March 1, 2007

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
DOMINION NUCLEAR NORTH ANNA, LLC	)	Docket No 52-008-ESP
	)	
(Early Site Permit for North Anna ESP Site)	)	

AFFIDAVIT OF GREGORY ALAN STOETZEL CONCERNING THE NRC STAFF RESPONSE TO THE BOARD'S ENVIRONMENT-RELATED QUESTIONS

I, Gregory Alan Stoetzel, do hereby state as follows:

1. I am employed as an Environmental Safety and Health Principal Engineer with the Safety and Health Department at the Pacific Northwest National Laboratory, managed by Battelle Memorial Institute's Pacific Northwest Division. I am providing responses to the Licensing Board's questions under a technical assistance contract with the staff of the U.S. Nuclear Regulatory Commission ("NRC"). A statement of my professional qualifications is attached.

2. As part of the NRC staff's environmental review of the North Anna ESP application, documented in NUREG-1811, the "Environmental Impact Statement for an Early Site Permit (ESP) at the North Anna ESP Site," December 2006, I assisted the NRC staff in its analysis of the aspects of the Applicant's Environmental Report that concerned the radiological environment, nonradiological and radiological health impacts of construction and normal operation, and uranium fuel cycle impacts.

3. I am responsible for those responses to Board questions (or portions of questions) in Attachment A to the "NRC Staff Legal Brief in Response to the Licensing Board's Environment-Related Questions" for which I am listed as the author.

4. I attest to the accuracy of those statements, support them as my own, and endorse their introduction into the record of this proceeding. I declare under penalty of perjury that those statements, and my statements in this affidavit. are true and correct to the best of my knowledge, information, and belief

Gregory A. Stoetzel

GREGORY A. STOETZEL, Environmental, Safety and Health Principal Engineer
Safety and Health Department
Battelle, Pacific Northwest National Laboratory

Education

B.S.	Science, Penn State University	1973
M.S.	Bionucleonics, Purdue University	1976

Experience

Mr. Stoetzel joined Battelle in 1976, and has over thirty years of work experience in the operational health physics, emergency preparedness, and environmental assessment areas. Details of his work experience are presented below:

- Operational Health Physics. Mr. Stoetzel has extensive experience in writing technical basis guidance documents to support Federal health physics regulations. He was the primary technical contributor to the Department of Energy (DOE) Implementation Guides on workplace air monitoring and on sealed radioactive source accountability and control. He was a technical contributor to the DOE Radiological Control Manual, the Hanford Site Radiological Control Manual, and to several DOE Good Practices Manuals covering topics such as ALARA and operation of uranium and plutonium facilities. He was also a contributor to the workplace air monitoring guidance developed by Nuclear Regulatory Commission (NRC) to support implementation of 10 CFR Part 20.

  Mr. Stoetzel has provided health physics support to DOE contractors and programs in the following areas: writing radiation protection manuals and radiological protection portions of safety analysis reports; evaluating facility conceptual design reports for adequacy of shielding, radiation detection instrumentation, and ALARA considerations; and performing occupational dose assessments for inclusion in environmental assessments and environmental impact statements.

  Mr. Stoetzel has performed qualitative air flow studies (i.e., smoke testing) at over 12 nuclear facilities as a means of evaluating the adequacy of workplace air sampler and monitor locations.

  Mr. Stoetzel has provided health physics support to several Department of Army projects. Specific work has included determination of the best survey methods and instrumentation for performing release surveys on depleted uranium contaminated components, and the evaluation of component decontamination methods to ensure worker safety.

  Currently, Mr. Stoetzel is assigned to Battelle's Safety and Health Department. Responsibilities include 1) conducting compliance inspections of nuclear facilities

against requirements in 10 CFR Part 835 and the DOE Radiological Control Manual (RCM), 2) writing health physics procedures to support implementation of 10 CFR Part 835 and the RCM, 3) providing technical support to Battelle's air sampling/monitoring program and area dosimeter program, and 4) developing technical methods for uncontrolled release of work areas and materials and equipment from radiological control.

- Emergency Preparedness. Mr. Stoetzel was a contributor for approximately fourteen years to a Battelle program that provided technical assistance to the Nuclear Regulatory Commission (NRC) in the area of emergency preparedness at commercial nuclear power plants. He was a team member on about 20 onsite appraisals and inspections of reactor emergency preparedness programs and an observer on over 50 exercises. Other activities related to this project included performing technical reviews of exercise scenarios, emergency plans, and emergency procedures. Mr. Stoetzel was also a technical contributor and coordinator on two special studies for the NRC, one that reviewed emergency offsite dose projection methods at commercial nuclear power plants and one that developed emergency environmental sampling and analysis guidance for radioactive material facilities.

  Mr. Stoetzel has provided emergency preparedness support to Department of Energy (DOE) Headquarters and DOE Richland Operations Office (DOE RL). This support has included 1) development of radiological and nonradiological field data for emergency preparedness exercises, 2) conduct of emergency preparedness appraisals of individual DOE facilities, 3) an evaluation of the applicability of the revised protective action guidelines developed by the Environmental Protection Agency to DOE sites, and 4) upgrading emergency environmental monitoring activities on the Hanford site. Mr. Stoetzel is currently part of the DOE-RL emergency response team filling the position of radiological field team coordinator.

- Environmental Assessments. For the past five years, Mr. Stoetzel has been a contributor to the environmental impact statements developed by the NRC for license renewal of nuclear plants and for early site permits. He has supported development of the radiological health impact and fuel cycle impact sections. He has worked on environmental impact statements for three license renewal applications and two early site permit applications.

