

## Testimony BAPE's inquiry commission on Uranium

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My name is Doug Brugge; I have a PhD in cellular and developmental biology from Harvard University and an MS in industrial hygiene from the Harvard School of Public Health. I am currently Professor in the Department of Public Health and Community Medicine at Tufts University School of Medicine. I direct a series of studies of traffic-related air pollution and the Tufts Community Research Center. I also hold adjunct appointments at the Jonathan M. Tisch College of Citizenship and Public Service, the Sackler School of Biomedical Science and the School of Engineering. I have over 25 academic publications about uranium, including a 2006 book, The Navajo People and Uranium Mining that I co-edited with Timothy Benally and Esther Yazzie-Lewis,<sup>1</sup> original research<sup>2</sup> and recent reviews of the toxicity of uranium and radium.<sup>3</sup>

Uranium is extracted from uranium ore, which contains a broad range of toxic substances in addition to uranium itself, including many that are radioactive, some that are toxic metals and a few that exert their toxicity through both radiation and their chemical properties. Uranium itself gives rise to a series of other radioactive elements after it decays that are found in raw, natural

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<sup>1</sup> Brugge D, Benally T, Yazzie-Lewis E eds. The Navajo People and uranium. University of New Mexico Press, Albuquerque, NM, 2006.

<sup>2</sup> Dustov A, Mirojov G, Yakubova M, Umarov S, Ishankulova D, Eliasziw M, Brugge D. Uranium mine proximity, immune function and Helicobacter pylori infection in Tajikistan. *Journal of Toxicology and Environmental Health, Part A: Current Issues* 2013, 76:1261–1268; deLemos JL, Bostick BC, Quicksall AN, Landis JD, George CC, Slagowski NL, Rock T, Brugge D, Lewis J, Durant JL. Rapid dissolution of soluble uranyl phases in arid, mine-impacted catchments near Church Rock, NM. *Environmental Science & Technology* 2008, 42:3951-3957.

<sup>3</sup> Brugge D, Buchner. Health effects of uranium: new research findings. *Reviews on Environmental Health*. 2011; 26:231–249; Brugge D, Buchner V. Radium in the environment: exposure pathways and health effects. *Reviews on Environmental Health*. 2012; 27:1–17.

ore. Significant among these are radium and radon, both of which are highly radioactive. When radium decays it produces radon gas, a potent toxin. Because it is a gas that becomes airborne, when radon decays it transforms into a series of highly radioactive "radon daughters" that can lodge in the lungs.

The primary metal toxins in many uranium ores include uranium itself and arsenic, as well as vanadium, beryllium, and manganese. Clearly, uranium ore is a toxic brew of numerous nasty hazardous materials. During the processing of uranium ore, many of the contaminants are removed as uranium becomes more and more pure, although some contaminants are carried forward, at least up to a point. The milling and processing of uranium, however, is done in industrial settings that may add other toxins to the environment, such as strong acids and organic solvents, exposures that I will not address here.

As it turns out, many of the toxic and radioactive elements in uranium ore have long been studied for their effects on human health, some, such as uranium itself, for hundreds of years. Because of the deep scientific record, we know more about some of these substances than more recent, manmade chemicals only recently brought into use. However, I must note, that while there is much that we know, there is new knowledge generated regularly. For example, a number of years ago, a paper appeared in the leading environmental health journal showing that uranium had estrogenic properties in mice, something I would not have suspected prior to that study.<sup>4</sup> So what we have is a solid base of knowledge showing some strong causal links between uranium ore and health and the possibility that there are additional toxic properties that have yet to emerge in the scientific literature.

The health effects of uranium ore components that rise to the level of proven or near-proven causal links include:

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<sup>4</sup> Raymond-Whish S, Mayer LP, O'Neal T, Martinez A, Sellers MA, Christian PJ, Marion SL, Begay C, Propper CR, Hoyer PB, Dyer CA. 2007. Drinking Water with Uranium below U.S. EPA Water Standard Causes Estrogen Receptor Dependent Responses in Female Mice *Environ Health Perspect*: doi:10.1289/ehp.9910. [Online 14 September 2007]

- 1) Radon causes lung cancer, in fact, it is the primary source of lung cancer among non-smoking Native American uranium miners;
- 2) Uranium causes damage to the kidneys, DNA damage and birth defects (the latter in animals);
- 3) Radium causes bone cancer, cancer of the nasal sinuses and mastoid air cells and leukemia; and
- 4) Arsenic causes lung and skin cancer, as well as neurotoxicity, hyperpigmentation and hyperkeratosis of the skin.

