. 113, pp. 2,441–2,447.

Walter, G.R. 2003. Fatal flaws in measuring landfill gas generation rates by empirical well testing. Journal of the Air and Waste Management Association. Vol. 53, pp. 461–468.

Festger, A. and G.R. Walter. 2002. The capture efficiency map: the capture zone under time-varying flow. Ground Water. 40(6), pp. 619–628.

Philip, R.D. and G.R. Walter. 1992. Prediction of Flow and Hydraulic Head Fields for Vertical Circulation Wells. Ground Water. 30(5), pp. 765–773.

Neuman, S.P., G.R. Walter, H.W. Bentley, J.J. Ward, and D.D. Gonzalez. 1983. Determination of horizontal aquifer anisotropy with three wells. Ground Water, Vol. 22, pp. 66–72.

Publications and Presentations:

G.R. Walter, SPE, S.A. Stothoff, D.M. Necsoiu, and C.L. Dinwiddie. 2011. Integrated Methodology for Mapping and Monitoring Permafrost and Seasonally Frozen Ground. Arctic Technology Conference, February 7-9, Houston Texas. Society of Petroleum Engineers Paper OTC 22046.

G.R. Walter. 2009. Feasibility of Producing Alternative Liquid Transportation Fuels from Landfill Gas. Presentation to National Environmental Monitoring Conference. San Antonio, Texas.

G.R. Walter. 2009. Emerging Technologies for Alternative Transportation Fuels from Domestic Resources and Their Carbon Footprints. Presented to Society of American Military Engineers. San Antonio, Texas.

Pabalon, R., S. Painter, G. Walter and P. Bertetti. 2008. CO_2 Releases from Deep Storage Formations into Drinking Water Aquifers—Assessment of Potential Impacts on Drinking Water Quality. Poster, American Geophysical Union Fall Meeting. San Francisco, California.

Walter, G.R. 2008. Carbon Dioxide Sequestration in the United States: Technical Direction, Regulation and New Research. Invited presentation to Japanese National Institute for Advanced Industrial Science and Technology. Tsukuba, Japan.

Walter, G.R. 2007. Prospects for Generation of Hydrogen as an Automotive Fuel Using Nuclear Fission Reactors in the United States. Report to Hydrogen Information Technology Service Subscribers by Southwest Research Institute.

Walter, G.R. 2005. Screening Level Analysis of Radon Emissions Produced from Landfill Disposal of Water Treatment Residues Containing Radium. Poster. Presented at American Water Works Association Annual Conference and Exposition, June 11–14, 2005. San Francisco, California.

Walter, G.R., R.R. Benke and D.A. Pickett. 2005. Potential Radon Emissions Due to Biogas Generation at TENORM Land Disposal Sites . Proc. Society Petroleum Engineers. Exploration and Production Environmental Conference, March 7-9, 2005. Galveston, Texas.

Walter, G.R., R.R. Benke, and D.A. Pickett. 2004. Potential exposures to radionuclides originating from technologically enhanced naturally occurring radioactive materials emitted by landfill gas extraction and control systems. Presented at WASTECON2004, Solid Waste Association of North America, September 21–23, 2004. Phoenix, Arizona.

Walter, G.R., S.J. Smith, L. Major, and J. Tang. 2001. Evaluating landfill bioreactions using a numerical model. Proceedings from the 14th Annual Symposium Arizona Hydrological Society. Tucson, Arizona.

Gallier, T., G.R. Walter, and R. Strassburg. 2001. Protecting groundwater wells before contamination strikes: a proactive approach. Presented at the 2001 Annual Conference of the American Water Works Association. Washington, DC.

Festger, A.D. and G.R. Walter. 2000. Design of a Plume Containment System Under Time varying Flow and Pumping Considerations. Presented at the Arizona Hydrological Society Environmental Technologies for the 21st Century Symposium. Phoenix, Arizona.

Festger, A.D. and G.R. Walter. 1999. Performance of Plume Containment Systems Under Time-varying Flow and Pumping Considerations. National Ground Water Association 1999 Petroleum Hydrocarbons Conference. Houston, Texas.

Slater, J.C., G.R. Walter, J.R. Norris, M. Wood, and W.A. Fuller. 1999. Optimization of a Containment Wellfield Design. Presented at SME Annual Meeting. Denver, Colorado.

Tang, J., G.R. Walter, and M.W. Kuhn. 1999. Field Pilot Study of Trench Air Sparging for Remediation of Petroleum Hydrocarbons in Groundwater. Presented at *In-situ* and On-Site Bioremediations 5th International Symposium. San Diego, California.

Smith, S.J., J. Pepe, and G.R. Walter. 1995. The Effect of Variable Injection Rates on Air Sparging Patterns in Heterogeneous, Porous Media. Presented at Annual Symposium of Arizona Hydrological Society. Tucson, Arizona.

McCaulou, D.R., W.T. Weinig, and G.R. Walter. 1995. Evaluation of Vertical Circulation Wells for Enhanced Bioremediation. Proceedings from the 3rd International Symposium on *In-Situ* and On-Site Bioremediations. San Diego, California.

Walter, G.R., R.D. Philip, and S.J. Smith. 1993. Chicken/Egg Arguments in the Establishment of Soil Cleanup Standards. Presented at Hazmacon '93. San Jose, California.

Walter, G.R., and J.R. Norris. 1991. Hydrochemical zoning in the Pinal Creek alluvium. Presented at the U.S. Geological Survey Toxic Substances Hydrology Technical Meeting. Monterey, California.

Norris, J.R., G.R. Walter, and T.A. Conto. 1991. Controls on acid water migration through the Pinal Creek alluvial aquifer, Globe-Miami Mining District, Arizona. Proceedings from the Symposium on Environmental Management for the 1990's. Society of Mining, Metallurgy, and Exploration. Denver, Colorado.

Philip, R.D. and G.R. Walter. 1991. Simple techniques for evaluating the feasibility of soil vapor extraction. Presented at Environmental Technology Expo, April 8–12, 1991. Chicago, Illinois.

Walter, G.R., A. Yiannakakis, and M. Hauptmann. 1990. Gas in a Hat. Proceedings from the Superfund 90 Conference, Hazardous Materials Control Research Institute, November 26–28, 1990. Washington, DC.

Walter, G.R., H.W. Bentley, V.K. Gupta, and J. Carrera. 1987. Computer Assisted Site Investigation and Management: A Tool for Assessing and Managing Groundwater Contamination. Proceedings from the National Water Well Association Conference on Solving Ground Water Problems With Models. Denver, Colorado.

Walter, G.R. and H.W. Bentley. 1986. The value and pitfalls of numerical modeling applied to groundwater contamination investigations. Proceedings from the Symposium on Current Practices for Hazardous Waste Management in Arizona. Phoenix, Arizona.

Gupta, V.K. and G.R. Walter. 1985. Toward a general philosophy for the interpretation of aquifer tests. (Abs) EOS, 66(46), p. 890.

Kuhn, M.W., G.R. Walter, and V.K. Gupta. 1985. Automatic parameter estimation techniques applied to a multiwell aquifer test. (Abs) EOS 66(46), p. 890.

Walter, G.R. 1985. Nonadvective transport processes in rocks of very low permeability. Proceedings from the Symposium on Hydrogeology of Rocks of Low Permeability, International Association of Hydrogeologists, 17th International Congress.

Walter, G.R. 1985. The Effects of Molecular Diffusion on Groundwater Solute Transport Through Fractured Tuff. Ph.D. Dissertation, University of Arizona.

Kuhn, M.W., W.A. Stensrud, and G.R. Walter. 1985. Comparison of hydraulic properties of fractured dolomite determined by pressure pulse, slug/bailer, and pumping tests. Proceedings from the Symposium on Hydrogeology of Rocks of Low Permeability, International Association of Hydrogeologists, 17th International Congress.

Carrera, J., G.R. Walter, M.W. Kuhn, H.W. Bentley, and G. Swanick. 1984. Three-dimensional modeling of saline pond leakage calibrated by INVERT-3, a quasi-three-dimensional, transient, parameter-estimation program. Proceedings from the 1984 Conference on Practical Applications of Ground-Water Modeling, NWWA. Worthington, Ohio.

Walter, G.R., H.W. Bentley, J.J. Ward, and D.D. Gonzalez. 1983. Continuum and non-continuum aspects of groundwater movement at the Waste Isolation Pilot Plant, Southeastern New Mexico, EOS (abs), 64(45), p. 713.

Walter, G.R. 1983. A three-well technique for determining formation anisotropy at the Waste Isolation Pilot Plant (WIPP) Southeast New Mexico. Sandia Contractor Report, SAND83–7011, p. 12.

Walter, G.R. 1982. Theoretical and experimental determination of matrix diffusion and related solute transport properties of fractured tuffs from the Nevada Test Site. Los Alamos National Lab., LA–9471–MS, p. 132.

Walter, G.R. and G.M. Thompson. 1982. A repeated pulse technique of evaluating the hydraulic properties of tight formations, Ground Water, 20(2), pp. 186–193.

Walter, G.R. 1980. Hydrochemical and geologic database to support the KBS-II Plan. In Review of the KBS-II Plan for Handling and Final Storage of Unprocessed Spent Nuclear Fuel, Swedish Ministry of Industry, Os I:27, pp. 183–204.

Walter, G.R., R.E. Kidd, and G.M. Lamb. 1979. Management techniques for the control of salt-water encroachment in coastal aquifers. Published by the Alabama Geological Survey.

Walter, G.R. and R.E. Kidd. 1978. Changes in water chemistry near the fresh water-saltwater transition zone. (Abs.) EOS Trans., 59(12), p. 1,063.

Walter, G.R. 1977. Water Resources in Geologic and Hydrologic Environmental Atlas of Mobile and Baldwin Counties, Alabama. P. H. Moser and R. L. Chermock, eds. Alabama Geological Survey Open File Report, pp. 97–170.

Walter, G.R. 1974. The morphological and sedimentological development of a small artificial channel in the Missouri Ozarks. Masters Thesis, University of Missouri. Columbia, Missouri.

AMITAVA "AMIT" GHOSH, Ph. D.

Current Position:

Staff Engineer
Engineering and Material Sciences
Center for Nuclear Waste Regulatory Analyses
Geosciences and Engineering Division
Southwest Research Institute®

Experience:

Dr. Ghosh has more than 25 years of consulting and research experience in mining engineering/geological engineering with specialization in rock mechanics/rock engineering and performing reliability/risk assessments. He specializes in applications of numerical simulations, probabilistic methods and risk assessment methodologies, field and laboratory experiments, blasting, rock fracture mechanics, fractal geometry, and artificial intelligence. Dr. Ghosh developed the geotechnical portion of the Standard Review Plan (SRP) for reviewing the reclamation plans of uranium mill tailings sites under Title II of the Uranium Mill Tailings Radiation Control Act (NUREG–1620). He has also developed the geotechnical portion of a new SRP on conventional uranium mill and heap leach facilities, which will be going for public comments. The review methods in the geotechnical section of this SRP also include use of probabilistic methods to demonstrate safety of a uranium facility. Dr. Ghosh conducted independent confirmatory analyses and developed the safety evaluation report for several uranium mill tailings facilities. He also inspected a uranium reclamation facility, as a part of the Nuclear Regulatory Commission team, for activities associated with construction of mill tailings disposal cells.

Dr. Ghosh played a vital role in preparing and conducting critical review to support NRC in developing regulatory positions for construction and operation of a geologic repository for nuclear waste at Yucca Mountain, several spent nuclear fuel storage installations, and irradiator facility in addition to several reclamation plans for uranium mill tailings facilities. Dr. Ghosh reviewed and, in some cases independently verified, potential hazards and their characterization in terms of their severity on repository facilities and operations. Handling of spent nuclear fuel canisters and waste packages were assessed using the Integrated Safety Assessment methodologies. He lead several investigations including estimation of ground response, assessment of the probability of failure of a slope as a function of consequence-tolerance level specified by the owner, soil-slope failure under static and seismic loads, and effects of repeated seismic events on stability of an underground excavation. He developed a report for the Korea Atomic Energy Research Institute on the effects of concrete degradation on long-term (more than 120 years) storage of spent nuclear fuel in dry storage. As the Principal Investigator for licensing proceedings of the Private Fuel Storage Facility, Dr. Ghosh reviewed and independently assessed the hazards to the storage casks and the facility from different external and internal hazards.

Dr. Ghosh has applied the probabilistic safety assessment methods to assess the design and performance of several nuclear-related facilities against different types of hazards including potential hazards at the underground facilities of the proposed repository at Yucca Mountain. He has extensive numerical modeling experience of complex rock engineering areas using both continuum (finite element, boundary element) and discontinuum (distinct element, particle-based) methods with special emphasis on use of probabilistic methodologies to account

for the data and model uncertainties. He has applied his modeling skills to assess performance of underground and surface mines, tunnels, rock and soil slopes, and earthen dams under both static and dynamic loading conditions.

Special Expertise:

Dr. Ghosh has special expertise in modeling and application of risk/reliability assessment; assessments of natural, human-induced, and operational hazards using risk-informed performance-based regulations; rock blasting; and stability of rock excavations. He has developed a methodology combining traditional rock engineering computational methods with risk assessment methodologies to estimate the probability of unacceptable performance of a design in terms of the level of consequences acceptable to the project or operation.

Education:

Ph.D. Mining Engineering, University of Arizona, Tucson, Arizona, U.S.A. (Dissertation: *Fractal and Numerical Models of Explosive Rock Fragmentation*)

M.S. Mining Engineering, University of Arizona, Tucson, Arizona, U.S.A. (Thesis: *A New Analytical Predictor of Ground Vibrations Induced by Blasting)*

B.Tech. (Honors) Mining Engineering, Indian Institute of Technology, Kharagpur, West Bengal, India.