Professional Certifications

Certified Health Physicist (November 1996 by American Board of Health Physics)

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DOMINION NUCLEAR NORTH ANNA, LLC	)	Docket No. 52-008-ESP
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(Early Site Permit for North Anna ESP Site)	)	

AFFIDAVIT OF LANCE W. VAIL CONCERNING THE NRC STAFF RESPONSE TO THE BOARD'S ENVIRONMENT-RELATED QUESTIONS

I, Lance W. Vail, do hereby state as follows:

1. I am employed as a senior research engineer with the Hydrology Group at the Pacific Northwest National Laboratory, managed by Battelle Memorial Institute's Pacific Northwest Division. I am providing this Affidavit under a technical assistance contract with the NRC Staff ("Staff"). I am the lead technical reviewer on the hydrology issues associated with the application submitted by Dominion Nuclear North Anna, LLC ("Applicant") for an early site permit ("ESP") for a site within the existing boundaries of the North Anna Power Station in Louisa County, Virginia. A statement of my professional qualifications is attached.

2. As part of the NRC staff's environmental review of the North Anna ESP application documented in NUREG-1811, the "Environmental Impact Statement for an Early Site Permit (ESP) at the North Anna ESP Site," December 2006, I assisted the NRC staff in its analysis of the aspects of the Applicant's Environmental Report that concerned hydrology.

3. I am responsible for those responses to Board questions (or portions of questions) in Attachment A to the "NRC Staff Legal Brief in Response to the Licensing Board's Environment-Related Questions" for which I am listed as the author.

4. I attest to the accuracy of those statements, support them as my own, and endorse their introduction into the record of this proceeding. I declare under penalty of perjury that those statements, and my statements in this affidavit, are true and correct to the best of my knowledge, information, and belief.

Lance W. Vail

STATEMENT OF PROFESSIONAL QUALIFICATIONS OF LANCE W. VAIL

CURRENT POSITION

Senior Research Engineer II
Environmental Technology Division
Battelle, Pacific Northwest Division
Pacific Northwest National Laboratory

Since joining Battelle in 1981, Mr. Vail has been involved in projects covering a diverse set of water related issues. His professional experience includes basic and applied research, and regulatory compliance assessments. His areas of expertise cover a broad spectrum of areas related to water resources.

RESEARCH INTERESTS

Water resource management
Multiple objective tradeoff analysis in water resources
Uncertainty analysis in water resources
Advanced hydrologic process modeling
Impacts of climate on water resources
Neural networks, fuzzy logic, and genetic algorithms applied to water resource issues
Linking simulation models with optimization methods to water resource problems
Linkage of physical and biological models in fisheries management

EDUCATION

B.S.	Humboldt State University, environmental resources engineering	1979
M.S.	Montana State University, civil engineering	1982

PROFESSIONAL AFFILIATIONS

American Geophysical Union
American Society of Civil Engineers
American Water Resources Association

CURRENT PROJECTS

Hydrologic Site Safety Reviews for Early Site Permits. Principal Investigator and Project Manager. Three applications for an Early Site Permit (ESP) have been submitted to the Nuclear Regulatory Commission. This project provides an independent assessment of hydrologic suitability of the proposed sites. Assessments include a broad range of considerations such as flooding, low water conditions, ice impacts, seiches, storm surge, and tsunamis.

Water-related Environmental Reviews for Early Site Permits. Task Manager. Three applications for an Early Site Permit (ESP) have been submitted to the Nuclear Regulatory Commission. This task provides an independent assessment of the proposed sites' environmental suitability. Assessments include a broad range of considerations such as water-use conflicts and changes in water quality.

Snohomish Basin Characterization. Technical Lead. Advanced distributed watershed models were applied to provide the Tulalip Tribes of Western Washington state a thorough understanding of the impacts of logging, development, and climate on the Snohomish River Basin.

Acid Rain TMDL. Principal Investigator and Technical Project Manager. The objective of this work assignment for Region II of the U.S. Environmental Protection Agency is to develop a preliminary assessment approach for TMDLs for pH impaired waters listed on the New York State Section 303(d) list. The intent is to enhance and further develop TMDL program capabilities by providing expertise in both acid deposition and TMDL development. The development of such an assessment approach requires that available models and data resources be reviewed. Systems engineering methods will be used in developing a conceptual model to ensure the relationships between models and data are fully understood. The assessment approach will be tested on one or more representative watersheds to be determined in close coordination with EPA, NYSDEC and Battelle. http://acidraintmdl.pnl.gov

PAST PROJECTS

- ***Environmental Impact of License Renewal of Commercial Nuclear Power Plants.*** Contributor. Mr. Vail assesses the water use, water quality, and hydrologic impacts of license renewal for the Nuclear Regulatory Commission's NEPA process. He has performed this function for the following commercial nuclear plants: Calvert Cliffs, Oconee, Arkansas Nuclear One, Hatch, McGuire, Catawba, North Anna, Robinson, Ginna, and St. Lucie.

- **Chehalis Basin Characterization.** Principal Investigator and Project Manager. Advanced numerical modeling and GIS methods were applied to assist the Corps of Engineers in characterizing the Chehalis Basin in Western Washington State. The Chehalis Basin is subject to frequent flooding. The native populations of anadramous fish have been stressed to adverse changes in habitat resulting from development and logging.

- ***Generic Environmental Impact Statement (GEIS) for Decommissioning Commercial Nuclear Power Plants.*** Contributor. Mr. Vail is providing expertise in the development of a GEIS for decommissioning of nuclear plants. He provides expertise on water use, water quality, and hydrologic impacts for the Nuclear Regulatory Commission.

