October 25, 2010

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
	)	
PROGRESS ENERGY FLORIDA, INC.	)	Docket Nos. 52-029 and 52-030
	)	
	)	
(Combined License Application for Levy County Nuclear Power Plant, Units 1 and 2)	)	

NRC STAFF ANSWER TO PROGRESS ENERGY FLORIDA'S
MOTION FOR SUMMARY DISPOSITION OF CONTENTION 4 CONCERNING
THE ENVIRONMENTAL IMPACTS OF SALT DRIFT AND PASSIVE DEWATERING

INTRODUCTION

The NRC staff (Staff) hereby answers Progress Energy Florida's (Applicant) "Motion for Summary Disposition of Contention 4 (Environmental Impacts of Dewatering and Salt Drift) with Regard to Salt Drift and Passive Dewatering" (Motion) pursuant to 10 C.F.R. § 2.1205(b) and the Atomic Safety and Licensing Board's Initial Scheduling Order dated August 27, 2009. *Progress Energy Florida, Inc*. (Levy County Nuclear Power Plant, Units 1 and 2), LBP-09-22, 70 NRC __ (slip op. at 8) (August 27, 2009). Summary disposition is appropriate because there is no genuine dispute of material fact relevant to the salt drift and passive dewatering portions of Contention 4; the Staff agrees with the Applicant that these portions of the contention should be dismissed as a matter of law. Two affidavits supporting the Staff's position are attached to this Answer.[1]

[1] *See* Attachment 2, "Affidavit of Daniel W. Baber, Larry K. Berg, Joseph Peyton Doub, (continued. . .)

BACKGROUND

On July 28, 2008, the Applicant filed an application for a combined construction permit and operating license (COL) for two new reactors in Levy County, Florida. On February 6, 2009, the Joint Intervenors collectively filed a petition to intervene and several contentions.[2] On July 8, 2009, the Board issued a Memorandum and Order granting the hearing request and admitting, among others, Contention 4 that included a challenge to the Applicant's analysis of passive dewatering and salt drift during operations. *Progress Energy Florida, Inc*. (Levy County Nuclear Power Plant, Units 1 and 2), LBP-09-10, 70 NRC 51, 104 (2009). After the Applicant appealed, the Commission affirmed the admission of Contention 4. *Progress Energy Florida, Inc.* (Levy County Nuclear Power Plant, Units 1 and 2), CLI-10-02, 71 NRC __ (slip op. at 3-18) (January 7, 2010).

As admitted, the portion of Contention 4 that challenges the Applicant's analysis of salt drift states that "impacts to wetlands, floodplains, special aquatic sites, and other waters, associated with salt drift and salt deposition resulting from cooling towers (that use salt water) being situated in an inland, freshwater wetland area of the LNP site" are incorrectly characterized as small. *Levy County*, LBP-09-10, 70 NRC at 109. In admitting this portion of Contention 4, the Board noted that the Joint Intervenors recognized that the Applicant's

---

(. . .continued)

and Rajiv Prasad Concerning the Staff's Analysis of the Environmental Impacts Due to Salt Drift and Salt Deposition" (Salt Drift Affidavit) and Attachment 3, the "Affidavit of Lance W. Vail Concerning the Environmental Impacts Due to Passive Dewatering" (Passive Dewatering Affidavit).

[2] The Joint Intervenors are the Ecology Party of Florida, the Green Party of Florida, and Nuclear Information and Resource Service.

Environmental Report (ER) contained an analysis of salt drift but they "question the adequacy of this discussion and the conclusion that these impacts are acceptable." *Id*. at 50. The passive dewatering portion of Contention 4 challenges the ER's conclusion that "impacts to wetlands, floodplains, special aquatic sites, and other waters, associated with dewatering" specifically "impacts resulting from . . . passive dewatering" are small. *Id*. at 109. Passive dewatering is defined as "non-mechanical dewatering related to surface impoundments." *Id*. at 50.

On October 4, 2010, the Applicant timely filed its Motion. On October 6, 2010, the Joint Intervenors filed a motion for extension of time to file their answer to the Applicant's Motion. The Board granted the Joint Intervenors' motion giving them until November 15, 2010, to file their response. Licensing Board Order (Granting Motions for Extensions of Time) at 2 (October 7, 2010) (unpublished). The Staff's Answer is timely under Section 2.1205 and the Board's Initial Scheduling Order. *Levy County*, LBP-09-22, 70 NRC __ (slip op. at 8).

DISCUSSION

I. Legal Standards

A. Summary Disposition Standards

In subpart L proceedings, the Board must apply the standard for summary disposition found in Subpart G. 10 C.F.R. § 2.1206 (c). Section 2.710(a) of Subpart G states that a party may move for summary disposition "for all or any part of the matters in the proceeding." 10 C.F.R. § 2.710(a). Section 2.710(d)(2) states that the presiding officer shall grant the summary disposition motion if the moving party "show[s] that there is no genuine issue as to any material fact and that the moving party is entitled to a decision as a matter of law." 10 C.F.R. § 2.710(d)(2).