Previous Positions:

Principal Engineer. Center for Nuclear Waste Regulatory Analyses. Southwest Research Institute. San Antonio, Texas, U.S.A.: 1999–2004.

Senior Research Engineer. Center for Nuclear Waste Regulatory Analyses. Southwest Research Institute. San Antonio, Texas, U.S.A.: 1994–1999.

Research Engineer. Center for Nuclear Waste Regulatory Analyses. Southwest Research Institute. San Antonio, Texas, U.S.A.: 1992–1994.

Post Doctoral Research Fellow. University of Nevada Reno, Reno, Nevada. U.S.A.: October 1990 to July 1992.

Teaching Associate. University of Arizona, Tucson, Arizona, U.S.A.: 1984 to September 1990.

Research Assistant. of Arizona, Tucson, Arizona, U.S.A.: 1984 to 1982.

Consultant. Hargis+ Associates, Inc., Phoenix, Arizona, U.S.A.: Summer 1988.

Research and Technical Service Engineer. IDL Chemicals Limited. Hyderabad, India. 1978-1981.

Professional Registrations and Affiliations:

- Member, Society of Mining, Metallurgy, and Exploration, Inc. of AIME

- Member, International Association for Mathematical Geology
- Member, American Rock Mechanics Association
- Associate Member, American Society of Civil Engineers
- Member, American Geophysical Union
- Session Chairman and Session Developer: 35th, 38th, and 42nd U.S. Symposiums on Rock Mechanics
- Paper Reviewer: 35th, 38th, and 42nd U.S. Symposiums on Rock Mechanics; First North American Rock Mechanics Conference; Society of Mining, Metallurgy, and Exploration, Inc.; Geotechnical and Geological Engineering; Engineering Geology; and Mathematical Geology

Awards and Honors:

- Winner of Rocha Medal 1992 of the International Society for Rock Mechanics in a worldwide competition for outstanding Ph.D. thesis in Rock Mechanics and Rock Engineering.
- Graduate Division Winner of 1989 SME Outstanding Student Paper Contest.
- Sulzer Memorial Scholarship at the Department of Mining and Geological Engineering, University of Arizona.
- Chandrakala Medal by the Mining, Metallurgical and Geological Institute of India and Institute Silver Medal at the Indian Institute of Technology (first position in the Mining Engineering batch of 1978).
- National Scholarship for academic excellence in High School.

Publications:

Technical Papers

Enright, M.P. and A. Ghosh. 2009. Reliability of a Rock Slope Against Plane Sliding Failure. Proceedings of the 10th International Conference on Structural Safety and Reliability (ICOSSAR), September 2009. Osaka, Japan.

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Rasoul, E.A. and A. Ghosh. 1985. Design of Surface Mine Blasts. Arizona Conference of AIME.

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Technical Reports

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Ghosh, A., D.J. Pomerening, and A.H. Chowdhury. 1999. Compatibility of Hi-storm 100 and Transtor™ Cask Systems with Private Fuel Storage Facility Site Characteristics and Design. CNWRA Report to NRC.

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Faculty in University Courses and Workshops:

- Taught three courses in Mining Engineering curriculum at the University of Arizona: Introduction to Mining Engineering, Underground and Surface Mining Methods, and Unit Operations.
- Substitute instructor for Rock Excavation and Advanced Geomechanics courses.
- Supervised class projects on application of numerical methods for excavation design.
- Ground Vibration and Airblast from Blasting–Their Generation, Propagation and Effects on Structures. Third Advanced Rock Blasting Course. IDL Chemicals Ltd. India. 1981.

SUI-MIN "SIMON" HSIUNG, Ph.D.

Current Position:

Staff Engineer
Engineering and Material Sciences
Center for Nuclear Waste Regulatory Analyses
Geosciences and Engineering Division
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Experience:

Dr. Hsiung is a mining engineer with a broad range of experience in geotechnical engineering and integrated safety analysis. He has more than 35 years of research and consulting experience in the disciplines of mining engineering and rock mechanics. He has authored over 130 technical papers and reports. For the last 30 years, Dr. Hsiung has conducted research and provided technical assistance in rock mechanics, geotechnical engineering, and natural phenomena and human-induced hazard assessment to NRC and other clients.

Dr. Hsiung worked on numerous research and consulting projects included solving practical ground control problems, designing longwall chain and yield pillars, evaluating room-and-pillar and multiple seam mining practices, investigating interactions of hydraulic power supports with rock strata of underground coal mines, and monitoring to support abandoned mine subsidence abatement. He also was responsible for a number of field investigations of entry roof deformation, roof strata movement at the longwall face, pillar stability, effectiveness of roof supports and hydraulic power supports, and surface subsidence induced by longwall mining.

At GED of SwRI, Dr. Hsiung provides technical support on performance and design review of a potential high-level waste geologic repository. He lead an effort of conducting soil-structure interaction analyses of a hypothetical waste handling facility to investigate the effects of characteristics of seismic ground accelerations, soil spatial variations, and soil geotechnical properties on structural seismic responses. In conducting the soil-structure interaction analyses, he also assessed the effects of key modeling parameters on analysis results. Dr. Hsiung has significantly contributed to (i) the design of a direct shear apparatus for dynamic experiments on large specimens, (ii) development of a rock joint constitutive model to better describe the dynamic joint behavior observed from laboratory experiments, (iii) field instrumentation and investigation of the effects of mining-induced seismicity on excavation response and local hydrology, and (iv) a small-scale (similitude) rock mass model experiment under scaled earthquake loads. He was a lead investigator in thermal-mechanical-hydrologic modeling of the U.S. Department of Energy (DOE) Drift Scale Heater Test under the international cooperative program DECOVALEX, developed an analytic relationship to assess effects of joint deformation on joint hydraulic conductivity, and developed a methodology to predict rockbursts in deep underground mines. Dr. Hsiung has developed technical evaluation reports for uranium tailings, reclamation plans for source material licenses in areas related to dynamic and static stability of slopes, potential liquefaction of foundation soils, settlement effects on radon barrier integrity, and integrated safety analyses for NRC-licensed nuclear fuel fabrication facilities. Dr. Hsiung also provided technical support to NRC on prelicensing activities relevant to high-level nuclear waste disposal, including review of DOE repository design and performance and conduct of independent site-response and soil-structure interaction analyses. His recent experience includes (i) reviewing structural designs for mixed oxide and gas centrifuge facilities; (ii) developing safety evaluation reports for NRC on several license

applications for mixed oxide, gas centrifuge, laser enrichment, and independent spent fuel storage installation facilities with focuses on tornado and high-wind evaluation; slope stability, liquefaction potential, aircraft crash, snow, and hurricane hazard characterizations; tornado and human-made missile impact assessments; settlement and soil bearing capacity determinations; (iii) performing final structural design review (including foundation design and soil-structure interaction analyses) and construction inspections on gas centrifuge facilities, and (iv) reviewing the DOE license application for high-level nuclear waste geologic disposal.

Special Expertise:

Geomechanical modeling, slope stability analyses, and site response analyses using the following computer codes:

- Universal Distinct Element Code (UDEC)
- Fast Lagrangian Analysis of Continua (FLAC)
- SASSI 2000—A System for Analysis of Soil-Structure Interaction
- Discontinuous Deformation Analysis (DDA)
- MSC Nastran
- ProShake
- EZ-FIRSK

Field instrumentation of underground opening stability

Education:

1984 Ph.D., Mining Engineering, West Virginia University
1979 M.S., Rock Mechanics, National Cheng Kung University
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Publications:

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CHANDRIKA MANEPALLY, EIT

Current Position:

Senior Research Engineer
Environmental Assessment and Hydrology
Center for Nuclear Waste Regulatory Analyses
Geosciences and Engineering Division
Southwest Research Institute®

Experience:

Ms. Manepally is a hydrologist with expertise in unsaturated and saturated flow and transport. Ms. Manepally has been the technical lead for several projects related to providing input to the safety assessment of *in-situ* uranium recovery sites. She also is involved in projects related to preparing and reviewing environmental assessments and environmental impacts statements under the requirements of NEPA. She is also the principal investigator in projects that provide technical support in licensing reviews related to disposal, long-term stabilization, and control of uranium mill tailings under the requirements of the Uranium Mill Tailings Radiation Control Act.

She has been involved in developing and evaluating complex numerical computer models for flow and transport in unsaturated and saturated conditions, mathematical interpretation of physical processes, and evaluation of field and laboratory data related to flow and transport of radionuclides under various hydrologic regimes and varying physical and thermal conditions associated with radioactive waste disposal. Ms. Manepally was the lead preparer for the technical evaluation of groundwater flow in unsaturated media for the NRC Technical Evaluation Report about the DOE Yucca Mountain license application. Additional responsibilities include providing technical expertise in review of independent spent fuel storage installation facilities.

Before joining CNWRA, Ms. Manepally's work focused on measuring and predicting unsaturated hydraulic properties of porous media. Her contributions included characterizing saturated and unsaturated properties and modeling heterogeneous domains under conditions of transient groundwater flow for recharge basins. She has a strong background in geotechnical and environmental engineering.

Special Expertise:

Development of coupled process and abstraction models in saturated and unsaturated environments; field and laboratory characterization of unsaturated hydraulic properties; thermohydrologic process modeling coupled with geochemical and geomechanical processes; and modeling nonequilibrium, multiphase mass transport in porous and fractured media.

Engineering packages—Groundwater Modeling Systems (GMS), MODFLOW, FEMWATER, MT3DMS, MULTIFLO, TOUGHREACT, Soil Vision, Soil Cover, and HELP.

Education:

1997 M.S., Civil Engineering, University of Toledo
1995 B.E., Civil Engineering, Osmania University, Hyderabad, India

Previous Positions:

Engineer, SwRI, San Antonio, Texas; 2000–2005.

Research Engineer, SwRI, San Antonio, Texas; 2005–2007.

Graduate Research Associate, Arizona State University, Department of Civil and Environmental Engineering; 1997–2000.

Graduate Research Assistant, University of Toledo, Department of Civil and Environmental Engineering; 1996–1997.

Professional Registrations and Affiliations:

American Geophysical Union

American Society of Civil Engineers

Society for Mining, Metallurgy and Exploration; Program Committee Division Officer for Hydrology

Women in Science and Engineering

Awards and Honors:

Reviewer for American Nuclear Society
Recipient of the Board of Trustees award, 1995–1997, University of Toledo
Award for Academic Excellence, 1991–1995, CBIT, Osmania University, Hyderabad, India

Publications:

Başağaoğlu, H., S. Succi, C. Manepally, R. Fedors, and D. Wyrick. 2009. Sensitivity of the Active Fracture Model Parameter to Fracture Network Orientation and Injection Scenarios. Hydrogeology Journal (in press).

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Manepally, C. and R. Fedors. 2005. Effects on Natural Drift Degradation on In-drift Moisture Distribution. Presented at the American Geophysical Union Fall Meeting, December 2005. San Francisco, California.

Manepally, C. and R.W. Fedors. 2004. Spatial Variation of In-drift Conditions Based on a Porous Media Approach. Presented at the 2004 American Society of Mechanical Engineers Heat Transfer/Fluids Engineering Summer Conference. Charlotte, North Carolina.

Fedors, R.W., C. Manepally, L.B. Browning, G.R. Adams, and S.T. Green. 2003. Evaluation of Large-Scale Temperature Gradients to Support Assessment of Convection and Cold-Trap Processes in Heated Drifts." Presented at the Society of Mining, Metallurgy and Exploration Annual Meeting and Exhibit. Denver, Colorado.

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Fedors, R.W., G.R. Adams, C. Manepally, and S.T. Green. 2003. Thermal Conductivity, Edge Cooling, and Drift Degradation—Abstracted Model Sensitivity Analyses for Yucca Mountain. San Antonio, Texas: CNWRA.

Green, R., S. Painter, B. Fratesi, C. Manepally, and G. Walter. 2003. Status Report for Multiphase Numerical Simulation. San Antonio, Texas: CNWRA.

Painter, S., C. Manepally, and D. Hughson. 2001. Evaluation of U.S. Department of Energy Thermohydrologic Data and Modeling Status Report. San Antonio, Texas: CNWRA.

ROBERT J. LENHARD, Ph.D.

Current Position:

Program Manager
Environmental Protection and Waste Management for Non-High-Level Radioactive Waste
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Experience:

Dr. Lenhard has more than 20 years experience. His work has been initiating, managing, and conducting projects that investigate fluid behavior in the subsurface, particularly in the vadose zone. The projects were designed to explore and elucidate the fundamental mechanisms that govern multiphase flow and chemical transport in soils and aquifers. He applies his knowledge to better predict and measure the subsurface behavior of fluids for practical and theoretical applications.

As a technical leader, he has published several seminal papers addressing innovative modeling and measurement of fluid flow behavior in three-phase air-oil-water systems. Work included developing theoretical models of multiphase fluid flow and contaminant transport; designing contaminant mobility experiments; and measuring integrated effects of physical, chemical, and biological interactions of multiphase fluid systems in porous media. His efforts have been applied to the remediation of contaminated soils and aquifers as well as to reservoir engineering associated with the petroleum industry. Dr. Lenhard has published more than 40 peer-reviewed papers in leading scientific journals. He has also given numerous invited presentations nationally and internationally and serves as an associate editor for two scientific journals: *Vadose Zone Journal* and *Journal of Contaminant Hydrology*.

As a manager, Dr. Lenhard oversees quality successful projects within costs. He currently manages projects on vadose zone fluid dynamics, solute transport in variably saturated porous and fractured media, regional-scale groundwater flow in arid to semi-arid environments, and *in-situ* uranium recovery from subsurface strata. He also develops strategic and tactical plans for developing programs in fluid flow and transport phenomena, builds and fosters interdisciplinary and multi-institutional teams, and develops and maintains strong working relationships with clients.