- ***Impact of Climate on the Lower Yakima Basin.*** Principal Investigator and Project Manager. The objective of this three-year EPA STAR Grant Project was to develop and demonstrate an integrated assessment of the impact of climate variability and climate change on a diverse set of interests in the Lower Yakima Valley in Central Washington State. Interests considered include: surface and groundwater supply, surface and groundwater quality, air quality, public health, farm and regional economics, and fisheries. The project considered the effectiveness of changes in land management (crop selection) and water management (reservoir operation) in adapting to an uncertain future climate. A diverse set of models was linked with an optimization procedure to ensure that the tradeoffs between various resource management objectives are clearly articulated. http://projects.battelle.org/yakima/

- ***Use of NOAA's Seasonal Climate Forecast for Water Resource Management.*** Task Manager of Reservoir Optimization Task. The objective of this NOAA funded project was to show the potential value of improved climate forecasts in managing surface water reservoirs for multiple objectives. Using a pareto genetic algorithm, the reservoir operating rules were optimized to define the tradeoff curves for hydropower, flood control, and instream flow requirements in the Tennessee River basin. Changes in forecast reliability result in changes to these tradeoffs and thereby express the value of such improved forecasts.

- ***Accelerated Climate Prediction Initiative.*** Task Manager of Water Resources and Habitat Task. This project will provided a limited, systematic assessment of the potential effects of anthropogenic climate change over the next half-century on water resources in the western United States. This objective was accomplished by "downscaling" the results of the global-scale simulations described above to the spatial and temporal resolution needed to drive impact assessment models. Downscaling is particularly important for the West, where topography is a dominant climate driver. An important aspect of the hydrology of

almost all western rivers is water management. Other than a few headwater streams, the hydrology of most rivers in the west is strongly affected by water use and artificial storage. Water management models were used to study the effect of reservoir operations and understand the implications of climate variability and change on the water resources of the west. http://acpiwater.pnl.gov

- ***Linking Physical and Biological Models***. Principal Investigator and Project Manager. The objective of this three-year Laboratory Directed Research and Development project is to develop and demonstrate an integrated natural resource analysis framework. This framework: dramatically improves the ability to integrate physical and biological models, thereby encouraging the utilization of advanced process models; allows utilization of large, sparse, and distributed data sets (including model output); communicates high-level tradeoffs and their respective uncertainties; and assesses, communicates, and minimizes scales issues. During the first year, the fundamental structural differences between such models was identified as a significant obstacle to successful linking of physical and biological models. The pervasive vagueness of rules and the multivaluedness associated with temporal/spatial upscaling suggested an approach using "fuzzy methods". The second year of this project utilized a variety of fuzzy methods including: fuzzy arithmetic, fuzzy logic, fuzzy clustering, and adaptive neural fuzzy inference systems (ANFIS). A series of rules and a database from the Multispecies Framework Process were employed to test the various fuzzy methods. These rules and data are used to define aquatic habitat diversity in the Pacific Northwest. A tool called FuzzyHab was developed to estimate habitat diversity from a set of categorical statements about the environment. Each of these categorical statements is vaguely defined. Estimates for each categorical statement are derived from physical process models.

- ***Integrated Natural Resource Data System.*** Contributor. This project is to demonstrate INRDS. INRDS is an advanced, web-based environmental information system that will promote public understanding of natural resource management issues and assist planners and decision makers in accessing the most relevant information and analytical tools and evaluating the tradeoffs of alternate actions. http://inrds.pnl.gov

- ***Early Warning of El Niño Southern Oscillation (ENSO) Events for Regional Agriculture.*** Task Manager of Reservoir Optimization Task. This project is investigating the current predictability of interannual variability in climate conditions in the Pacific Northwest to determine whether and how early warning and seasonal climate forecasts by the Climate Prediction Center (CPC) of the National Oceanic and Atmospheric Administration (NOAA) forecasts can be used to reduce the vulnerability of irrigated agriculture to low water-availability conditions. The study is funded by a grant from the economics and Human Dimensions Program of the NOAA Office of Global Programs. The Economics and Human Dimensions program aims to improve our understanding of how social and economic systems are currently influenced by fluctuations in short-term climate (seasons to years), and how human behavior can be (or why it may not be) affected based on information about variability in the climate system. http://elrino-northwest.labworks.org

- ***Impact of Reservoir Operating Strategies on Resident Fish*** - Mr. Vail has employed several models to assess the impact on resident fish species of a variety of reservoir operating strategies. This study was undertaken as part of the Columbia Basin System Operation Review process. Mr. Vail helped define the values and value measures of the Resident Fish Work Group.

- ***Multiobjective Optimization*** - Mr. Vail is the project manager of an effort to assess the multiobjective optimization needs of Bonneville Power Administration. Objectives include: hydropower, resident fish, anadramous fish, irrigation, flood control, wildlife, and navigation. Mr. Vail is developing definitions of the canonical mathematical form of each of these objectives. The resulting multiobjective statement will be used to define the required optimization tools.

- ***Integrated Environmental Monitoring Initiative*** - Mr. Vail is a co-principal investigator for the Integrated Environmental Monitoring Initiative. The objective of this initiative is to develop and demonstrate a

comprehensive interdisciplinary methodology targeted to improve the effectiveness of environmental monitoring and restoration activities. This objective required comprehensive integration of monitoring regimes, analytical practices, design methodologies, and compliance needs.

- ***Coupled Simulation/Optimization of Ground Water Remediation*** - Mr. Vail developed a computer code that coupled a ground water flow model with an optimization procedure. The code was able to provide estimates of the pumping/injection rates that would mitigate or remove a plume at minimal cost.