There are other health effects that have been seen in some studies, but the ones I listed are some of the outcomes for which the science is strongest. A more complete review of the toxicity of uranium and radium can be found in my review articles.<sup>5</sup> I would also be happy to direct your staff to complete and detailed documentation about the science that backs up my assertions as well as studies suggesting other health effects. The US ATSDR has compiled detailed toxicological profiles for each of the main contaminants I listed above, which summarize thousands of scientific studies.

The point here is that there is a solid core of health effects that are documented scientifically at a level that supports a causal link between these exposures and human health. In addition, there are numerous other possible health effects that are emerging, such as growing evidence in animal studies of neurological effects or uranium and growing evidence of reproductive effects. In short, uranium ore is well proven to have adverse health impacts. There are no known benefits to such exposure and as time proceeds, it is only likely that additional health concerns will be added to the list.

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<sup>5</sup> Brugge D, Buchner. Health effects of uranium: new research findings. *Reviews on Environmental Health*. 2011; 26:231–249; Brugge D, Buchner V. Radium in the environment: exposure pathways and health effects. *Reviews on Environmental Health*. 2012; 27:1–17.

## BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors in the order listed on Form Page 2.  
Follow this format for each person. **DO NOT EXCEED FOUR PAGES.**

NAME Douglas M. Brugge	POSITION TITLE Professor		
eRA COMMONS USER NAME (credential, e.g., agency login) DBRUGGE1			
EDUCATION/TRAINING (Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable.)			
INSTITUTION AND LOCATION	DEGREE (if applicable)	MM/YY	FIELD OF STUDY
Washington University	BA	05/82	Biology and Chemistry
Harvard University	PhD	11/87	Biology
Harvard School of Public Health	MS	06/88	Industrial Hygiene

### A. Personal Statement

I have worked on the issue of uranium mining for 15 years, primarily with Native Americans in the South Western US. My background is in biology and chemistry and I recently completed critical readings and reviews of the epidemiological and toxicological literature of health effects of both uranium and radium. I am also well versed in the literature on radon. I have participated in exposure assessment for a study of Native Americans living near uranium mining in the US and was a co-investigator on the Nuclear Risk Management for Native Communities project [ES 07255-06, Goble PI]. I have also published a couple of papers about the history of uranium mining in the US. Pertinent to this proposal, I have a degree in industrial hygiene and considerable experience with environmental exposure assessment. I currently direct the Community Assessment of Freeway Exposure and Health study [ES015462, Brugge PI; CA148612, Brugge Project PI; HUD MALHH0194-09] which is collecting extensive air monitoring data next to highways in and near Boston and recruited 700 participants from whom extensive health data was collected, including blood samples. This study met its recruitment and other data collection goals. This project has produced 17 papers in academic journals so far. My past experience includes being co-director of the Healthy Public Housing Initiative, a multi-year observational and intervention study of asthmatic children funded primarily by US HUD and the Kellogg Foundation. My experience and skills are a good fit for the proposed work, because of my demonstrated ability to navigate intercultural collaborations, my knowledge of the uranium literature, my demonstrated ability to direct large environmental epidemiology studies and my record of producing peer reviewed publications.

### B. Positions and Honors

1988 – 1994 Labor Educator/Industrial Hygienist, Mass. Coalition for Occupational Safety and Health  
1994 – 1998 Lecturer/Researcher, Department of Family Medicine and Community Health, Tufts University School of Medicine  
1998 – 2004 Assistant Professor, Department of Family Medicine and Community Health, Tufts University School of Medicine  
2004 – 2009 Associate Professor, Department of Public Health and Community Medicine, Tufts University School of Medicine  
2009 – present Professor, Department of Public Health and Community Medicine, Tufts University School of Medicine

#### Reviewer:

Health Careers Opportunities Program Review, US HRSA, (2005)  
CBPR Special Review Panel, ZRG1 HOP-M 50 R (2008-2009)  
Community Level Health Promotion Study Section ad hoc reviewer, NIH (2005-2006)  
Epidemiology of Bacterial Infection and Asthma, NIH (2007), 2008/01 ZRG1 HOP-W (02) M  
Health Literacy Study Section, NIH (2007-2009), 2008/01 ZRG1 RPHB-B (50) R  
Full member and chair, Community Level Health Promotion Study Section, NIH, starting July 1, 2010