Special Expertise:

Dr. Lenhard is a world leader in constitutive theory that is needed for predicting the flow of multiple fluid phases in porous media. He has developed computer algorithms for predicting relationships among fluid relative permeabilities, saturations, and pressures. His models, or variations thereof, are commonly used in computer codes predicting the flow of gas, oil (nonaqueous phase liquids), and water in the subsurface. He has also extended his models to account for hysteresis in relative permeability-saturation-pressure relations. Dr. Lenhard is a porous media physicist, who can apply his expertise to various practical and theoretical problems.

Gee, G.W., C.T. Kincaid, R.J. Lenhard, and C.S. Simmons. 1991. Recent Studies of Flow and Transport in the Vadose Zone. U.S. National Report to International Union of Geodesy and Geophysics 1987-1990. Reviews of Geophysics, Supplement, Vol. 29:227–239.

Lenhard, R.J., J.C. Parker, and J.J. Kaluarachchi. 1991. Comparing Simulated and Experimental Hysteretic Two-Phase Transient Fluid Flow Phenomena. Water Resour. Res., Vol. 27:2,113–2,124.

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Lenhard, R.J., T.G. Johnson, and J.C. Parker. 1993. Experimental Observations of Nonaqueous-Phase Liquid Subsurface Movement. J. Contaminant Hydrology, Vol. 12:79–101.

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Lenhard, R.J., M. Oostrom, C.S. Simmons, and M.D. White. 1995. Investigation of Density-Dependent Gas Advection of Trichloroethylene: Experiment and a Model Validation Exercise. J. Contaminant Hydrology, Vol. 19:47–67.

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Morel-Seytoux, H.J., P.D. Meyer, M. Nachabe, J. Touma, M.T. van Genuchten, and R.J. Lenhard. 1996. Parameter Equivalence for the Brooks-Corey and van Genuchten Soil Characteristics: Preserving the Effective Capillary Drive. Water Resources Res., Vol. 32(5):1,251-1,258.

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Lenhard, R.J. and M. Oostrom. 1998. A Parametric Model for Predicting Relative Permeability-Saturation-Capillary Pressure Relationships of Oil-Water Systems in Porous Media with Mixed Wetability. Transport in Porous Media, Vol. 31:109–131.

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Lenhard, R.J., A.R. Kacimov, A.M. Tartakovsky, and H. AbdelRahman. 2002. Modeling Residual NAPL in Water-Wet Porous Media. J. Sci. Res.: Agricultural Sciences, Sultan Qaboos Univ., Oman, Vol. 7:1–7.

Oostrom, M., C. Hofstee, R.J. Lenhard, and T.W. Wietsma. 2003. Flow Behavior and Residual Saturation Formation of Liquid Carbon Tetrachloride in Unsaturated Heterogeneous Porous Media. J. Contaminant Hydrol., Vol. 64:93–112.

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Lenhard, R.J. and J.C. Parker. 1986. Measurement of Pressure-Saturation Relations and Saturated Permeabilities of Water and Trichloroethylene in Quincy Soil. Prepared for Battelle, Pacific Northwest Laboratories, Richland, Washington. (Subcontract B–N3935–A–E).

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Parker, J.C., R.J. Lenhard, and T. Kuppusamy. 1988. Physics of Immiscible Flow in Porous Media. EPA 600/S2–87/101, Washington, DC: U.S. Environmental Protection Agency.

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Lenhard, R.J., R.S. Skeen, and T.M. Brouns. 1995. Contaminants at DOE Sites and Their Susceptibility to Bioremediation. Bioremediation: Science and Applications, Soil Science Society of America, H.D. Skipper and R.F. Turo (eds.), Chapter 10, pp. 157–172.

Oostrom, M., R.J. Lenhard, and M.D. White. 1995. Infiltration and Redistribution of Dense and Light Nonaqueous Phase Liquids in Partly Saturated Sand Columns. Proceedings from the 15th Annual American Geophysical Union Hydrology Days. Fort Collins, Colorado: Hydrology Days Publications, Colorado State University. pp. 215–226.

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Oostrom, M., R.J. Lenhard, M. Delshad, and S.D. Robertson. 1999. Modeling Relations Among Relative Permeabilities, Fluid Saturations, and Capillary Pressures in Mixed-Wet Porous Media: Model Testing and Application to Oil-Water Systems. Proceedings from the Characterization and Measurement of the Hydraulic Properties of Unsaturated Porous Media. Riverside, California: U.S. Salinity Laboratory. pp. 189–198.

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Lenhard, R.J. 2002. Investigation of the Movement and Fate of Chlorinated Hydrocarbons. Laboratory-Directed Research and Development: Annual Report for FY-2002, INEEL/EXT–03–00390. Idaho Falls, Idaho: Idaho National Engineering & Environmental Laboratory. pp. 333–334.

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Lee, B.D., R.J. Lenhard, and A.R. Miller. 2005. Mesoscale Tank Experiments for Investigating Carbon Tetrachloride Biodegradation. *In-Situ* and On-Site Bioremediation. Paper M–57. B.C. Alleman and M.E. Kelly (eds.) Columbus, Ohio: Battelle Press, Columbus, Ohio.

Book Contributions

Lenhard, R.J., M. Oostrom, and J.H. Dane. 2002. Multi-Fluid Flow: Introduction. Methods of Soil Analysis. Part 1: Physical Methods. J.H. Dane and G.C. Topp (eds.). Madison, Wisconsin: Soil Science of America. (peer reviewed)

Oostrom, M., J.H. Dane, and R.J. Lenhard. 2002. Multi-Fluid Flow: Fluid Contents. Methods of Soil Analysis. Part 4: Physical Methods. J.H. Dane and G.C. Topp (eds.). Madison, Wisconsin: Soil Science of America. (peer reviewed)

Lenhard, R.J., J.H. Dane, and M. Oostrom. 2002. Multi-Fluid Flow: Saturation-Pressure Relationships. Methods of Soil Analysis. Part 1: Physical Methods. J.H. Dane and G.C. Topp (eds.). Madison, Wisconsin: Soil Science of America. (peer reviewed)

Dane, J.H., R.J. Lenhard, and M. Oostrom. 2002. Multi-Fluid Flow: Relative Permeability Measurements. In: Methods of Soil Analysis. Part 1: Physical Methods. J.H. Dane and G.C. Topp (eds.). Madison, Wisconsin: Soil Science of America. (peer reviewed)

Lenhard, R.J., M. Oostrom, and J.H. Dane. 2002. Multi-Fluid Flow: Prediction of Capillary Pressure-Relative Permeability Relations. In: Methods of Soil Analysis. Part 1: Physical Methods. J.H. Dane and G.C. Topp (eds.). Madison, Wisconsin: Soil Science of America, Madison, Wisconsin. (peer reviewed)

Dane, J.H., and R.J. Lenhard. 2005.0 Hysteresis. Encyclopedia of Soils in the Environment, Vol. 2. D. Hillel (ed.). Oxford, United Kingdom: Elsevier Ltd. (peer reviewed)

Lenhard, R.J., J.H. Dane, and M. Oostrom. 2005. Immiscible Fluids. Encyclopedia of Soils in the Environment, Vol. 2. D. Hillel (ed.). Oxford, United Kingdom: Elsevier Ltd. (peer reviewed)

Invited Presentations

June 1988. Seminar at Battelle Pacific Northwest Laboratories, Richland, Washington. Modeling Hysteresis in Air-Oil-Water Fluid Systems.

May 1989. Seminar at Battelle Pacific Northwest Laboratories, Richland, Washington. Modeling Multiphase Flow and Saturation-Pressure Distributions in Soils and Aquifers.

June 1989. Seminar at R.S. Kerr Environmental Research Laboratory, Oklahoma City, Oklahoma. Modeling Multiphase Organic Chemical Transport in Soil and Groundwater.

September 1989. Seminar at Soil and Crop Sciences Department, Texas A&M University, College Station, Texas. Modeling Hysteretic Multiphase Permeability-Saturation-Pressure Relations in Porous Media.

September 1989. Seminar at Geosciences Department, New Mexico Institute of Mining and Technology, Socorro, New Mexico. Modeling Multiphase Hysteretic Constitutive Relations.

April 1990. Presentation at the DOE/OHER Subsurface Science Program workshop on Intermediate-Scale Experimentation to Investigate Microbiological, Chemical, and Hydrologic Processes Affecting Subsurface Reactive Contaminant Migration, April 24–26, 1990. Lewes, Delaware.

December 1990. Seminar at Agricultural Engineering Department, University of Idaho, Moscow, Idaho. Estimation of Subsurface Petroleum Liquid Volumes from Monitoring Well Data.

February 1991. Seminar at Environmental Sciences Department, Washington State University, Tri-Cities, Washington. Modeling of Multiphase Fluid Flow.

October 1991. Seminar at Geosciences Department, New Mexico Institute of Mining and Technology, Socorro, New Mexico. Nonunique Saturation-Pressure Relations in Two- and Three-Phase Fluid Systems: Measurement and Modeling.

October 1991. Seminar at Sandia National Laboratory, Albuquerque, New Mexico. Measurement and Modeling of Multiphase Hysteresis.

October 1991. Seminar at Agricultural & Chemical Engineering Department, Colorado State University, Fort Collins, Colorado. Two- and Three-Phase Saturation-Pressure Relations: Measurement and Modeling of Hysteresis.

February 1992. Seminar at the Department of Hydrology and Water Resources, University of Arizona, Tucson, Arizona. Measurement and Modeling of Three-Phase Saturation-Pressure Relations.

October 1992. Seminar at the Department of Geological Engineering, Geology, and Geophysics, Michigan Institute of Technology, Houghton, Michigan. Modeling Nonaqueous Phase Liquid Subsurface Movement.

November 1992. Seminar at the Department of Soil and Water Sciences, University of Arizona, Tucson, Arizona. Modeling Nonaqueous Phase Subsurface Movement.

April 1992. Presentation at the 13th Annual American Geophysical Union Hydrology Days, April 1, 1993. Fort Collins, Colorado. Modeling Subsurface Flow of Air-Oil-Water Systems.

April 1993. Seminar at the Oil and Gas Research Institute/Russian Academy of Sciences, Moscow, Russia. Two- and Three-Phase Saturation-Pressure Relations: Measurement and Modeling of Hysteresis.

November 1993. Presentation at the Bioremediation: Science, Applications, Regulations, & Education Symposium, November 6–7, 1993. Cincinnati, Ohio. Contaminant Mixtures at DOE Sites and Their Relevance to Bioremediation.

April 1993. Presentation at the 14th Annual American Geophysical Union Hydrology Days, April 1, 1993. Fort Collins, Colorado. Modeling Subsurface Flow of Air-Oil-Water Systems.

February 1994. Seminar at the Geology Department, Washington State University, Pullman, Washington. Measurement and Modeling of Multiphase Flow in Porous Geologic Material.

May 1994. Seminar at the Civil Engineering Department, University of Waterloo, Waterloo, Ontario, Canada. Integrated Multiphase Modeling Activities at Pacific Northwest Laboratory for the U.S. Department of Energy.

September 1994. Seminar at the Soil and Water Department, University of Arizona, Tucson, Arizona. Integrated Multiphase Modeling Activities at Pacific Northwest Laboratories for the U.S. Department of Energy—Density-Driven Vapor Flow of NAPLs.

May 1995. Seminar for the Soil Science Department, Oregon State University, Corvallis, Oregon. Experimental and Modeling Investigations of Organic Liquid Movement in the Subsurface.

October 1997. Presentation at an International Workshop on Characterization and Measurement of the Hydraulic Properties of Unsaturated Porous Media, October 22–24, 1997. Riverside, California. Modeling Relations Among Relative Permeabilities, Fluid Saturations, and Capillary Pressures in Mixed-Wet Porous Media: Theory.

August 1998. Seminar at the Institute of Terrestrial Ecology of Swiss Federal Institute of Technology, Zurich, Switzerland. Results of Two Studies Involving the Movement of Organic Contaminants in the Subsurface.

September 1998. Seminar at the Ministry of Water Resources of the Sultanate of Oman, Muscat, Oman. Using Predictive Tools to Model the Movement of Organic Contaminants in the Subsurface.

July 1999. Seminar at the Swiss Federal Institute of Technology, Zurich, Switzerland. Modeling Relations Among Relative Permeabilities, Saturations, and Pressures in Mixed-Wet Porous Media.

May 2002. Seminar at the University of Stuttgart, Stuttgart, Germany. Scaling Capillary Pressure-Saturation Relations in Water- and Mixed-Wet Porous Media.

January 2003. Keynote presentation at the International Conference on Soil & Groundwater Contamination & Cleanup in Arid Countries at Sultan Qaboos University, Muscat, Oman.

October 2003. Seminar at Utah State University, Logan, Utah. INEEL's Subsurface Science Initiative: Current and Future Activities.

November 2004. Seminar at Lawrence Berkeley National Laboratory for the Earth Sciences Division, Berkeley, California. Mesoscale Experiments: An Approach for Testing Models Describing Fluid Flow Through Fractured Porous Media.

August 2005. Seminar at the University of Edinburgh, Edinburgh, Scotland. Advances in Modeling Multiphase Fluid Flow.

September 2005. Seminar at Heriot-Watt University, Edinburgh, Scotland. Modeling Irreducible Oil in Three-Phase Water-Wet Porous Media.

Awards and Honors:

Received numerous distinguished service awards from Idaho National Laboratory and Pacific Northwest Laboratory for superior performance and team building from 1992-2004.