- ***Simulation of Watershed Hydrologic Responses to Alternative Climates*** - Mr. Vail is the principal investigator of a project studying the impacts of global climate change on the hydrologic response of a watershed. The results of hydrologic simulations using distributed snowmelt and soil moisture accounting algorithms were graphically compared via video displays of daily simulated snow water equivalent, soil moisture, and runoff for the American River, Washington, which drains 204 square kilometers of the east slopes of the Cascade Mountains, Washington. Snow water equivalents and snowmelt were simulated using a simplified distributed temperature-index model augmented with seasonally estimated net solar radiation. A classification scheme was used to partition the empirical cumulative probability distributions of precipitation (rain plus melt) and a topographic index over the basin into groups of near-equal membership. Topographically-based soil moisture capacities were assumed for each class and were estimated via automated calibration methods using historical data. The simulated soil moisture and snow water accumulations for each class were geographically mapped for visualization. Test of the effect of alternative, warmer climates on snow accumulation, the seasonal distribution of soil moisture, and runoff were conducted by adjusting historical (daily) temperature and precipitation and repeating the analysis.

- ***Pacific Northwest Climate Change Case Study - Water Resource Impacts*** - Mr. Vail is investigating the effects of global climate change on water resources of the Pacific Northwest. Spatially distributed snowmelt, soil moisture, and runoff models have been combined with a graphics visualization package to understand the changes in snowpack, soil moisture, and evapotranspiration over time. A weather classification scheme has been developed which estimates point precipitation as a function of large-scale atmospheric variables. This allows the synthesis of point precipitation given large-scale meteorological information as might be produced by GCM simulations. Orographic effects also have a significant role in defining climate at the watershed scale. Efforts are under way to develop a scientific basis to extend the sparse meteorological measurements basis to extend the sparse meteorological measurements available for any watershed to estimate the spatial distribution of precipitation, temperature, and wind speed within the watershed. A reservoir network model for the Columbia River Basin has been aggregated to fourteen nodes. This network model of the Columbia River Basin has been aggregated to fourteen nodes. This network model will be driven by a collection of index watersheds. A daily hydroclimatological data set has been developed to aid in the selection of index watersheds.

- ***Acid Rain Watershed Modeling Project*** - Mr. Vail directed the hydrologic part of a study to evaluate and apply several coupled hydrology/geochemical codes that were developed to model the impact of acid rain on surface water chemistry. The project involved extensive behavior and sensitivity analyses of three coupled geochemical/hydrological simulation codes.

- ***Incineration at Sea*** - The objective of this project was to assess the impact of incinerating toxic waste at sea on the aquatic environment. Mr. Vail developed a model on an IBM-PC to estimate the concentration of contaminant in the ocean.

- ***Aquifer Thermal Energy Storage*** - The objective of this project was to develop and apply computer codes that would simulate the trade-offs between different management policies of an Aquifer Thermal Energy Storage system. Mr. Vail independently developed, validated, and applied several computer codes for this purpose.

- ***Flow and Fractured Media*** - The objective of this study is to develop a state-of-the-art predictive capability for flow and transport in saturated fractured media. Mr. Vail was responsible for implementing, modifying, and testing a computer code that models steady flow in permeable media with discrete fractures. Mr. Vail has also developed a computer code that models steady flow through fractures in an impermeable rock mass. The fractures can either be specified or generated via Monte Carlo Methods. This code was applied in an investigation of the potential impact of a nuclear meltdown on groundwater.

- ***Modeling Flow With Certainty in Hydraulic Parameters*** - The objective of this study is to develop a methodology to analyze the uncertainty in predicting piezometric surfaces caused by uncertainty in groundwater flow parameters. Mr. Vail developed a computer code that couples perturbation and finite-element techniques to estimate the mean and variance of the piezometric surface.

- ***Stripa Mine Hydrogeologic Characterization*** - The objective of this study was to perform three-dimensional simulations with the CFEST code for ground water flow at the Stripa Mine in Sweden. Mr. Vail was the Battelle project manager of this effort.

PUBLICATIONS

Coleman A, LW Vail, and A Savery. 2005. "Landscape Classification for Assessment of Impacts of Landuse and Climate on Water Resources." Presented by Andre M Coleman (Invited Speaker) at 25th Annual Environmental Systems Research Institute International User Conference, San Diego, CA on July 25, 2005. PNWD-SA-7118.

Prasad R, LW Vail, CB Cook, and G Bagchi. 2005. "Establishment of Safety-Related Site Characteristics Based on Consideration of External Sources of Flooding at Nuclear Power Plant Sites in the United States of America." Presented by Rajiv Prasad (Invited Speaker) at IAEA-India External Flooding Hazards Workshop , Kalpakkan, Tamil Nadu on August 29, 2005. PNNL-SA-46005.

Scott MJ, LW Vail, CO Stockle, A Kemanian, KM Branch, R Prasad, MS Wigmosta, and JA Jaksch. 2005. "Benefits and Costs of Options to Mitigate the Uncertain Effects of Climate Change on Irrigated Agriculture in the Yakima Basin. What Matters? What Doesn't?" Presented by Michael J. Scott (Invited Speaker) at 39th Annual Pacific Northwest Regional Economic Conference, Bellingham, WA on May 20, 2005. PNWD-SA-6980.

Scott MJ, LW Vail, and R Prasad. 2005. "Managing Water for Irrigated Agriculture Under Extended Climate-Related Drought." Presented by Micahel J. Scott at American Water Resources Association 2005 Annual.