The NRC's summary disposition standards are based on Rule 56 of the Federal Rules of Civil Procedure. *Entergy Nuclear Generating Co.* (Pilgrim Nuclear Power Station), CLI-10-11,

71 NRC __ (slip. op. at 11-12) (March 26, 2010). A party that opposes a motion for summary disposition "may not rest upon [ ] mere allegations or denials," but must state "specific facts showing that there is a genuine issue of fact" for hearing. *Id*. at 12 *citing* 10 C.F.R. § 2.710(b). There cannot merely be the existence of "some alleged factual dispute between the parties," for "the requirement is that there be no genuine issue of material fact." *Id*. *quoting Anderson v. Liberty Lobby*, 477 U.S. 242, 247-48 (1986) (emphasis in original). "'Only disputes over facts that might affect the outcome' of a proceeding would preclude summary disposition." *Id*. The ruling on a summary disposition motion, however, should not be a "trial on affidavits." *Id*. at 13. At the summary disposition stage, "the judge's function is not himself to weigh the evidence and determine the truth of the matter but to determine whether there is a genuine issue for [hearing]." *Id*. *quoting Anderson*, 477 U.S. at 249. "The evidence of the non-movant is to be believed, and all justifiable inferences are to be drawn in his favor." *Id*. If "reasonable minds could differ as to the import of the evidence," summary disposition is inappropriate. *Id*.

B. Standards for Analyzing Environmental Impacts

Using the approach outlined in regulations promulgated by the Council on Environmental Quality, 40 C.F.R. § 1508.27, the Staff developed a three-level (*i.e.*, SMALL, MODERATE, and LARGE) standard system to guide its categorization of impact significance in environmental reviews. *See*, 10 C.F.R. Part 51, App. B, Table B-1 n.3. The Staff followed this approach in drafting the Levy COL Draft Environmental Impact Statement (DEIS). DEIS at 1-3. As explained in Table B-1 n.3 and the DEIS, an impact is SMALL if "environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important

attribute of the resource."[3] Impacts are MODERATE when they alter noticeably, but do not destabilize, important attributes of the resource; they are LARGE when they are clearly noticeable and sufficient to destabilize important attributes of the resource. 10 C.F.R. Part 51, App. B, Table B-1 n.3.

The NEPA principle that federal agencies must take a "hard look" at the environmental impacts of a proposed action is subject to a "'rule of reason' in that consideration of environmental impacts need not address every impact that could possibly result, but rather only those that are reasonably foreseeable or have some likelihood of occurring." *Southern Nuclear Operating Co.* (Early Site Permit for Vogtle ESP Site), LBP-09-07, 69 N.R.C. 613, 631 (2009) *citing Long Island Lighting Co.* (Shoreham Nuclear Power Station), ALAB-156, 6 AEC 831, 836 (1973). Agencies may decline to analyze issues that are "'remote and speculative' or 'inconsequentially small.'" *Id. citing Vermont Yankee Nuclear Power Corp.* (Vermont Yankee Nuclear Power Station), ALAB-919, 30 NRC 29, 44 (1989).

II. Argument

The Staff agrees with the Applicant that there are no material facts in dispute and that summary disposition is appropriate. The Staff's Statement of Material Facts Not in Dispute is included as Attachment 1. The Staff also agrees with the Motion that given the material facts not in dispute, the Applicant is entitled to a decision as a matter of law, and the salt drift and passive dewatering portions of Contention 4 should be dismissed.

[3] The Applicant incorrectly described the SMALL standard in its Motion as "no reasonable prospect of destabilizing a resource." Motion at 6-7.

A. Salt Drift

The salt drift portion of Contention 4 challenges the Applicant's conclusion that the "impacts to wetlands, floodplains, special aquatic sites, and other waters, associated with salt drift and salt deposition resulting from cooling towers (that use salt water) being situated in an inland, freshwater wetland area of the LNP site" are small. *Progress Energy Florida*, LBP-09-10, 70 NRC at 109. In admitting this portion of Contention 4, the Board noted that the Joint Intervenors recognized that the ER contained an analysis of salt drift but they "question the adequacy of this discussion and the conclusion that these impacts are acceptable." *Id*. at 50.

The Staff agrees with the Motion that there are no material facts in dispute regarding salt drift and that the Applicant is entitled to a decision as a matter of law. Contention 4 is a contention of inadequacy, not a contention of omission, challenging the ER's finding that environmental impacts form salt drift are small. The test for any impact being larger than small is if the impact will "noticeably alter any important attribute of the resource." *See*, 10 C.F.R. Part 51, App. B, Table B-1 n.3. As discussed below, the facts regarding salt drift are undisputed, and given those facts it is not reasonably foreseeable that there would be any more than a small impact, because it is not reasonably foreseeable that any important attribute of an onsite or offsite resource will be noticeably altered due to salt drift.