Professional and Scientific Committees and Activities:

- Serves on the Editorial Board (associate editor) of the *Journal of Contaminant Hydrology*, 1996-present
- Serves on the Editorial Board (associate editor) of the Vadose Zone Journal, 2002-present
- Served as Guest Editor of a Special Issue on INEEL Subsurface Science Research for the journal, Vadose Zone Journal, 2003-2004

- Served as a section editor of the Sultan Qaboos University Journal for Scientific Research: Agricultural Sciences, 1997-1999

- Served as Guest Editor of a Special Issue on Multiphase Flow for the journal, Advances in Water Resources, 1998

- Served as chairperson of the Unsaturated Zone Committee for the American Geophysical Union, 1994-1996

- Serves on the Unsaturated Zone Committee of the American Geophysical Union, 1991-present
- Chaired a special meeting on Description and Measurement of Constitutive Relations Governing Fluid Flow in Variably Saturated Media, Geologic Society of America, October 1994

- Chaired a special meeting on Multiphase Flow and Transport in Porous Media, American Geophysical Union, May 1993

- Chaired a special meeting on Multiphase Flow and Chemical Transport, Soil Science Society of America, November 1992

- Served on a technical/scientific steering committee for the VOC Arid-Site Integrated Demonstration for the U.S. Department of Energy, 1991-1995

- Co-chaired a special meeting on Recent Advances in Constitutive Relationships for Multiphase Flow in Porous Media at a Gordon Research Conference on Modeling of Flow in Permeable Media, August 1996

- Served as a contributor for the DOE Complex-Wide Vadose Zone Science and Technology Roadmap, 2000-2001

- Served on the scientific committee for an International Conference on Soil and Groundwater Contamination in Arid Countries, 2002-2003

JAMES S. DURHAM, Ph.D.

Current Position:

Principal Engineer
Risk Analysis and Performance Assessment
Center for Nuclear Waste Regulatory Analyses
Geosciences and Engineering Division
Southwest Research Institute®

Experience:

At CNWRA, Dr. Durham contributes to the performance assessments of the potential geologic repository for high-level nuclear waste at Yucca Mountain, Nevada, and to the evaluation of risk insights. He managed the Biosphere Characteristics Project, and led a project to write a user guide for the performance assessment code Total-system Performance Assessment (TPA) Version 6.1. He was a major contributor to two standard review plans for uranium recovery licensing reviews and he was the principal investigator for a project that collected air samples to evaluate the adequacy of the airborne effluent system at a licensee's facility. He developed VARSKIN 3, a skin dose calculation tool and the associated user's manual for NRC. He was the principal investigator evaluating the effects of potential natural phenomena and aviation accidents at the proposed Pa'ina Hawaii, LLC, irradiator facility for the NRC. He was also a major contributor to the environmental review conducted as part of the Nuclear Fuel Services, Inc., license renewal.

Before joining GED, Dr. Durham was an assistant professor in the Department of Environmental and Radiological Health Sciences at Colorado State University. He taught lectures and laboratories in radiation physics, internal and external dosimetry instrumentation, and waste management. He served 5 years as chair of the Radiation Safety Committee and advised five Master of Science candidates. His research involved design and development of an extremity dosimeter and an *in-situ*, long-term monitor for radioactive contamination based on optically stimulated luminescence readout of aluminum oxide.

From 1995 through 1998, Dr. Durham was the principal engineer for the Cesium Chloride Legacy Safety Program in the 324 Building, a Hazard Category 2 nonreactor nuclear facility located on the Hanford Site for Pacific Northwest National Laboratory and for B&W Hanford Company. While at PNNL from 1986 through 1995, he participated in radiation safety assessments at several Department of Energy sites, and he was the manager and principal investigator for a project to measure extremity doses received by Pantex employees during weapon disassembly operations. His research included several projects in the field of beta and skin dosimetry, including managing a project to study the biological effects of hot particles on pigskin for the Electric Power Research Institute.

Special Expertise:

Dr. Durham has special expertise as a health physicist with diverse experience in many areas of nuclear engineering and radiological health. His background includes radiation detection and measurement, skin dosimetry, education, and environmental monitoring.

Education:

1987 Ph.D., Nuclear Engineering, University of Illinois, Urbana-Champaign, Illinois
1984 M.S., Nuclear Engineering, University of Illinois, Urbana-Champaign, Illinois
1980 B.S., Nuclear Engineering, University of Illinois, Urbana-Champaign, Illinois

Previous Positions:

Senior Research Engineer, Center for Nuclear Waste Regulatory Analysis (CNWRA®), SwRI, San Antonio, Texas: 2005-2008.

Assistant Professor, Colorado State University, Department of Environmental and Radiological Health Sciences, Ft. Collins, Colorado; 1998-2005.

Project Engineer, B&W Hanford Company, Richland, Washington; 1996-1998.

Technical Group Manager, Battelle Pacific Northwest National Laboratory, Project Management and Engineering Technical Group, Richland, Washington; 1995-1996.

Senior Research Scientist, Battelle Pacific Northwest National Laboratory, Health Protection Department, Richland, Washington; 1986-1995

Professional Registrations and Affiliations:

Health Physics Society
American Nuclear Society
International Solid State Dosimetry Organizing Committee

Publications:

Akselrod, M.S., S.W.S. McKeever, M. Moscovitch, D. Emfietzoglou, J.S. Durham, and C.G. Soares. 1996. A Thin-Layer Al2O3:C Beta TL Detector. Radiation Protection Dosimetry. Vol. 66, Nos. 1–4. pp. 105–110.

Akselrod, M.S., A.L. Odegove, and J.S. Durham. 1994. Aluminum Oxide Exoelectron Dosimetry. Radiation Protection Dosimetry. Vol. 54, Nos. 1–3. pp. 353–356.

Benke, R.R., D.M. Hooper, J.S. Durham, D.R. Bannon, K.L. Compton, M. Necsoiu, and R.N. McGinnis, Jr. 2009. Measurement of Airborne Particle Concentrations Near the Sunset Crater Volcano, Arizona. Health Physics. Vol. 96, No. 2. pp. 97–117.

Blue, T.E., B.W. Wehring, S.J. Briggs, C.S. Wepprecht, J.S. Durham, and J.W. Blue. 1986. Dosimetry in Fast-Neutron Therapy by Automatic Readout of CR–39. Nuclear Instruments and Methods. Vol. B14. pp. 589–595.

Blue, T.E., J.W. Blue, J.S. Durham, D.B. Harris, A.S. Hnesh, and J.J. Ryes. 1983. D-He(3) Proton Yield as a Diagnostic for F-T and D(2)-Filled Inertial Confinement Fusion Experiments. Journal of Applied Physics. Vol. 54. pp. 615–620.

Blue, T.E., J.J. Reyes, J.S. Durham, B.W. Wehring, J.W. Blue, and W.K. Roberts. 1983. Dosimetry with CR–39 in TE Liquid for Clinical Neutron Beams. Transactions of the American Nuclear Society. Vol. 44. p. 484. (Nominated for Radiation Protection and Shielding Division "Best Paper" Award.)

Durham, J. 2009. Environmental Assessment for the Renewal of U.S. Nuclear Regulatory Commission License No. SNM–1097 for Global Nuclear Fuel—Americas, Wilmington Fuel Fabrication Facility. San Antonio, Texas: CNWRA.

Durham, J. 2008. Environmental Assessment for the Renewal of U.S. Nuclear Regulatory Commission License No. SNM–1227 for AREVA NP, Inc., Richland Fuel Fabrication Facility. San Antonio, Texas: CNWRA.

Durham, J., A. Ghosh, J. Stamatakos, K. Das, and C. Dinwiddie. 2007. Topical Report on the Effects of Potential Aviation Accidents and Natural Phenomena at the Proposed Pa'ina Hawaii, LLC. Irradiator Facility. San Antonio, Texas: CNWRA.

Durham, J.S. 2006. NUREG/CR–6918, VARSKIN 3: A Computer Code for Assessing Skin Dose from Skin Dose Contamination. Springfield, Virginia: The National Technical Information Service.

Durham, J.S. 2006. Concepts, Quantities, and Dose Limits in Radiation Protection Dosimetry. Radiation Measurements. Vol. 41, Supplement 1. pp. S28–S35.

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Durham, J.S. 1996. Chapter 15—Skin Dose Assessment. Applications of New Technology: External Dosimetry. J. Higginbotham, ed. Madison, Wisconsin: Medical Physics Publishing.

Durham, J.S. and D.L. Gardner. 1993. Methodology for Performing Measurements to Release Material From Radiological Control. PNL–8820. Richland, Washington: Battelle Pacific Northwest Labs.

Durham, J.S. 1991. Hot Particle Dose Calculations Using the Computer Code VARSKIN MOD2. Radiation Protection Dosimetry. Vol. 39, Nos. 1–3. pp. 79–84.

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Durham, J.S., S.E. Merwin, and K.L. Swinth. 1991. Skin Dose Evaluations Using Exoelectron Dosemeters. Radiation Protection Dosimetry. Vol. 39. pp. 67–70.

Durham, J.S., W.D. Reece, and S.E. Merwin. 1991. Modeling Three-Dimensional Beta Sources for Skin Dose Calculations Using VARSKIN MOD2. Radiation Protection Dosimetry. Vol. 37, No. 2. pp. 89–94.

Durham, J.S., T.E. Blue, B.W. Wehring, M.H. Ragheb, and J.W. Blue. 1989. Microdosimetry in Fast-Neutron Therapy by Automatic Readout of CR–39 Solid State Nuclear Track Detectors. Nuclear Instruments and Methods in Physics Research. Vol. B36. pp. 319–331.

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Gerdin, G., J.S. Durham, and R. Ilic. 1981. Solid State Nuclear Track Detectors and High Fluences of Light Ions. Nuclear Tracks. Vol. 5, No. 3. pp. 299–209.

Ilic, R., G. Gerdin, J.S. Durham, B. Wehring, W. Stygar, and T. Emoto. 1980. Dense Plasma Focus Studies With Solid State Nuclear Track Detectors (SSNTD). Bulletin of the American Physical Society. Vol. 25. p. 9.

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James A.C., P. Gehr, R. Masse, R.G. Cuddihy, F.T. Cross, A. Birchall, J.S. Durham, and J.K. Briant. 1991. Dosimetry Model for Bronchial and Extrathoracic Tissues of the Respiratory Tract. Radiation Protection Dosimetry. Vol. 37, No. 4. pp. 221–230.

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Klein, D.M., E.G. Yukihara, S.W.S. McKeever, J.S. Durham, M.S. Askselrod. 2006. *In-Situ,* Long-Term Monitoring System for Radioactive Contaminants. Radiation Protection Dosimetry. Vol. 119. pp. 421–424.

Klein, D.M., E.G. Yukihara, E. Bulur, J.S. Durham, M.S. Akselrod, and S.W.S. McKeever. 2005. An Optical Fiber Radiation Sensor for Remote Detection of Radiological Materials. IEEE Sensors Journal. Vol. 5, No. 4. pp. 581–588.

Reece, W.D., J.S. Durham, S.E. Merwin, and M.P. Moeller. 1993. Nonstochastic Skin Effects From Discrete Radioactive Particles Emitting High-Energy Spectra. EPRI TR–102658. Palo Alto, California: Electric Power Resource Institute.

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Vargo, G.J., E.E. Hickey, J.S. Durham, and S.F. Snyder. 1993. Analysis of Area Monitoring Options for Westinghouse Hanford Company. PNL–8934. Richland, Washington: Battelle Pacific Northwest Labs.

Presentations:

Durham, J. 2006. Skin Dosimetry and VARSKIN 3. Presentation at the 51st Health Physics Society Annual Meeting, June 25–29, 2006. Providence Rhode Island. McLean, Virginia: Health Physics Society.

Durham, J., K. Krobl, H. Karagiannis, and S. Sherbini. 2006. A Backscatter Correction Model for Three-Dimensional Beta Sources. Presentation at the 51st Health Physics Society Annual Meeting, June 25–29, 2006. Providence, Rhode Island. McLean, Virginia: Health Physics Society.

Durham J. 2005. Adding Radionuclides to the VARSKIN 3 Library Correctly. Presentation at the 50th Health Physics Society Annual Meeting, July 10–14, 2005. Spokane, Washington. McLean, Virginia: Health Physics Society.

OLUFEMI O. OSIDELE, Ph.D.

Current Position:

Senior Research Engineer
Risk Analysis and performance Assessment
Center for Nuclear Waste Regulatory Analyses
Geosciences and Engineering Division
Southwest Research Institute®

Experience:

Dr. Osidele has over 20 years experience in engineering hydrology and environmental systems analysis. He specializes in watershed hydrologic modeling, water quality management, integrated systems modeling, uncertainty analysis, environmental risk assessment, and stakeholder–science integration. At SwRI, Dr. Osidele has reviewed system risk assessments to support regulatory analyses of geologic radioactive waste disposal facilities, including hydrologic models of flood protection measures for surface facilities. He has evaluated impacts to surface water quality to support licensing reviews for conventional and *in-situ* uranium mining and milling facilities in Wyoming. Prior to joining SwRI, he developed computational methods for uncertainty and sensitivity analyses in a multimedia risk assessment model for EPA hazardous waste program. He also applied these methods in examining surface water hydrology and water quality models supporting EPA's Total Maximum Daily Load watershed management program. Dr. Osidele has published in widely read, peer-reviewed journals. He has reviewed grant proposals and technical papers for several national and international organizations, journals, and conferences.

Special Expertise:

Dr. Osidele is exceptionally skilled in identifying and exploring interfaces among multiple environmental science, technology, and policy issues. His multidisciplinary training and experience has allowed him to continuously succeed on diverse project topics. He is proficient in Matlab, Simulink, and SimBiology modeling environments; the Soil and Water Assessment Tool (SWAT); and other hydrologic modeling software.