Scott MJ, LW Vail, CO Stockle, A Kemanian, KM Branch, R Prasad, MS Wigmosta, and JA Jaksch. 2005. "Benefits and Costs of Options to Mitigate the Uncertain Effects of Climate Change on Irrigated Agriculture in the Yakima Basin. What Matters? What Doesn't?" Presented by Michael J. Scott (Invited Speaker) at Pacific Northwest Regional Economic Conference, Bellingham, WA on May 20, 2005. PNWD-SA-6902.

Vail LW. 2005. "Adaptive Management of Water Resources in the Puget Sound." Presented by Lance W. Vail (Invited Speaker) at Puget Sound Georgia Basin Research Conference, Seattle, WA on March 29, 2005. PNNL-SA-44581.

Scott MJ, LW Vail, CO Stockle, A Kemanian, KM Branch, R Prasad, MS Wigmosta, and JA Jaksch. 2005. "Adapting Irrigated Agriculture to Climate Variability and Change." Presented by Michael J. Scott (Invited Speaker) at 2005 Annual Meeting, American Association for the Advancement of Science, Washington, DC on February 20, 2005. PNWD-SA-6848.

Scott MJ, LW Vail, CO Stockle, A Kemanian, KM Branch, R Prasad, MS Wigmosta, and JA Jaksch. 2005. "Adapting Irrigated Agriculture to Climate Variability and Change." Presented by Michael J. Scott (Invited Speaker) at 2005 Annual Meeting, American Association for the Advancement of Science, Washington, DC on February 20, 2005. PNWD-SA-6743.

Scott MJ, LW Vail, and R Prasad. 2005. "Managing Water for Irrigated Agriculture Under Extended Climate-Related Drought." Presented by Michael J. Scott (Invited Speaker) at American Water Resources Association 2005 Annual Conference, Seattle, WA on November 8, 2005. PNNL-SA-47342.

Scott MJ, LW Vail, CO Stockle, and A Kemanian. 2005. "Impacts of Water Availability on Washington Agriculture in a Changing Climate." Presented by Michael J. Scott (Invited Speaker) at 2005 Fall Climate Change Conference, Seattle, WA on October 27, 2005. PNNL-SA-47128.

Meza EP, and LW Vail. 2005. Real-time Harvesting of Distributed Environmental Data for Improved Management of Complex Distributed Water and Power Management Systems . PNNL-15333, Pacific Northwest National Laboratory, Richland, WA.

Prasad R, LW Vail, CB Cook, and G Bagchi. 2005. "Establishment of Safety-Related Site Characteristics Based on Consideration of External Sources of Flooding at Nuclear Power Plant Sites in the United States of America". In

Proceedings of International Workshop on External Flooding Hazards at Nuclear Power Plant Sites (tentative; title yet to be finalized by IAEA). PNNL-SA-46268, Pacific Northwest National Laboratory, Richland, WA.

Coleman A, LW Vail, and A Savery. 2005. "Landscape Classification for Assessment of Impacts of Landuse and Climate on Water Resources." PNWD-SA-7118, Battelle—Pacific Northwest Division, Richland, WA.

Prasad R, LW Vail, CB Cook, and G Bagchi. 2005. "Establishment of Safety-Related Site Characteristics Based on Consideration of External Sources of Flooding at Nuclear Power Plant Sites in the United States of America." PNNL-SA-46005, Pacific Northwest National Laboratory, Richland, WA.

Scott MJ, LW Vail, CO Stockle, A Kemanian, KM Branch, R Prasad, MS Wigmosta, and JA Jaksch. 2005. "Benefits and Costs of Options to Mitigate the Uncertain Effects of Climate Change on Irrigated Agriculture in the Yakima Basin. What Matters? What Doesn't?" PNWD-SA-6902, Battelle—Pacific Northwest Division, Richland, WA.

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Scott MJ, LW Vail, and R Prasad. 2005. "Managing Water for Irrigated Agriculture Under Extended Climate-Related Drought." PNWD-SA-6946, Battelle—Pacific Northwest Division, Richland, WA.

Vail LW. 2005. "Adaptive Management of Water Resources in the Puget Sound." PNNL-SA-44581, Pacific Northwest National Laboratory, Richland, WA.

Scott MJ, LW Vail, CO Stockle, A Kemanian, KM Branch, R Prasad, MS Wigmosta, and JA Jaksch. 2005. "Adapting Irrigated Agriculture to Climate Variability and Change." PNWD-SA-6848, Battelle—Pacific Northwest Division, Richland, WA.

Scott MJ, LW Vail, CO Stockle, and A Kemanian. 2005. "Climate Change and Adaptation in Irrigated Case Study of the Yakima River ." American Association for the Advancement of Science, Portland, OR.

Cook, CB, LW Vail, and DL Ward. 2005. "North Anna Early Site Permit Water Budget Model (LakeWBT) for Lake Anna". PNNL-14944, Pacific Northwest National Laboratory, Richland, WA.

Pennell WT, LR Leung, MS Wigmosta, and LW Vail. 2004. "Prospects for Adapting to Near-Term Climate Change: The Yakima River Example ." Presented by William T. Pennell (Invited Speaker) at American Water Resource Association's annual state conference, Seattle, WA on October 28, 2004. PNNL-SA-43189.

Scott MJ, JA Jaksch, and LW Vail. 2004. "Water Exchanges: Tools to Beat Climate Variability." Journal of the American Water Resources Association 40(1):15-31.

Scott MJ, LW Vail, R Prasad, and JA Jaksch. 2004. "Can WE Use Long-Lead Climate Forecasts to Operate the Pacific Northwest Rivers Better?" PNWD-SA-6512, Battelle – Pacific Northwest Division, Richland, WA.