### C. Peer-reviewed Publications (Selected from over 100 publications)

#### Most relevant to the current application

- 1) Dustov A, Mirojov G, Yakubova M, Umarov S, Ishankulova D, Eliasziw M, **Brugge D**. Uranium mine proximity, immune function and Helicobacter pylori infection in Tajikistan. *Journal of Toxicology and Environmental Health, Part A: Current Issues* 2013, 76:1261–1268.
- 2) **Brugge D**, Buchner V. Radium in the environment: exposure pathways and health effects. *Reviews on Environmental Health*. 2012; 27:1–17.
- 3) **Brugge D**, Buchner V. Health effects of uranium: new research findings. *Reviews on Environmental Health*. 2011; 26:231–249.
- 4) deLemos JL, **Brugge D**, Cajero M, Downs M, Durant JL, George CM, Henio-Adeky S, Nez T, Manning T, Rock T, Seschillie B, Shuey C, Lewis J. Development of Risk Maps to Minimize Uranium Exposures in the Navajo Churchrock Mining District. *Environmental Health: A Global Access Science Source.*, 2009, 8:29. PMID: 19589163
- 5) deLemos JL, Bostick BC, Quicksall AN, Landis JD, George CC, Slagowski NL, Rock T, **Brugge D**, Lewis J, Durant JL. Geochemical controls on uranium mobilization in a waste-burdened mining district. *Environmental Science & Technology* 2008, 42:3951-3957. PMID: 18589950
- 6) **Brugge D**, deLemos JL, Bui C. The Sequoyah Corporation fuels release and the Church Rock spill: unpublicized nuclear releases in American Indian communities. *American Journal of Public Health*. 2007 97:1595-600. PMID: 17666688
- 7) Hindin R, **Brugge D**, Panikkar B. An epidemiological perspective on the teratogenicity of depleted uranium aerosols. *Environmental Health: A Global Access Science Source.*, 2005, 4:17. PMID: 16124873
- 8) **Brugge D** and Goble R. The history of uranium mining and the Navajo People. *American Journal of Public Health*, 92:1410-1419, 2002.

#### Additional recent publications of importance to the field (in chronological order)

- 1) **Brugge D**, Lane K, Padró-Martínez LT, Stewart A, Hoesterey K, Weiss D, Wang DD, Levy JI, Patton AP, Zamore W, Mwamburi M. Highway proximity associated with cardiovascular disease risk: the influence of individual-level confounders and exposure misclassification. *Environmental Health* 2013, 12:84.
- 2) Lane KJ, Scammell MK, Levy JI, Fuller CH, Parambi R, Zamore W, Mwamburi M, **Brugge D**. Positional error and time-activity patterns in near-highway proximity studies: An exposure misclassification analysis. *Environmental Health* 2013, 12:75.
- 3) Fuller CH, **Brugge D**, Williams PL, Mittleman MA, Lane K, Durant JL, Spengler JD. Indoor and outdoor measurements of particle number concentration in near-highway homes. *Journal of Exposure Science and Environmental Epidemiology*. 2013:1-7.
- 4) Padró-Martínez LT, Allison P, Patton AP, Trull JB, Zamore W, **Brugge D**, Durant JL. Mobile monitoring of particle number concentration and other traffic-related air pollutants in a near-highway neighborhood over the course of a year. *Atmospheric Environment*. 2012; 61:253-264.
- 5) Fuller CH, **Brugge D**, Williams P, Mittleman M, Durant JL, Spengler JD. Estimation of ultrafine particle concentrations at near-highway residences using data from local and central monitors. *Atmospheric Environment* 2012; 57:257-265.
- 6) Rioux CL, Tucker KL, Mwamburi M, Gute DM, Cohen SA, **Brugge D**. Residential Traffic Exposure, Pulse Pressure and C-Reactive Protein: Consistency and Contrast Among Exposure Characterization Methods. *Environmental Health Perspectives* 2010; 118:803-811. PMID: 20123638
- 7) Durant JL, Ash CA, Wood EC, Herndon SC, Jayne JT, Knighton WB, Canagaratna MR, Trull JB, **Brugge D**, Zamore W, and Kolb CE. Short-term variation in near-highway air pollutant gradients on a winter morning. *Atmospheric Chemistry and Physics Discussions*. 2010, 10:5599-5626.
- 8) Repace JL, Hyde JN, **Brugge D**. Air pollution in Boston bars before and after a smoking ban. *BMC Public Health*, 6:266, 2006.

### D. Research Support

#### Ongoing Research Support

5R01 ES015462-05 (Brugge)  
NIH/NIEHS

06/13/08 - 03/31/14  
**NCE**

**Community Assessment of Freeway Pollution and Health (CAFEH)**

To study the relationship between air pollutants emitted from motor vehicles on major highways and chronic health effects in individuals living in nearby communities.

Role: Principal Investigator

Tufts University (Brugge)

07/01/05 - 06/30/14

**Tufts Community Research Center**

Jonathan M. Tisch College of Citizenship and Public Service

Tufts Community Research Center operating budget.