Education:

Ph.D., Environmental Systems Analysis, University of Georgia, 2001
M.Sc. (with Distinction), Hydrology, Imperial College, University of London, 1992
B.Sc. (First Class, Honors), Civil Engineering, University of Ife, Nigeria, 1987

Previous Positions:

Research Engineer, Southwest Research Institute, San Antonio, Texas; 2004–2006
Post-Doctoral Associate, University of Georgia, Athens, Georgia; 2002–2004
Research Assistant, University of Georgia, Athens, Georgia; 1998–2001
Assistant Manager/Network Administrator, Citibank, Nigeria; 1996–1997
Network Supervisor, Citibank, Nigeria; 1994–1996
Management Associate, Citibank, Nigeria; 1993–1994
Hydrologist / Project Engineer, Enplan Group, Nigeria; 1988–1991

Professional Registrations and Affiliations:

National Advisory Council for Environmental Policy and Technology
American Water Resources Association
Water Environment Federation
International Water Association (IWA)
American Geophysical Union
Water Environment Association of Texas
IWA Specialist Group in Systems Analysis and Integrated Assessment

Publications:

Beck, M.B., F. Jiang, F. Shi, R. Villaroel Walker, O.O. Osidele, Z. Lin, I. Demir and J.W. Hall. 2010. Re-engineering cities as forces for good in the environment. Proceedings of the Institution of Civil Engineers (ICE), Engineering Sustainability, 163(ES1):31–46. (Nominated for ICE Award for Papers.)

Osidele, O.O., O. Pensado, J. McMurry, S. Mohanty and B. Goodwin. 2008. A decision-analysis framework to support risk assessment for geologic radioactive waste disposal systems. The Integrated Assessment Journal, 8(2):127–136.

Borrett, S.B. and O.O. Osidele. 2007. Environ indicator sensitivity to flux uncertainty in a Phosphorus model of Lake Sidney Lanier, USA. Ecological Modelling, 200(3–4):371–383.

Osidele, O.O., W. Zeng and M.B. Beck. 2006. A random search methodology for examining parametric uncertainty in water quality models. Water Science and Technology, 53(1):33–40.

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Osidele, O.O., W. Zeng and M.B. Beck. 2003. Coping with uncertainty: a case study in sediment transport and nutrient load analysis. Journal of Water Resources Planning and Management, 129(4):345–355.

Beck, M.B., J. Chen and O.O. Osidele. 2002. Random search and the reachability of target futures. M.B. Beck (ed): Environmental foresight and models: a manifesto. Oxford, United Kingdom: Elsevier. pp.207–226.

Beck, M.B., B.D. Fath, A.K. Parker, O.O. Osidele, G.M. Cowie, T.C. Rasmussen, B.C. Patten, B.G. Norton, A. Steinemann, S.R. Borrett, D. Cox, M.C. Mayhew, W. Zeng and X-Q. Zeng. 2002. Developing a concept of adaptive community learning: case study of a rapidly urbanizing watershed. Integrated Assessment, 3(4):299–307.

Parker, P., R. Letcher, A. Jakeman, B. Beck, G. Harris, R. Argent, M. Hare, A. Voinov, M. Janssen, P. Sullivan, M. Scoccimarro, A. Friend, M. Sonnenshein, D. Barker, L. Matejicek, D. Odulaja, P. Deadman, K. Lim, G. Larocque, P. Tarikhi, C. Fletcher, A. Put, T. Maxwell, A. Charles, H. Breeze, N. Nakatani, S. Mudgal, W. Naito, O. Osidele, I. Eriksson, U. Kautsky, E. Kautsky, B. Naeslund, L. Kumblad, R. Park, S. Maltagliati, P. Girardin, A. Rizzoli, D. Mauriello, R. Hoch, D. Pelletier, J. Reilly, R. Olafsdottir, and S. Bin. 2001. Progress in integrated assessment and modeling." Environmental Modeling and Software, 17(3): 209–217.

Osidele, O.O. and M.B. Beck. 2001. Identification of model structure for aquatic ecosystems using regionalized sensitivity analysis. Water Science and Technology, 43(7):271–278.

Presentations:

Osidele, O.O., A.Y. Sun and R.T. Green. 2011. Assessing the impacts of climate and land use change on streamflow and nutrient loading in the Arroyo Colorado watershed in Southern Texas. Presented at the American Geophysical Union Fall 2011 Meeting.

Osidele, O.O. and S. Mohanty. 2010. A real-time data fusion framework for adaptive adversary modeling and risk analysis. Presented at the 30th Annual Meeting, Society for Risk Analysis.

Osidele, O.O. 2009. Simulation-based data fusion for real-time threat detection in municipal drinking water and wastewater systems. Presented at the 2009 Water Security Congress, American Water Works Association.

Osidele, O.O. and S. Mohanty. 2006. Application of regionalized sensitivity analysis to a performance assessment model of a high-level waste repository. Presented at the International High Level Radioactive Waste Management Conference, American Nuclear Society.

Osidele, O.O and M.B. Beck. 2006. TMDL insights: significance of uncertainty in assessing the consequences of sediment transport and nutrient loading in the Chattahoochee River, Georgia. Presented at the NSF Environmental Observatories Workshop, National Science Foundation.

Osidele, O.O and M.B. Beck. 2006. Environmental foresight for ecological behavior in Lake Lanier, Georgia. Presented at the NSF Environmental Observatories Workshop, National Science Foundation.

Osidele, O.O., W. Zeng and M.B. Beck. 2003. Uncertainty evaluation of sediment loading and transport for the Chattahoochee River at Atlanta, Georgia. Presented at the TMDL 2003 Conference, Water Environment Federation.

Osidele, O.O. 2003. Predicting structural change in environmental systems: a complement to model-based forecasting. Presented at the 13th Annual International Symposium, International Council on Systems Engineering.

Osidele, O.O., W. Zeng and M.B. Beck. 2002. Coping with model uncertainty: a case study in sediment transport and nutrient load analysis. Presented at the National TMDL Science and Policy Conference, Water Environment Federation.

Osidele, O.O. and M.B. Beck. 2002. Integrating stakeholder imagination with scientific theory: a case study of Lake Lanier, USA. A.E. Rizzoli and A.J. Jakeman (eds): Integrated Assessment and Decision Support. Proceedings from the 1st Biennial Meeting, International Environmental Modelling & Software Society (2), pp31–36.

Osidele, O.O. and M.B. Beck. 2001. Analysis of uncertainty in model predictions for Lake Lanier, Georgia. J.J. Warwick (ed.): Water Quality Monitoring and Modeling. Proceedings from the 2001 Annual Spring Specialty Conference of the American Water Resources Association, Middleburg, Virginia.

Osidele, O.O. and M.B. Beck. 2001. Analysis of uncertainty in model predictions for Lake Lanier, Georgia. K.J. Hatcher (ed.). Proceedings from the 2001 Georgia Water Resources Conference, University of Georgia, Athens, Georgia.

Osidele, O.O., M.B. Beck and B.D. Fath. 2000. A case study in integrating stakeholder concerns with the water sciences. Proceedings from the 7th National Hydrology Symposium, British Hydrological Society, University of Newcastle, Newcastle upon Tyne, England.

Fath, B.D., M.B. Beck and O.O. Osidele. 2000. Stakeholder preferences of water quality parameters: a case study of Lake Lanier, Georgia, USA. EcoSummit 2000, Halifax, Nova Scotia, Canada.

Osidele, O.O. and M.B. Beck. 1999. Identifying key model parameters in matching observed past and possible future behaviors for Lake Oglethorpe, Georgia. K.J. Hatcher (ed.). Proceedings from the 1999 Georgia Water Resources Conference, University of Georgia, Athens, Georgia. Winner, Best Student Paper in the Physical Sciences.

Awards and Honors:

Invited Reviewer, Integrated Modeling Workgroup, National Advisory Council for Environmental Policy and Technology, 2008

John Mann Mentor Distinguished Mentor Award, The Geologic Society of America, 2005

Best Theoretical Paper Award, Environmental & Water Resources Institute, 2004

Invited Speaker, International Workshop on Uncertainty, Sensitivity, and Parameter Estimation for Multimedia Environmental Modeling, Interagency Steering Committee on Multimedia Environmental Modeling, 2003

IDEAS Grant, University of Georgia, 2001

John "Alec" Little Water Resources Scholarship, University of Georgia, 1999

EPA STAR Grant, University of Georgia, 1998–2001

Victor Appleby Prize for Engineering Hydrology, Imperial College, London, 1992

Foreign and Commonwealth Office Scholarship, The British Council, 1991–1992

BRADLEY A. WERLING

Current Position:

Research Scientist
Environmental Assessment and Hydrology
Center for Nuclear Waste Regulatory Analyses
Geosciences and Engineering Division
Southwest Research Institute®

Experience:

Mr. Werling has 18 years' experience in environmental science and chemistry. Mr. Werling has conducted environmental review activities both reviewing and preparing NEPA documents. Mr. Werling contributed to many environmental assessments for various Nuclear Regulatory Commission-regulated sites including several uranium recovery environmental impact statements. He has provided technical input for NEPA documents in several resource areas including air quality, land use, socioeconomics, and noise. In 2007, Mr. Werling successfully completed the NEPA certificate program as part of the Duke University Environmental Leadership Program cosponsored by the Council on Environmental Quality.

Mr. Werling has a strong background in chemistry. He has provided laboratory and field support for GED research on radionuclide transport in natural systems since joining the division in 2000. Mr. Werling has conducted mineral solubility and sorption experiments. He has led groundwater sampling campaigns to better characterize saturated zone water chemistries potentially important to radionuclide transport, and has used techniques such as atomic adsorption spectroscopy, total organic carbon oxidation, and infrared spectroscopy for chemical and mineralogical analyses. Mr. Werling has served as the division's hazard communication program manager and laboratory chemical hygiene officer. Before joining GED, Mr. Werling worked in the Chemistry and Chemical Engineering Division where he performed gas chromatography analyses and gained experience maintaining the instruments and optimizing analytical procedures.

Special Expertise:

NEPA document preparation or review
Gas chromatography analyses

Education:

2000 M.S., Environmental Science, University of Texas at San Antonio
1999 B.S., Chemistry, Southwest Texas State University
1985 B.A., Engineering Physics, Westmont College, Santa Barbara

Previous Positions:

Southwest Research Institute:
- Scientist, 1990–1993
- Research Scientist, 1993–1996
- Scientist, 1999–2004
- Research Scientist, 2004–present

Professional Registrations and Affiliations:

National Association of Environmental Professionals
Air and Waste Management Association
Geological Society of America

Publications and Presentations:

Bertetti, F.P. and B. Werling. 2005. Sorption of Neptunium-237 on Alluvium Collected from Fortymile Wash, Nye County, Nevada. San Antonio, Texas: CNWRA.

Bertetti, F.P., J. Prikryl, and B. Werling. 2004. Development of Updated Total-System Performance Assessment Parameter Distributions for Radionuclide Transport in the Saturated Zone. San Antonio, Texas: CNWRA.

Bertetti, F.P., J. Prikryl, and B. Werling. 2001. Summary of Early Warning Drilling Program Data Relevant to Radionuclide Transport in the Alluvium South of Yucca Mountain, Nevada. San Antonio, Texas: CNWRA.

Nes, R., J. Russell, and B. Werling. 2004. Dose Assessment for Compliance with the Radiological Criteria for License Termination at the Dow Chemical Company Site at Bay City, Michigan. San Antonio, Texas: CNWRA.

Contributor:

NRC. August 2010. Environmental Impact Statement for the Moore Ranch ISR Project in Campbell County, Wyoming. Washington, DC: U.S. Nuclear Regulatory Commission.

NRC. January 2011. Environmental Impact Statement for the Nichols Ranch ISR Project in Campbell and Johnson Counties, Wyoming. Washington, DC: U.S. Nuclear Regulatory Commission.

NRC. May 2009. Final Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities. Washington, DC: U.S. Nuclear Regulatory Commission.

NRC. May 2009. Environmental Assessment for the Renewal of U.S. Nuclear Regulatory Commission License No. SNM-1097 for GNF-Americas, Wilmington Fuel Fabrication Facility. Washington, DC: U.S. Nuclear Regulatory Commission.

NRC. September 2008. U.S. Nuclear Regulatory Commission Staff's Adoption Determination Report for the U.S. Department of Energy's Environmental Impact Statements for the Proposed Geologic Repository at Yucca Mountain. Washington, DC: U.S. Nuclear Regulatory Commission.

NRC. June 2008. Environmental Assessment for the Renewal of U.S. Nuclear Regulatory Commission License No. SNM–1227 for AREVA NP, Inc. Richland Fuel Fabrication Facility. Washington, DC: U.S. Nuclear Regulatory Commission.

NRC. April 2007. Environmental Assessment for the Renewal of U.S. Nuclear Regulatory Commission License No. SNM-1107 for Westinghouse Columbia Fuel Fabrication Facility. Washington, DC: U.S. Nuclear Regulatory Commission.

CNWRA. July 2006. Center for Nuclear Waste Regulatory Analyses Review Comments on the U.S. Department of Energy Report Titled: Draft Environmental Assessment for the Proposed Infrastructure Improvements for the Yucca Mountain Project, Nevada. San Antonio, Texas: CNWRA.

NRC. September 2005. Environmental Assessment Related to the Renewal of NRC License No. SNM–42 for BWX Technologies, Inc. (BWXT). Washington, DC: U.S. Nuclear Regulatory Commission.

NRC. June 2002. Environmental Assessment for Proposed License Amendments to Special Nuclear Material License No. SNM–124 Regarding Downblending and Oxide Conversion of Surplus High-Enriched Uranium. Washington, DC: U.S. Nuclear Regulatory Commission.