RL Skaggs, LW Vail, and SA Shankle. 2003. "Operationalizing Adaptive Management for Water Supply Planning: Sustaining Mexico City's Water Supply." In Urban Water Supply Infrastructure Management Handbook. J. Wiley. New York, NY.

Burke JS, GR Danielson, DA Schulz, and LW Vail. 2002. "Parallel computing for automated model calibration." vol. XVIII, pp. 424-429. The 6th World Multiconference on Systemics, Cybernetics, and Informatics (SCI 2002), Orlando, FL.

Scott MJ, LW Vail, and A Kemanian. 2002. "Integrated Impact of Climate Warming on Yakima Valley Water Demand and Availability." PNWD-SA-5613, Battelle—Pacific Northwest Division, Richland, WA.

Scott MJ, LW Vail, JA Jaksch, CO Stockle, and A Kamenian. 2002. "Early Warning of ENSO Events For Regional Agriculture." PNWD-SA-5834, Battelle—Pacific Northwest Division, Richland, WA

Skaggs R, and LW Vail. 2002. "Adaptive Management Platform: Approach and Application." PNNL-SA-36755, Pacific Northwest National Laboratory, Richland, WA.

Vail LW. 2002. "Adaptive Management in Nooksak River, Wa Flow Selection." PNNL-SA-36605, Pacific Northwest National Laboratory, Richland, WA.

Vail LW, and R Skaggs. 2002. "Adaptive Management Platform for Natural Resources in the Columbia River Basin." PNNL-13875, Pacific Northwest National Laboratory, Richland, WA.

Vail LW, and R Skaggs. 2002. "Integrated Process Modeling to Assess Performance of Salmon Recovery Strategies." PNNL-13903, Pacific Northwest National Laboratory, Richland, WA

Vail LW, MS Wigmosta, R Prasad, and CK Knudson. 2002. "Accelerated Climate Prediction Initiative." PNNL-SA-36759, Pacific Northwest National Laboratory, Richland, WA.

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Scott MJ, LW Vail, and CK Knudson. 2001. "El Nino and the Yakima Valley." PNWD-SA-5597, Battelle—Pacific Northwest Division, Richland, WA.

Scott MJ, JA Jaksch, and LW Vail. 2001. "Water Exchanges: Tools to Beat Climate Variability." PNWD-SA-5425, Battelle—Pacific Northwest Division, Richland, WA.

Scott MJ, LW Vail, A Kemanian, and CO Stockle. 2001. "Integrated Impact of Climate Warming on Irrigated Crop Production." PNWD-SA-5468, Battelle—Pacific Northwest Division, Richland, WA.

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March 1, 2007

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
DOMINION NUCLEAR NORTH ANNA, LLC	)	Docket No. 52-008-ESP
	)	
(Early Site Permit for North Anna ESP Site)	)	

AFFIDAVIT OF JEFFREY A. WARD CONCERNING THE NRC STAFF RESPONSE TO THE BOARD'S ENVIRONMENT-RELATED QUESTIONS

I, Jeffrey A. Ward, do hereby state as follows:

1. I am employed as a senior research scientist with the Ecotoxicology and Biotechnology Technical Group at the Pacific Northwest National Laboratory, managed by Battelle Memorial Institute's Pacific Northwest Division. I am providing responses to the Licensing Board's questions under a technical assistance contract with the staff of the U.S. Nuclear Regulatory Commission ("NRC"). I am the lead technical reviewer on the aquatic biology issues associated with the application submitted on September 25, 2003, by Dominion Nuclear North Anna, LLC ("Applicant") for an early site permit ("ESP") for a site within the existing boundaries of the North Anna Power Station in Louisa County, Virginia. A statement of my professional qualifications is attached.

2. As part of the NRC staff's environmental review of the North Anna ESP application, documented in NUREG-1811, the "Environmental Impact Statement for an Early Site Permit (ESP) at the North Anna ESP Site," December 2006, I assisted the NRC staff in its analysis of the aspects of the Applicant's Environmental Report that concerned aquatic biology.

3. I am responsible for those responses to Board questions (or portions of questions) in Attachment A to the "NRC Staff Legal Brief in Response to the Licensing Board's Environment-Related Questions" for which I am listed as the author.

4. I attest to the accuracy of those statements, support them as my own, and endorse their introduction into the record of this proceeding. I declare under penalty of perjury that those statements, and my statements in this affidavit, are true and correct to the best of my knowledge, information, and belief.

Jeffrey A. Ward

JEFFREY A. WARD
Senior Research Scientist
Pacific Northwest National Laboratory, Battelle Marine Sciences Laboratory

Education

M.S. Environmental Engineering, Kennedy Western University, Thousand Oaks, CA, 2000
B.A. Zoology, University of Washington, Seattle, WA, 1980

Qualifications

Mr. Jeff Ward joined Battelle in 1986 and has over 20 years experience in environmental baseline studies, ecological risk assessments, benthic community structure and function, and the management of contaminated sediment in urban waterways. Mr. Ward's current activities involve serving as a senior technical advisor to research on endocrine disruptor compounds; manager of the PEMEX program, a large-scale environmental baseline study to better understand the effects of oil platforms and related activities in the Gulf of Mexico; and continued support for the US Navy environmental programs for bases located in California. Mr. Ward is involved in several innovative programs involving evaluation of contaminants and assessment of risk. Some of these include the evaluation and development of technologies to decontaminate sediment, beneficial-use options analysis, the use of a weight-of-evidence approach to the evaluation of contaminants, development of the "toxic unit" approach to assessing complex mixtures in stormwater, development of sensor systems to assess the aquatic surface microlayer (top 50 microns), and the evaluation of pathways for evaluating contaminant transport and potential exposure in determining risk.