Role: Director

Kresge Foundation (Brugge)

6/1/13 – 5/30/16

**Improving the Health of Near-Highway Communities**

This project will seek to change municipal policy in the City of Somerville and alter building designs in the Chinatown community in ways that protect residents from highway air pollution.

Role: Principal Investigator

RFA-EH-12-00102 (Adamkiewicz)

07/01/13 – 06/30/14

NIH/NCEH/Subcontract with Harvard

**Green Housing Study: Follow-up measurements of housing factors and respiratory health of children located in Cincinnati and Boston**

This study is looking at changes in environmental factors and asthma in families living in housing that is undergoing upgrades designed to reduce energy use and to be more environmentally healthy.

1P50HL10518503(Tucker)

09/01/13 – 11/30/15

NIH/NHLBI/-UMASS subcontract)

**Boston Puerto Rican Health Study**

Our overall aim for this renewal is, to extend follow-up and to measure and analyze relevant characteristics and CVD risk factors, and to add additional contextual and outcome measures for CVD risk in this established cohort of Puerto Rican adults, so that we may better understand the dynamics of these disparities.

Role: Principal Investigator of Project 4.

MALHH0194-09 (Durant)

02/01/13 – 01/31/15

Federal Office of Housing and Urban Development (HUD)

**NCE**

**Evaluation of Cardiovascular Health Benefits of In-home Air Filtration**

We propose to measure the health benefits of air cleaning technology in homes adjacent to a highway in Somerville, Massachusetts, just north of Boston. This study builds on an on-going, NIEHS-funded, investigation of health effects in people exposed to near-highway air pollution.

Role: Co-Investigator

MALHH0194-09 (Durant)

05/01/10 – 08/31/13

Federal Office of Housing and Urban Development (HUD)

**NCE**

**Evaluation of Cardiovascular Health Benefits of In-home Air Filtration**

We propose to measure the health benefits of air cleaning technology in homes adjacent to a highway in Somerville, Massachusetts, just north of Boston. This study builds on an on-going, NIEHS-funded, investigation of health effects in people exposed to near-highway air pollution.

Role: Co-Investigator

**PENDING**

EPA

09/01/14 – 08/31/17

EPA-G2013-STAR-H1

**Reducing traffic pollution in schools: Impact on learning-related measures**

This study we propose a filtration intervention study to reduce near highway particulate air pollution and to test association of the reductions with measures of cognitive function in a school in Somerville, MA.

Score: Excellent

NIH  
UMASS, Boston (Wong) Subcontract 07/01/13 – 06/30/16  
**Visualizing Highway Pollution and It's Effects: A Study of Inter-Generational Health Communication in an Immigrant Community**  
This is a developmental project to produce a health communication intervention. The goal is to make complex scientific information about exposure of Boston Chinatown to traffic-related air pollution, an important health factor, accessible to the community's residents. We will use a computer program to make invisible air pollution visible on a computer display screen to lay persons with limited English proficiency.  
Role: Co- Principal Investigator  
This application was reviewed and got a score of 41 and will be resubmitted in March 2014.

### **Completed Research Support**

UL1 RR025752 (Selker) 05/19/08 - 04/13/13

NIH  
**Clinical and Translational Science Initiative**  
The community engagement component of the CTSI will work with local community organizations to improve their understanding of and involvement in research.  
Role: Co-Investigator

RFA-EH-12-001 (Adamkiewicz) 07/01/12 – 06/30/13

NIH/NCEH/Subcontract with Harvard

### **Green Housing Study: Boston Follow-up**

This study is looking at changes in environmental factors and asthma in families living in housing that is undergoing upgrades designed to reduce energy use and to be more environmentally healthy.

1 D18HP13622-03-00 (Brugge) 09/01/09 – 06/30/13

HRSA

### **Health Careers Opportunity Program**

Our program will increase the number of disadvantaged students graduating from: 1) medical school in primary care and/or 2) public health graduate programs. The partnership includes students, teachers, professors, professionals, administrators, and parents.

Role: Principal Investigator

Tufts University internal grant (McWayne) 07/1/11 to 6/30/12

University-Municipal Partnerships for Children's School Success

### **Evolving SomerPromise by Bringing Systems Together through Integrated Data**

Role: Co-Principal Investigator

1R24MD005095-01 (Martinez & Brugge) 09/21/09 – 06/30/12

NIH  
**Nuestro Futuro Saludable: The JP Partnership for Healthy Caribbean Latino Youth**  
This project is significant because. (1) it is a within-group intervention research project targeting a not well-understood sub-population of the Latino demographic; (2) the project is unique because it brings together a diverse group of community stakeholders; (3) key personnel are primarily people of color, with a majority of bilingual Latina women of varying backgrounds; and (4) the project introduces two new investigators of color.  
Role: Co-Principal Investigator