CLEAR CREEK ASSOCIATES

MICHAEL ALTER, R.G., P.G.

Principal Hydrogeologist

Mine Water Management
Aquifer Studies/Remedial Investigations
Environmental Permitting Support
Pit Lakes
ARD and Contaminant Fate Analyses

M.S., Geology, Arizona State University, 1994
B.S., Geology, Virginia Polytechnic Institute and State University, 1992

Registered/Professional Geologist: Virginia (2009) No. 1814; Arizona (1998) No. 33261; Pennsylvania (2009) No. 4867; AIPG CPG (2010)

Clear Creek Associates, Leesburg, Virginia from August 2009
Clear Creek Associates, Tucson, Arizona 1999 to 2009
Dames & Moore Group, Tucson, Arizona 1997 to 1999
Dames & Moore Inc., Phoenix, Arizona 1995 to 1997

Michael (Mike) Alter is a Principal Hydrogeologist who specializes in managing large-scale aquifer and remedial investigation studies and groundwater supply and development programs. His recent focus has been assisting clients with hydrogeologic and groundwater issues pertaining to mining and industrial operations. His mining related expertise includes geochemistry of mine materials and solutions, mine facility siting, mine pit hydrology and pit lake geochemistry, regulatory guidance for mining projects, permit acquisition, and mine contaminant transport in bedrock and basin-fill settings. Mr. Alter has worked on mine water management and hydrogeologic studies at various North American mining sites since 1995.

Mine-Related Project Experience

Cyprus Tohono Corporation, Groundwater Remedial Investigation, Cyprus Tohono Mine, Tohono O'odham Nation, Arizona (since 2001)
Mr. Alter has served as the technical lead and Remedial Investigation (RI) Manager for Remedial Investigation of mining-related groundwater impacts at the Cyprus Tohono Mine, an inactive copper mine in Central Arizona since 2001. A primary component of this characterization and remediation project involves an evaluation of the generation, fate, and transport of radionuclides, including uranium and its decay elements, in mine materials, soil, and groundwater. Mr. Alter was responsible for constructing and using a groundwater and contaminant transport model to simulate radionuclide transport at the Site. Mr. Alter also managed field investigations associated with the groundwater RI, including the siting, design, and construction oversight of over 60 monitor wells. Also responsible for preparing RI scope of work and related RI planning documents, including plans for groundwater monitoring, quality assurance, and health and safety.

Conceptual Site Hydrogeologic Model Development, Climax Molybdenum, Henderson Mill, Henderson, Grand County, Colorado
Mr. Alter is responsible for developing a conceptual site hydrogeologic model of an existing mill tailings impoundment for a metals mine located in the Colorado Front Range. The location of the site above 9,000 feet contributes to high winter snowpacks and large spring surface runoff, creating a challenging setting for water management. Mr. Alter completed a review of the site geology and hydrogeology and is using this information to develop a plan for future monitoring at the site.

CLEAR CREEK ASSOCIATES

MICHAEL ALTER, R.G.

Asarco Inc, Hayden Smelter, Hayden, Arizona
Mr. Alter is currently providing environmental permitting support for groundwater permitting to accommodate continued operations at Asarco's Hayden Mill and Smelter facility, in Hayden, Arizona

Historical Operations Assessment of Potential Groundwater Impacts, New Cornelia Mine, Ajo, Arizona (2007-2008)
Technical lead and project manager during completion of review of historical operations and an assessment of potential groundwater impacts, including Technologically-Enhanced Naturally Occuring Radionuclides, in the area of the New Cornelia Mine in Ajo, Arizona.

Phelps Dodge Mining Company, Multiple Locations (2004)
As subcontractor to engineering consulting firm, Mr. Alter conducted analysis of community water systems operated by PDMC to identify potential in-well or new well strategies to bring each water utility into compliance with future arsenic standard. Evaluations were performed for water systems in Ajo, Baghdad, and Sierrita. For each site, Mr. Alter developed list of potential well rehabilitation and well siting alternatives.

Pinal Creek Group, Claypool, Arizona (2000-2002)
Project Manger for the siting, design, and installation of three deep production wells, two domestic wells, and two deep exploratory borings. The production wells were installed to meet local water supply needs. Each of the three completed production wells yielded high-quality water at rates that exceeded expectations.

Mine Development/Water Supply Development, Freeport-McMoRan Miami Operations, Claypool, Arizona (2007 – 2008)
Project Manager for the installation and testing of three new water wells to support Miami Smelter operations. Well designs were prepared based on the results of exploration drilling conducted in 2001. Each well met production goals.

Mine Development/Water Supply Investigation, Lone Star Mine, Safford, Arizona (2007 – 2008)
Senior Hydrogeologist for study to evaluate the feasibility of developing a groundwater supply to support a future mine in southeastern Arizona. The objective was to characterize the potential of a local bedrock aquifer to supply water for mine operations.

Permitting Support for Mine Development Feasibility Study, Freeport-McMoRan Copper Queen Branch, Bisbee, Arizona (2007 – 2008)
Project Manager for preparing an Aquifer Protection Permit (APP) application that would accommodate resumed mining operations at the Copper Queen mine.

Permitting Support for Mine Development Feasibility Study, New Cornelia Mine, Ajo, Arizona (2007 – 2008)
Project Manager for preparing an Aquifer Protection Permit (APP) application that would accommodate resumed operations at an inactive Arizona copper mine.

Pit Hydrology Study, Freeport-McMoRan Bagdad Mine, Bagdad, Arizona (2006)
Project Manager for hydrogeologic study of the Bagdad mine pit. The objective was to evaluate the effectiveness of on-going mine pit dewatering activities. Field activities to date included test well drilling and analysis, groundwater quality sampling, isotopic analyses, and various aquifer tests comprising both falling head tests and long-term pumping and

CLEAR CREEK ASSOCIATES

MICHAEL ALTER, R.G.

recovery tests.

Morenci District Fresh-Water Supply Development Project (1996-1998)
Served as field manager on groundwater investigation and water resources development project to identify 10,000 additional gallons per minute of fresh water to be used for mining operations. Responsibilities included supervising multiple drilling subcontractors and a field team of up to 10 geologists. Directed the siting, drilling, installation, and aquifer testing of over 40 test wells and 15 production wells.

Arizona Geological Society (Past President 2003)
American Institute of Professional Geologists
Arizona Hydrological Society
Society of Mining, Metallurgy, and Exploration, Inc.
Virginia Water Well Association
Arizona Water Well Association

MSHA – New Miner (Surface Metal/Nonmetal)
MSHA – Annual Refresher Training
OSHA – 40 Hour HAZWOPER Training
OSHA – 8 Hour Health and Safety Supervisor
OSHA – 8 Hour HAZWOPER Refresher Training

Daniel Meges

Economist & Business Development Manager

Daniel joined Chmura Economics and Analytics in 2011 as an economist and business development manager. Prior to joining the Chmura team, Daniel worked eight years as an economist for the U.S. government, specializing in economic development, international assistance, and trade policy. In this capacity he travelled widely in Europe while advancing U.S. foreign policy and serving as a special advisor for political affairs for two U.S. ambassadors. Daniel has wealth of experience in conveying the functioning of complex economic systems and economic trends to senior policy makers in accessible and easily absorbable format. Daniel also has deep experience in industrial and labor relations, having worked several years in the auto and steel industries in the capacity of a human resources/labor relations manager.

PROFESSIONAL EXPERIENCE

Chmura Economics & Analytics **2011 – Present**

Economist & Business Development Manager

- Works with clients to provide tailored economic studies and customized software solutions that meet or exceed our clients' expectations so as to help our clients realize their business goals.
- Research, analyze and advise our clients on trends in local, state, and national labor market.
- Serves as Chmura's media contact for the Mid Western states, and manages Chmura's marketing strategy.

U.S. Department of State **2007 – 2011**

Political/Economic Officer- Europe

- Worked with U.S. and foreign government officials, business leaders, and opinion makers to promote national security and implement U.S. economic and trade policy in the global economy.
- Researched, advised, analyzed and interpreted the economic policies and business practices of foreign countries in order to advance U.S. economic interests.
- Served as the Political Advisor (2008-2010) to the U.S. Ambassador to Croatia regarding internal politics, regional relations, and bilateral disputes.

U.S. Central Intelligence Agency **2003 – 2007**

Lead Economist- Central and Southeastern Europe

- Prepared analytical reports and studies, and delivered briefings for high level U.S. policy makers on a variety of socioeconomic and financial issues.
- Full command of written research/assessment products, briefing, and editing skills with substantial expertise applied to in depth studies of financial and industrial sectors and public policy analysis.

- Lead economist and leadership analyst working Southeastern European countries providing economic analysis and leadership profiles covering economic developments, regional issues, and political economy dynamics.

Shiloh Industries Incorporated **2000 – 2001**

Human Resources/Labor Relations Manager

Eaton Corporation **1996 – 1999**

Human Resources/Labor Relations Generalist

EDUCATION

Loyola University Chicago, Chicago, Illinois	MBA	Finance	2003
University of Chicago, Chicago Illinois	MA	International Relations/Development Economics	2002

Thesis: Croatian Economic Development-The Orchestration of Economic Growth through the Labor Market
Co chair: Merck funded Slovakia Economic Research Team;
Co-author Slovakia- Political and Economic Stability

Cornell University, Ithaca, New York	B.S.	Industrial & Labor Relations	1997

4 PLAN FOR MEETING STATEMENT OF NEEDS

The relatively short timeframe for completing this project will require efficient use of the expertise of the project team. Many of the topics and issues in the Statement of Needs were identified in the National Academy of Sciences study of uranium mining in Virginia[3], could be the subject of their own individual projects, and we view such a level of effort as outside the scope of this project and inconsistent with timeframe for meeting the needs of the Workgroup. For this reason, we will use the experience and expertise of our staff to focus our efforts on advising the Workgroup on the key issues that will need to be addressed by regulations and guidance for uranium mining, milling, and waste management in Virginia. Particular emphasis will be placed on identifying aspects and, if appropriate, gaps in existing Federal, state, and international regulations and guidance that may need to be addressed to meet the special environmental setting of Virginia.

In order to meet the timeframe of the project, most of the tasks required by the Statement of Needs will be performed in parallel and will be scheduled to be completed so that particular tasks can be reviewed during the monthly Workgroup meetings. Figure 4-1 provides a tentative schedule for completion of tasks based on our assessment of their regulatory priority and complexity. This proposed schedule will be discussed and, if necessary, revised based on discussions at the kickoff meeting. This schedule assumes that a contract is awarded by April 30, 2012

Our proposed approaches to specific items in the Statement of Needs, identified by the correspondence test in the Request for Proposal, are described as follows.

III. A Statement of Needs—Initial Literature Review and Recommendations

> • *Virginia & Other Relevant Studies: Utilizes summaries prepared by the Workgroup of existing Virginia uranium mining studies (National Academy of Sciences/National Academies Press [NAS/NAP], Virginia Beach, Fairfax, Roanoke River Basin Association, Chmura Economics and Analytics, and RTI International, and the 1984 Senes Assessment of Risk and associated Uranium Task Force Report), as well as other relevant studies, and makes recommendations concerning findings of these studies that are relevant to Virginia's existing regulatory framework that would apply to uranium mining and milling.*
>
> • *Existing Regulatory Programs: Compares existing uranium mining and milling regulatory programs including Nuclear Regulatory Commission (NRC), any agreement state programs, and international programs (such as Australia, Canada and France), and recommends provisions from within those regulatory programs that are relevant to the Commonwealth and would be effective in Virginia.*
>
> • *International Emerging Standards: Summarizes pertinent information and studies from such groups as the International Atomic Energy Agency, the World Nuclear Association, etc. and provides recommendations based on this review that are relevant to the Commonwealth's regulation of the life span of uranium mining and milling including recommendations regarding modem best international practices and other emerging standards and technologies. Identify internationally accepted best practices that can be implemented to mitigate the risk of radioactive*

[3]National Academy of Sciences. 2011. "Uranium Mining in Virginia: Scientific, Technical, Environmental, Human Health and Safety, and Regulatory Aspects of Uranium Mining and Processing in Virginia."

Statement of Needs	Project Week																									
	30-Apr	7-May	14-May	21-May	28-May	4-Jun	11-Jun	18-Jun	25-Jun	2-Jul	9-Jul	16-Jul	23-Jul	30-Jul	6-Aug	13-Aug	20-Aug	27-Aug	3-Sep	10-Sep	17-Sep	24-Sep	1-Oct	8-Oct	15-Oct
Kickoff Meeting	■																								
III.A Initial Literature Review and Recommendations			M																						
III.B.1 Coordination with Workgroup Meetings/Conference Calls		C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	
III.2 Assist the Workgroup in Preparing Reports Meetings				M				M				M				M				M			M		
III.2.a Water Quality Monitoring for Surface Water					▒	▒	▒	X																	
III.2.b Water Quality Monitoring for Groundwater					▒	▒	▒	X																	
III.2.c Air Quality Monitoring Plan									■	■	■	X													
III.2.d Adequacy of Virginia's Water Quality Standards													■	■	■	X									
III.2.e Standards for Safe Disposal of Mine Waste													■	■	■	X									
III.2.f Engineering Designs and Best Management Practices																				X					
III.2.g Necessary Components of a Full Environmental Impact Analysis		■	■	X																					
III.2.h Methods for Incorporating ALARA Standards						▒	▒	X																	
III.2.i Methods for Addressing Risk of Catastrophic Events	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	X									
III.2.j Identification of Life Span Financial Assurance Mechanisms				▒	▒	▒	▒	▒	▒	▒	▒	X													
III.2.k Evaluation of Validity of Site-specific Data																		■	■	X			X		
Draft Final Report																									
Final Report																									X

Shaded Area = Work Period
X = Presentation to Workgroup
C = Conference Call or On-Site Meeting
M = Workgroup Meeting

Figure 4-1. Tentative Schedule for Completion of Tasks

releases, discussing technologies available to reduce emissions and maintain a focus on pollution prevention and reduction.