- **PEMEX Marine Program (Phase I & II) (1996 - 2006). Phase II Program Manager.** The goal of this study was to understand the impacts of PEMEX activities (oil platform operations, transshipment, waste disposal) on the marine environment and nearshore areas in the southern Gulf of Mexico. Mr. Ward coordinating all research activities associated with determining human health and ecological impacts associated with all aspects of PEMEX operations. This study included an assessment of impacts to air, receiving water, sediment, and biota in the study area. The analysis of impact and resulting environmental baseline will be used by PEMEX to identify operational changes that reduce the impacts of their operations, and monitor environmental change after impact reduction is employed. Mr. Ward was also responsible for multiple tasks during Phase I of this project, including the development of a screening database of worldwide regulations and standards, technical evaluation of United States and Mexico monitoring data, participation in meeting with colleagues in Mexico City and Geneva, Switzerland, and coordination and integration of data and results into a geographical information system platform.

- **Assessment of Aquatic Impacts Associated with Nuclear Power Plants Equipped with Once-through Cooling Systems: Supplemental Envirionmental Impact Statements for Plant Relicensing.** The Calvert Cliffs Nuclear Power Plant in Solomons, Maryland, was the first facility in the United States to request an extension to its operating license. In support of this request, Mr. Ward participated in a multidisciplinary team of scientists, engineers, environmental planners, sociologists, and economists working with the US Nuclear Regulatory Commission (NRC) to develop the draft and final supplementary environmental impact statement (SEIS) to extend the plant's operation on the shores of Chesapeake Bay. Mr. Ward was responsible for addressing all potential effects of the plant on the marine communities in Chesapeake Bay near the plant, including the impacts associated with once-through cooling water discharge, the development of the SEIS, participation at public meetings, and the formal response to questions associated with the study. The final SEIS was submitted to the EPA by NRC in early 1999. Relicensing is pending. Mr. Ward was also a key member of a multidisciplinary team evaluating the environmental impacts of relicensing the Millstone Power Station Units 2 and 3, operated by Dominion Nuclear Connecticut, and is currently working with the NRC on a similar project in New Jersey. All of these projects require critical review of complex environmental monitoring data, environmental assessment models, and other technical documentation to determine whether the available information is adequate to support a determination of impact at local and regional scales.

- **Evaluation of Stormwater Effects on Nearshore Communities to Support Restoration Efforts:** Mr. Ward developed a "toxic-unit" approach to characterizing complex mixtures typical of stormwater, which can then be simulated and tested as a dilution series in the laboratory to develop dose-response relationships. Testing is

designed to determine the concentrations at which adverse effects are likely to be observed in the environment. The approach will provide restoration ecologists with a useful tool for assessing the potential impacts of stormwater on candidate restoration sites, and for determining appropriate source-control measures.

- **Weight-of-Evidence Approach to Evaluating Regulatory Programs for Contaminated Sediment Management:** Mr. Ward applied a weight-of-evidence evaluative model, typically used in risk assessment and sediment evaluation studies, to national and regional regulatory guidance manuals to determine whether species selection and test recommendations are applicable and appropriate to safeguard environmental quality. National guidance documents reviewed included EPA/USACE publications associated with dredged material testing in marine, estuarine, and freshwater environments; regional practices included current guidance in New York/New Jersey and Puget Sound, Washington. The approach to assessing current environmental testing guidelines may serve as a basis for potential changes in legislation relative to the assessment of dredged material.
- **Behavior-Based Exposure Framework:** Mr. Ward developed a semi-quantitative behavior-based exposure framework for selecting species that are the best indicators of potential ecological damage resulting from exposure to xenobiotic or natural contaminants. The approach provides sufficient discriminatory power to observe differences among species relative to their potential for exposure. The framework can be adapted to a variety of ecosystems throughout the world, and can enhance environmental assessments by providing a consistent, documented approach to selection of ecologically relevant species.
- **US EPA Centredale Manor Environmental Risk Assessment Program.** Mr. Ward served as Program Manager for the Centredale Manor fish early-life-stage (ELS) toxicity testing study designed to help EPA develop protective sediment cleanup levels relative to dioxin and PCB contamination at this listed Superfund site. Toxicity testing focused on innovative methods for assessing chronic sediment toxicity using catfish fry. Preliminary data suggested the ELS experiment was successful in developing a dose-response relationship between sediment contaminants and maternal uptake, and may lead to new ways to assess environmental contamination and develop meaningful cleanup criteria.
- **Post-Remedial Biomonitoring of Pesticides at the EPA United Heckathorn Superfund Site, Richmond, California:** Mr. Ward was responsible for the oversite of operations for EPA during cleanup of this superfund site. Mr. Ward dealt with important safety and hazard issues and addressed issues of turbidity, sediment core sampling, and water quality. In addition, he presented to Waste Management innovative ideas of various means of dewatering hazardous sediment and time- and cost-saving measures to meet important deadlines. The Post-Remedial Biomonitoring program is a continuation of the original remedial investigation and feasibility study, which included determination of the areal and vertical extent of contamination and volume of sediment requiring remediation, characterization of biological effects of sediment and the quality of effluent derived from dewatered sediment, and development and evaluation of alternatives for removing, containing, and/or treating contaminated sediment.