CNWRA/SwRI Staff: Principal Investigator G. Walter
C. Manepally
S. Hsiung
A. Ghosh

Subcontractor Staff: Clear Creek Associates, M. Alter

CNWRA will review the relevant studies, standards, and guidance. Given the short timeframe for this work and purpose of the review, we will organize our findings in the form of

- Tables showing findings from the previous studies and their relationship to existing regulatory framework applicable to uranium mining and milling in Virginia;
- Tables that compare NRC, other regulations and guidance such as agreement state, other countries, and international organizations . Measures for comparison will be defined such as dose to the public, design standards, operational standards, application of ALARA. Standards that are suitable for applicable to uranium mining and milling in Virginia will be identified;
- Tables that identify potential gaps in NRC and international regulations and guidance with respect to environmental conditions in Virginia;
- List of recommendations based on the above analysis to address regulatory gaps, if any;
- Prepare summary of international recommendations for mitigating environmental risks from uranium mining, milling, and ore processing.

These findings and tables will be presented in the initial report for Statement of Needs item III.A.

III. B. Statement of Needs—Coordination With Workgroup

1. Coordinate with the Workgroup through at least monthly progress meetings to develop analyses of the following items and to develop and provide a final report. The contractor must be available to meet with the Workgroup, either face-to-face or via conference calls, as needed to develop interim deliverables and the final report that:

a. Compares recommendations in the initial report (referenced in A. above) to the statutory jurisdictions of the DEQ and DMME;

b. Identifies areas where regulatory coverage might need to be created, modified or expanded to ensure protection of public health and the environment with respect to the lifespan of mining and milling projects in Virginia and long-term site monitoring requirements;

c. Recommends changes (including statutory changes) to meet these needs.

CNWRA/SwRI Staff: Project Manager, P. Mackin
Other subject matter experts, as needed

Subcontractor Staff: Clear Creek Associates, M. Alter

The CNWRA team will closely coordinate their work with the Workgroup to avoid any missteps. We propose a brief (less than a half-hour) call once a week and a more extensive meeting once a month. Brief written minutes of such meetings will be kept and provided to all team members. The meetings could be face-to-face or by conference calls as needed to address the needs expressed in III.B.1. Although the CNWRA project manager and several of the key staff are based in San Antonio, Texas, the project manager travels to the District of Columbia area routinely, and we have extensive in-house video conferencing capabilities in San Antonio. Mr. Michael Alter, key staff for Clear Creek, is based in Leesburg, Virginia, and key staff for Chmura are based in Richmond, Virginia, so that they also can easily interact with the Workgroup and coordinate with the CNWRA staff. These coordination meetings will be focused on assuring the project needs are met at the requisite level of detail. Specifically, (i) the correspondence between the recommendations developed in reference A and the statutory jurisdiction of the DEQ and DMME will be examined and (ii) any modifications to existing regulations or addition of new requirements to protect public health and safety will be discussed.

III. B. 2. a. Statement of Needs—Water Quality Monitoring for Surface Water

(1) Ecological risks associated with radiological toxicity and radiation exposure;
(2) Impacts of mine dewatering activities;
(3) Tracking and minimizing the impacts of elevated concentrations of trace elements;
(4) Impacts of land disturbance activities and surface water run-off; and,
(5) Potential for long-term water quality degradation.

CNWRA/SwRI Staff: Principal Investigator G. Walter
C. Manepally
O. Osidele
A. Ghosh

Subcontractor Staff: Clear Creek Associates, M. Alter

The potential impacts of uranium mining, milling, dewatering, and transportation to surface water quality and quantity, and aquatic organisms can vary from physical disturbance of natural drainage due to mining and waste disposal to physical degradation of aquatic habitat from sediment runoff to releases of chemicals and radionuclides including trace elements. In general, these potential impacts have been identified in the National Academy of Sciences study of uranium mining in Virginia and other studies of uranium mining, milling, and waste disposal, such as the Generic Environmental Impact Statement for *In-Situ* Leach Uranium Milling Facilities[4]. The CNWRA team will focus its efforts on evaluating for adequacy and completeness existing regulatory frameworks and guidance addressing these potential impacts and on identifying any regulatory modifications or extensions needed with respect to the mining and hydrologic environment of Virginia. With respect to mine dewatering impacts to surface water, the CNWRA team will review the geologic and hydrologic setting of uranium ore deposits in Virginia, particularly Coles Hill, and advise the Workgroup as to whether mine dewatering is

[4]NRC. NUREG–1910, "Generic Environment Impact Statement for *In-Situ* Leach Uranium Milling Facilities." Washington, DC: U.S. Nuclear Regulatory Commission. 2009.

likely to be a significant issue with respect to open pit or underground mining at these locations. Site specific assessment of potential mine dewatering impacts is outside the scope of this statement of work.

III. B. 2. b. Statement of Needs—Water Quality Monitoring for Groundwater

(1) The potential impacts on groundwater associated with the construction, operation and decommissioning of a mine, mill and tailings facility;

(2) The threats to groundwater quality related to failure of structures designed to limit movement of contaminants from the tailings into surrounding groundwater and issues associated with inadequate hydraulic isolation in below grade disposal facilities;

(3) Effects of mine dewatering on groundwater quality and quantity;

(4) Effects of mine flooding on groundwater quality and quantity; and,

(5) Effects of exploratory bore holes on groundwater quality.

CNWRA/SwRI Staff: Principal Investigator G. Walter

Subcontractor Staff: Clear Creek Associates, M. Alter

The potential impacts of uranium mining, milling, and waste management on groundwater water quality and surface water quantity have been identified in the National Academy of Sciences study of uranium mining in Virginia and other studies of uranium mining, milling, and waste disposal, such as the Generic Environmental Impact Statement for *In-Situ* Leach Uranium Milling Facilities[4], and through experience with hard mining in general. The CNWRA team will focus its efforts on advising the Workgroup on existing regulatory frameworks and guidance addressing these potential impacts and on identifying any regulatory gaps with respect to the mining and hydrologic environment of Virginia. With respect to the effect of exploratory boreholes on groundwater quality, the potential impacts are highly site-specific, depending on the composition of the ore body being penetrated and local hydrogeologic conditions. These impacts can usually be eliminated by proper surface casing and abandonment of bore holes. The CNWRA team will review existing mining regulations and regulations of states with hard rock mining to identify relevant and appropriate exploratory bore hole regulations with respect to the geologic and hydrologic conditions expected at potential uranium mining sites in Virginia. An assessment of exploratory bore hole groundwater quality impacts at specific sites is outside the scope of this statement of work.

III. B. 2. c. Statement of Needs—Air Quality Monitoring Plan

(1) Evaluation of technologies;

(2) Release of particulate matter from wind erosion of ore stockpiles, waste rock, mine tailings, processing facilities, and mine blasting;

(3) Mobilization of contaminants;

(4) Adequacy of the U.S. Environmental Protection Agency's National Emissions Standards for Hazardous Air Pollutants (NESHAP) for radon;

(5) The emission of radon from waste rock piles, ore stockpiles and windblown particulates;

(6) The potential for the release of radon from evaporation ponds and tailings impoundments; and,

(7) The release of radon during dewatering activities.

CNWRA/SwRI Staff: Principal Investigator J. Durham
B. Werling

The project team will evaluate the processes associated with uranium mining, processing, transportation, and waste management that may result in releases of radionuclides and other toxics to the atmosphere. The project team will review existing standards and regulations governing radon and particulates with respect to their adequacy for regulating exposures from uranium mining activities in Virginia. Standards that could possibly apply include the following:

U.S. Nuclear Regulatory Commission

- 10 CFR 20 Appendix B - Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of radionuclides for occupational exposure
- 10 CFR 40 Appendix A - Criteria 8 - ALARA requirements for airborne effluent releases from milling operations

U.S. Environmental Protection Agency

- 40 CFR 192 - Health and environmental protection standards for uranium and thorium mill tailings
- 40 CFR 61 - NESHAPs for radon emissions from the disposal of uranium mill tailings (Subpart T) and operating mill tailings (Subpart W)
- 40 CFR 50.6 (a) and 40 CFR 50.7(a) - Primary and secondary ambient air quality standards for PM_{10} and $PM_{2.5}$, respectively

The project team's analysis will be presented to the Workgroup in the form of tables that identify the relevant exposure pathways, relevant existing regulations, and potential gaps in the existing regulatory framework. The team will provide recommendations for appropriate monitoring requirements. While developing detailed requirements for site specific monitoring is outside the scope and timeframe for this project, the recommendations developed in this task will be able to be used to design and/or evaluate a site-specific system.

III. B. 2. d. Statement of Needs—Adequacy of Virginia's Water Quality Standards

(1) Water-soluble radionuclides or absorbed chemicals;

(2) The potential for the increase in radioactivity concentrations in a river/reservoir system and the exceedance of the Maximum Contaminant Level (MCL) established for radiological

contaminants for drinking water, recreational use, irrigation, agricultural use, and other non-potable uses;

(3) A sampling protocol and regulatory oversight for radiological contaminants in surface water and groundwater;

(4) The potential for undiluted tailings liquids to exceed existing Safe Drinking Water Act standards for uranium; and,

(5) Identify additional water quality criteria if needed.

CNWRA/SwRI Staff: Principal Investigator O. Osidele
C. Manepally

Radionuclides associated with uranium mining have a potential to impact water quality, if not properly managed. These impacts can come from regulated point sources and fugitive emissions to both air and water from milling processes, piles, ponds, and transportation facilities. Existing Federal and Commonwealth of Virginia water quality standards for radionuclides are limited to combined radium-226 and radium-228, radon, total uranium, gross alpha particles, and beta and photon emissions. There are no specific water quality standards for other radionuclides, such as uranium and thorium daughter products. The CNWRA term will review the scientific basis for these standards and develop recommendations with respect to the adequacy and completeness of existing standards to address the full range of radionuclides likely to be released from the types of uranium ore bodies present in Virginia. Our experience in reviewing license applications indicates that current regulations may not include requirements to monitor the complete range of radionuclides that may impact public health and the environment.

Because the Virginia uranium deposits are significantly different from western roll front uranium deposits, the types of radionuclides and other contaminants released from mining and ore processing may be different from those released from roll front deposits. In Virginia, deposits with potentially viable uranium mineralization occur in granites, pegmatites, and related host rocks that have been metamorphosed to varying degrees. There are uranium occurrences in shale and sandstone that are more like western roll front deposits, but those Virginia occurrences are unlikely to be economic in the foreseeable future.

In most of the Virginia granitoid-hosted deposits the main uranium-containing minerals are allanite, autunite, uranothorite, monazite, thorogummite, and uranophane. There tends to be a strong association with thorium, although information provided in the National Academy of Sciences study of uranium mining in Virginia does not indicate that thorium is elevated in the Coles Hill deposit.

Although surface and groundwater standards can be applied in a relative straightforward manner to the monitoring of potential point sources of radionuclides at mining facilities, they may also be exceeded in water bodies distal from the mining facility and potentially attributable to multiple point and non-point sources in the water shed because naturally occurring radioactive materials are not limited to economic uranium ore bodies.

The project team will review existing studies on the distribution of naturally occurring radioactive materials in Virginia and water quality databases to evaluate if current water quality standards for radiation and radionuclides in the areas of potential uranium mining are close to being exceeded. The project team will then develop recommendations on whether fugitive emissions

from uranium mining and transportation activities would likely cause exceedances of water quality standards in the future. This evaluation will be limited to a qualitative discussion of the issue for the purpose of guiding the development of regulations and monitoring strategies because an in-depth analysis is beyond the time frame available for this project.

III. B. 2. e. Statement of Needs—Standards for Safe Disposal of Mine Waste

(1) The potential of serious environmental problems resulting from acid mine drainage or other leachate from mine waste;

(2) Segregation and safe disposal of sub-ore grade waste rock;

(3) The safe control and disposal of uranium tailings;

(4) Mitigation of contaminants from existing sources (e.g., tailings, ore stock piles and waste rock piles) to both groundwater and surface water; and,

(5) To address on-site workers health and safety.

CNWRA/SwRI Staff: Principal Investigator P. Mackin
A. Ghosh
C. Manepally

Subcontractor Staff: Clear Creek Associates, M. Alter

The issues addressed in this statement of needs are wide-ranging and their significance will depend on the specific mining, ore processing, and waste management practices adopted for a specific ore body and mine. Our work related to this particular Statement of Needs will consist of summarizing existing best management practices that address these issues and assisting the Workgroup in developing a regulatory framework that is flexible enough to cover the range of mining, processing, and waste management activities that may reasonably occur in Virginia, which will most likely consist of surface mine pits, overburden piles, sub-ore grade waste rock, and, possibly, on-site milling wastes to impoundments.

III. B. 2. f. Statement of Needs—Engineering Designs and Best Management Practices

(1) Minimizing the ecological risks from the loading and transportation of the uranium product and chemicals used in the processing operation;

(2) Minimizing the impacts of accidents or natural disasters or management oversight failures that impair the normal operations of the mining, processing, tailings management, or water treatment facilities;

(3) Minimizing the exposures to humans and populations of aquatic and terrestrial biota to elevated levels of radionuclides and other hazardous substances;

(4) Minimizing the exposures of the public to elevated levels of radionuclides and other hazardous substances; and,

(5) Determining if an effective hydrogeological model is available for use at potential sites.

CNWRA/SwRI Staff: Principal Investigator P. Mackin
A. Ghosh
S. Hsiung

Subcontractor Staff: Clear Creek Associates, M. Alter

We propose addressing this Statement of Needs as two distinct activities. The first is to provide the Workgroup with recommendations on engineering designs and Best Management Practices (BMPs) to minimize releases of radionuclides and other contaminants associated with uranium mining and milling activities to the environment. With the exception of vapor phase releases of radon, engineering designs and BMPs for hard rock uranium mining, milling, and waste management are not significantly different than those for other hard rock mines. The project team will (i) review the wealth of guidance on BMPs that exists for controlling releases from hard rock mining-related activities including uranium mining and mill tailings impoundments, (ii) compare them to existing mining regulations in Virginia, and (iii) advise the Workgroup on any gaps that may exist with respect to the climatic and other environmental conditions in Virginia. Regulations and guidance also exist for controlling radon emissions from uranium mines, ore processing, and waste management. The project team will also review these materials, provide recommendations as to which existing regulations and guidance are most appropriate for Virginia, and identify any gaps that may require developing new regulations and guidance appropriate to the climate and other environmental conditions in Virginia.

The second activity will be to determine if an effective hydrogeological model is available for use at potential sites. We interpret this need as "Can groundwater flow and contaminant transport at potential uranium mining sites in Virginia be reliably simulated using mathematical models." A wide range of mathematical models are available for simulating groundwater flow and contaminant transport in both porous and fractured media. The practical issue in judging the reliability of these models for a particular site is whether or not the hydrogeologic conditions and contaminant transport properties at the site can be adequately characterized so that the models make reliable predictions. Conditions at some sites may be so complex that adequate characterization to support modeling might be extremely difficult or expensive. To address this question, the project team will review the geologic and hydrologic conditions at potential uranium mining sites in Virginia, and, based on its experience, provide the Workgroup with a qualitative assessment of the issues and difficulties in modeling these sites.

III. B. 2. g. Statement of Needs—Necessary Components of a Full Environmental Impact Analysis

> *(1) Timing of the environmental impact analysis;*
> *(2) Required components, including baseline and characterization data needed; and,*
> *(3) Legal requirements.*

CNWRA/SwRI Staff: Principal Investigator R. Lenhard

The project team will provide the Workgroup with an outline of an environmental impact analysis for a uranium mining site in Virginia based on NEPA requirements for environmental assessments and impact statements. We note, however, that NEPA requirements apply to federal actions and while many of the components to a NEPA environmental impact assessment would be relevant to a uranium mine, some may not apply to a private action on private land. The Commonwealth of Virginia also requires an environmental impact report for

state actions (http://www.deq.virginia.gov/eir/stateimpact.html). The project team will compare the requirements of NEPA and the Commonwealth of Virginia for consistency and identify those requirements relevant to uranium mining on private land, and identify any gaps in these requirements that might need to be filled in performing a full environmental impact of uranium mining in Virginia.

III. B. 2. h. Statement of Needs—Methods for Incorporating ALARA Standards

Methods for incorporating "As Low As Reasonably Achievable" (ALARA) standards into Commonwealth regulations of uranium mining and milling.

CNWRA/SwRI Staff: Principal Investigator J. Durham

ALARA is a radiation safety principle that requires that exposure to radiation should be maintained at as low a level as is reasonably achievable. This safety principle is based on the linear no-threshold assumption made in describing the relationship between the radiation dose and the consequent health effects. The linear no-threshold assumption asserts that radiation-related health effects are proportional to radiation exposure, no matter how small the exposure. Hence the smaller the exposure, the safer it is. ALARA is applied to enhance the safety by lowering the radiation dose below the maximum limit provided in applicable regulations. In other words, the intent of ALARA is to reduce the potential dose or increase the safety margin from what is built into quantitative regulatory dose limits such as 100 mrem per year in 10 CFR Part 20.

CNWRA will investigate appropriate approaches to implementing ALARA. The main methods to lower radiation dose are to (i) reduce time of exposure, (ii) increase distance between radiation source and receptor, (iii) use shielding, (iv) use reliable technology, and (iv) develop good practices such as monitoring, inspections, and action plans. The actual approach may be dependent on site conditions but it has to be "reasonably" achievable meaning that the benefits should be compatible with the additional costs. The CNWRA team proposes to develop a generally applicable method to design and evaluate ALARA techniques that may be considered for inclusion in Commonwealth regulations.

III. B. 2. i. Statement of Needs—Methods for Addressing Risk of Catastrophic Events

(1) Assessment of risks;

(2) Vulnerability Analysis for security events;

(3) Risk Analysis for natural disasters (including extreme weather events such as tornadoes, hurricanes, etc.);

(4) Minimization of both long-term and short-term environmental effects of the failure of a waste containment facility or a temporary storage area;

(5) The potential for extreme flooding events;

(6) The potential for landslides and debris flows;

(7) The potential for seismic events; and,

(8) Addressing the potential impact of failures of on-site storage facilities or accidents in the loading and transportation of chemicals on groundwater quality.

CNWRA/SwRI Staff: Principal Investigator P. Mackin
A. Ghosh
S. Hsiung

Catastrophic events in the potential uranium mining region are fundamentally related to three primary causative factors—shaking from seismic events, effects from winds and flooding due to extreme weather conditions, and transportation accidents. Catastrophic releases could also due to acts of sabotage.

CNWRA will address risk from these catastrophic events in uranium mining, milling, beneficiation, and tailings disposal activities by first analyzing the published literature on these events in the proposed uranium-mining region of the State of Virginia to identify the reasonable upper ranges for them. Once the reasonable upper ranges have been identified, best practice designs, operations, and existing risk assessments for addressing similar events at existing uranium mining-related facilities will be examined to determine whether these have proven adequate. If current regulations, designs, practices, and risk assessments have proven adequate for application to the reasonable upper ranges of effects in the proposed uranium mining areas, CNWRA will recommend examples for use in the proposed uranium mining-related activities. Otherwise, CNWRA will recommend specific additional analyses, measures, design considerations, or practices for the Workgroup to consider.

Uranium mining-related activities in the State of Virginia will be in a region of positive water balance, and currently available experience and knowledge base in the United States are generally biased toward negative water balance regions. CNWRA will give this situation special consideration in the recommendations made to the Workgroup. CNWRA will review disaster preparedness plans for catastrophic events at similar facilities with focus on limiting long-term environmental impacts and will recommend what additional measures, if any, need to be taken given the region is in the positive water balance region.

Performance of recovery actions at uranium mining and beneficiation-related facilities in the United States during and after a catastrophic event are regulated by different federal and state regulations. CNWRA will review these regulations to assess whether gaps or overlaps exist and recommend follow-up actions to the Workgroup, if needed.

III. B. 2. j. Statement of Needs—Identification of Life Span Financial Assurance Mechanisms

(1) Providing for modern mining practices for continuous rehabilitation during the life of the mining and milling operation;

(2) Ensuring that life cycle costs as well as long-term stewardship are reflected in the type of and amount of financial surety;

(3) Providing for minimization of long-term impacts to water resources;

(4) The potential financial impact on municipal and critical infrastructure related to catastrophic or operational events; and,

(5) Liability provisions for catastrophic events.

CNWRA/SwRI Staff: Principal Investigator P. Mackin
A. Ghosh
S. Hsiung

Subcontractor Staff: Chmura Economics & Analytics, D. Meges

The project team will evaluate and develop recommendations on modern mining practices that include continuous rehabilitation and how these practices affect financial assurance requirements. (Best practices for minimizing impacts to water resources will be addressed in Statement of Needs III.B.2.f and III.B.2.i).

Chmura will perform a review of industry best practices and trends, model and simulate different life-cycle cost scenarios, assess impacts on municipal and county finances in the case of low-probability adverse events, and identify and analyze analogous/corresponding financial instruments that could inform the pricing of a long-term insurance-bond.

III. B. 2. k. Statement of Needs—Evaluation of Validity of Site-specific Data

Evaluation of validity and reliability of site-specific data provided by Virginia Uranium, Inc. and its contractors, and analysis of these baseline conditions at the Coles Hill site with regard to the air, water, soil, ore and waste rock, and biota issues that the Commonwealth's uranium mining and milling regulations should be expected to address. Gap analysis of site-specific data available and what is necessary for overall understanding of issues related to statutory and regulatory framework for the protection of human health and the environment.

CNWRA/SwRI Staff: Principal Investigator G. Walter

Subcontractor Staff: Clear Creek Associates, M. Alter

The project team will review by Virginia Uranium, Inc. on the Coles Hill site with respect to the validity and adequacy of information needed by the Commonwealth of Virginia to develop a uranium regulatory framework. Data gaps will be identified and cross-referenced to the topics covered by the general Statement of Needs. This work will be performed primarily by Clear Creek under the direction of the CNWRA principal investigator.

5 PROPOSED PRICING SCHEDULE

Southwest Research Institute proposes to conduct the Uranium Study according to the Statement of Needs for a Grant Total Price of $534,699.

6 ATTACHMENT B: SUBCONTRACTING PLAN

ATTACHMENT B

Small Business Subcontracting Plan

Definitions

Small Business: "Small business " means a business, independently owned or operated by one or more persons who are citizens of the United States or non-citizens who are in full compliance with United States immigration law, which, together with affiliates, has 250 or fewer employees, or average annual gross receipts of $10 million or less averaged over the previous three years.

Women-Owned Business: Women-owned business means a business concern that is at least 51% owned by one or more women who are citizens of the United States or non-citizens who are in full compliance with United States immigration law, or in the case of a corporation, partnership or limited liability company or other entity, at least 51% of the equity ownership interest is owned by one or more women who are citizens of the United States or non-citizens who are in full compliance with United States immigration law, and both the management and daily business operations are controlled by one or more women who are citizens of the United States or non-citizens who are in full compliance with the United States immigration law.

Minority-Owned Business: Minority-owned business means a business concern that is at least 51% owned by one or more minority individuals or in the case of a corporation, partnership or limited liability company or other entity, at least 51% of the equity ownership interest in the corporation, partnership, or limited liability company or other entity is owned by one or more minority individuals and both the management and daily business operations are controlled by one or more minority individuals.

All small businesses must be certified by the Commonwealth of Virginia, Department of Minority Business Enterprise (DMBE) by the due date of the solicitation to participate in the SWAM program. Certification applications are available through DMBE online at www.dmbe.virginia.gov (Customer Service).

Offeror Name: Southwest Research Institute

Preparer Name: Eva G. Carpenter **Date:** March 28, 2012

Instructions

A. If you are certified by the Department of Minority Business Enterprise (DMBE) as a small business, complete only Section A of this form. This shall not exclude DMBE-certified women-owned and minority-owned businesses when they have received DMBE small business certification.

B. If you are not a DMBE-certified small business, complete Section B of this form. For the proposal to be considered and the offeror to be declared responsive, the offeror shall identify the portions of the contract that will be subcontracted to DMBE-certified small business in Section B.

Section A

If your firm is certified by the Department of Minority Business Enterprise (DMBE), are you certified as a (**check only one below**):

_____ Small Business

_____ Small and Women-owned Business

_____ Small and Minority-owned Business

Certification number:_____ Certification Date:_____

Section B

Populate the table below to show your firm's plans for utilization of DMBE-certified small businesses in the performance of this contract. This shall not exclude DMBE-certified women-owned and minority-owned businesses that have received the DMBE small business certification. Include plans to utilize small businesses as part of joint ventures, partnerships, subcontractors, suppliers, etc.

B. Plans for Utilization of DMBE-Certified Small Businesses for this Procurement

Small Business Name & Address DMBE Certificate #	Status if Small Business is also: Women (W) Minority (M)	Contact Person, Telephone & Email	Type of Goods and/or Services	Planned Involvement During Initial Period of the Contract	Planned Contract Dollars During Initial Period of the Contract
Clear Creek Associates 6155 E. Indian School Rd. Ste. 200 Scottsdale, Arizona 85251 Certificate # 697428	S	Doug Bartlett Dbartlett@clearcreek associates.com 703-777-4863	Literature review, attend meetings, review potential threats	Provide summary of best practices, prepare report	$76,300
Chmura Economics & Analytics 1309 East Cary Street Richmond, Virginia 23219 Certificate # 9700	WS	Dan Meges, Dan.meges@chmuracon .com 804-649-1107	Attend kickoff meeting, review industry best practices		$43,000
Totals $					$119,300

7 ATTACHMENT C: STATE CORPORATION COMMISSION FORM

ATTACHMENT C

STATE CORPORATION COMMISSION FORM

Virginia State Corporation Commission (SCC) registration information. The offeror:

☒ is a corporation or other business entity with the following SCC identification number: F1431420 **-OR-**

☐ is not a corporation, limited liability company, limited partnership, registered limited liability partnership, or business trust **-OR-**

☐ is an out-of-state business entity that does not regularly and continuously maintain as part of its ordinary and customary business any employees, agents, offices, facilities, or inventories in Virginia (not counting any employees or agents in Virginia who merely solicit orders that require acceptance outside Virginia before they become contracts, and not counting any incidental presence of the offeror in Virginia that is needed in order to assemble, maintain, and repair goods in accordance with the contracts by which such goods were sold and shipped into Virginia from offeror's out-of-state location) **-OR-**

☐ is an out-of-state business entity that is including with this offer an opinion of legal counsel which accurately and completely discloses the undersigned offeror's current contacts with Virginia and describes why those contacts do not constitute the transaction of business in Virginia within the meaning of § 13.1-757 or other similar provisions in Titles 13.1 or 50 of the Code of Virginia.

****NOTE**** >> Check the following box if you have not completed any of the foregoing options but currently have pending before the SCC an application for authority to transact business in the Commonwealth of Virginia and wish to be considered for a waiver to allow you to submit the SCC identification number after the due date for offers (the Commonwealth reserves the right to determine in its sole discretion whether to allow such waiver): ☐