SELECTED PUBLICATIONS AND PRESENTATIONS

Peer-Reviewed Journals

Ward, JA, HL Diefenderfer, AD Skillman, and SL Blanton. 2002. "The Use and Utility of Early Life-stage Toxicity Tests in Characterizing Contaminated Sediment." PNWD-SA-5599. Invited presentation at the Association for Environmental Health and Sciences, Twelfth Annual West Coast Conference on Contaminated Soils, Sediments, and Water, March 18, 2002, San Diego, California. Published in *Soil and Sediment Contamination: An International Journal,* Vol. 11(3), May 2002.

Presentations / Proceedings

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Pinza MR, JA Ward, and NP Kohn. 2002. "Results of Interspecies Toxicity Comparison Testing Associated with Contaminated Sediment Management." PNWD-SA-5731. Invited presentation by Nancy P. Kohn at the Sediment Management Annual Review Meeting (SMARM), May 1, 2002, Portland Oregon. Invited presentation by Jeff Ward at Dredging '02: Third Specialty Conference on Dredging and Dredged Material Disposal; Orlando, Florida, May 5-8, 2002; also presented by Jeff Ward at the Society for Environmental Toxicology and Chemistry (SETAC) 23rd Annual Meeting: "Achieving Global Environmental Quality: Integrating Science & Management," November 16-20, 2002, Salt Lake City, Utah.

Ward, JA, and DG Gunster. 2002. "Use of a Weight-of-Evidence Method in Designing Regulatory Programs for Contaminated Sediment Management." PNWD-SA-5535. Invited presentation at Dredging '02: Third Specialty Conference on Dredging and Dredged Material Disposal; Orlando, Florida, May 5-8, 2002.

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Navy 11th Annual West Coast Conference on Contaminated Soils, Sediments and Water conference in San Diego, California, March 19-22, 2001.

Ward, JA, N Winters, S Martin, and T Gries. 2001. "The Challenge of Sediment Decontamination in Urban Waterways." PNWD-SA-5439. Invited presentation at the Society of Environmental Toxicology and Chemistry (SETAC) 22nd Annual Meeting--*Changing Environmental Awareness: Societal Concerns and Scientific Responses.* Baltimore, Maryland, November 11-15, 2001.

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Word, J.Q., H.L. Mayhew, M.R. Pinza, J.A. Ward. 1993. "Metals Bioaccumulation by *Macoma nasuta* and *Nephtys caecoides* after 28-Day Exposure to Dredged Sediment." 1993. Presented at the 14th Annual Society for Environmental Toxicology and Chemistry (SETAC) meeting in Houston, Texas, November 15-18, 1993. Prepared by Battelle/Marine Sciences Laboratory, Sequim, Washington.

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Technical Reports

Ward JA, and JM Brandenberger. 2005. *Results of the Screening Study to Determine the Magnitude and Extent of Metals Contamination in Sediment Near Coal Creek, Skagit Key, Washington.* PNWD-3530. Prepared by Battelle Marine Sciences Laboratory, Sequim, Washington.

Ward JA, VI Cullinan, RK Kropp, RK Karls, KD Hall, and BA Romano. 2005. *Evaluation of the Environmental Impacts of Offshore Oil Activities and Associated Coastal Facilities on the Marine Environment of the Campeche Sound* (WBS 3.7.1--Toxicological Testing and Bioaccumulation Exposures). PNWD-3546. Prepared for PEMEX, the Mexican Petroleum Institute, by Battelle—Pacific Northwest Division, Sequim, Washington.

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Ward JA. 2003. "Review of Analytical Data Associated with the Electrochemical Remediation Technology (ECRT) Process Used at the Georgia Pacific Log Pond Demonstration Site, Bellingham, Washington." PNWD-3296. Prepared for the Washington State Department of Ecology under contract with Science Applications International Corporation (SAIC) by Battelle Marine Sciences Laboratory, Sequim, Washington.

Diefenderfer HL, and JA Ward. 2002. *Analysis of Potential Downstream Contamination from Dike Removal for Restoration: Willapa River Estuary, Washington.* PNWD-3161. Prepared for Ducks Unlimited by Battelle Marine Sciences Laboratory, Sequim, Washington.

Diefenderfer HL, JA Ward, SL Sargeant, AD Skillman, and VI Cullinan. 2002. *Centredale Manor Channel Catfish (Ictalurus punctatus) Early Life-Stage Exposures with 2,3,7,8-TCDD, PCB 77, PCB 126, and 1,2,4,5,7,8-hexachloroxanthene (HCX).* PNWD-3159. Prepared for the U.S. Army Corps of Engineers, New England District; funded by the U.S. Environmental Protection Agency. Battelle Marine Sciences Laboratory, Sequim, Washington.

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Blanton, SL, and JA Ward. 2000. 45-Day Bioaccumulation Test with *Macoma nasuta* and *Nephtys caecoides:* Hylebos Wood Debris Group PSDDA. PNWD-3052. Prepared for Pentec Environmental, Edmonds, Washington, by Battelle Marine Sciences Laboratory, Sequim, Washington.

Pinza, MR, JQ Word, JA Ward, and RK Kropp. 2000. *Ecotoxicological Testing to Address Confounding Factors for Hong Kong Contaminated Sediments.* PNWD-3020. Prepared for ERM-Hong Kong, Ltd., by Battelle Marine Sciences Laboratory, Sequim, Washington.

Ward, JA, and SL Blanton. 2000. Amphipod and Bivalve Larvae Bioassay Results: Hylebos Wood Debris Group PSDDA. PNWD-3043. Prepared for Pentec Environmental, Edmonds, Washington, by Battelle Marine Sciences Laboratory, Sequim, Washington.

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