The salt drift portion of the Staff's Answer is supported by the affidavit of Dr. Daniel W. Baber, Larry K. Berg, Joseph Peyton Doub, and Dr. Rajiv Prasad. Copies of the affiants' credentials are attached. Dr. Daniel W. Baber is an NRC contractor with ICF International, and he is the lead author for the sections of the DEIS discussing terrestrial ecology and wetland issues. Dr. Baber has more than 25 years experience as an environmental consultant performing natural resource assessments, environmental impact analyses, wildlife and wetlands studies, threatened and endangered species evaluations, and other environmental and

ecological investigations. Salt Drift Affidavit at ¶ 1(a). Dr. Larry K. Berg is a scientist on the technical staff of the Pacific Northwest National Laboratory (PNNL), an NRC contractor for the preparation of the DEIS. He has studied atmospheric dispersion and transport for nearly 10 years, and he contributed to the cooling systems impacts section of the DEIS. Salt Drift Affidavit at ¶ 1(b). Joseph Peyton Doub is an environmental scientist/terrestrial ecologist in the Division of Site and Environmental Reviews in the NRC Office of New Reactors. Mr. Doub directed and reviewed the assessment of impacts to terrestrial ecological resources and wetlands included in the DEIS. Mr. Doub has more than 20 years of experience as an environmental consultant performing wetland delineations and assessments, environmental impact analyses, forest and vegetation studies, and other environmental and ecological investigations. Salt Drift Affidavit at ¶ 1(c). Dr. Rajiv Prasad is a scientist in the Hydrology Group of the Energy and Environment Directorate at PNNL. Dr. Prasad prepared sections on surface water use and quality for the DEIS. Dr. Prasad has been employed by PNNL for the last six years, during which time he has been involved in surface water-related reviews of several Early Site Permit (ESP) and COL Applications including the Clinton, North Anna, Grand Gulf, and Vogtle ESP EISs and the Levy and South Texas Project COLA EISs. Salt Drift Affidavit at ¶ 1(d).

1. Undisputed Facts Regarding Salt Drift

As discussed below, the Staff agrees with the Applicant that there are no material facts in dispute regarding impacts from salt drift and salt deposition. While the Staff would state some facts differently than the Applicant's "Statement of Material Facts as to Which No Genuine Issue Exists",[4] because the differences would not affect the outcome of the proceeding the Staff

[4] Motion at Attachment A ("Applicant's Statement of Facts")

agrees that there is no dispute of material fact. *See Pilgrim*, CLI-10-11, 71 NRC at __ (slip op. at 12) ("Only disputes over facts that might affect the outcome of a proceeding would preclude summary disposition.") (internal quotations omitted).

The Staff agrees with the Applicant that there is no genuine dispute of fact, but the Staff adds clarifying details to paragraphs 5, 15, 16, and 17 from the Applicant's Statement of Facts. Salt Drift Affidavit at ¶¶ 5, 6, 7, 14. All of the Staff's restated facts for which there is no dispute are included in Attachment 1. For paragraph 5 from the Applicant's Statement of Facts, the Staff provides more detail regarding the source of cooling water, to make this statement of fact consistent with the analysis in the DEIS. Salt Drift Affidavit at ¶ 14. The Staff also adds more detail to paragraph 15 from the Applicant's Statement of Facts to specify that the threshold used by the Applicant in its analysis is from the Environmental Standard Review Plan, NUREG-1555, and that it is a threshold for evaluating the effects of salt drift from cooling tower operation on vegetation. Salt Drift Affidavit at ¶¶ 5, 9, 10. For paragraph 16 from the Applicant's Statement of Facts, the Staff provides more details regarding the similarities and differences between the plant communities at the Crystal River Energy Complex and the Levy site. Salt Drift Affidavit at ¶ 6. The Staff also adds further detail to paragraph 17 from the Applicant's Statement of Facts. Salt Drift Affidavit at ¶¶ 7, 11, 12, 16. The Staff added to paragraph 17 from the Applicant's Statement of Facts to specifically discuss the soil and aquatic salinization portions of the contention. *Id*.

While the Staff added details to several of the facts in the Applicant's Statement of Facts, there is no material dispute between the Applicant and Staff regarding these facts; the Staff's changes merely add detail or clarity to the Applicant's Statement of Facts. The Staff is also unaware of any facts that have been put forth by the Joint Intervenors that show a genuine dispute over any material fact regarding salt drift or salt deposition. Because there is no genuine

dispute over any material fact regarding salt drift or salt deposition, it is appropriate for the Board to decide this portion of the contention as a matter of law. 10 C.F.R. § 2.710(d).

2. Salt Drift Onsite and Offsite

The Applicant is entitled to a decision as a matter of law regarding salt-drift impacts both onsite and offsite. The Applicant's Statement of Facts show that total salt deposition offsite will be 6.81 kilogram/hectare/month (kg/ha/mo) and the maximum salt deposition rate onsite will be 10.75 kg/ha/mo. Applicant's Statement of Facts at ¶ 14. When determining impact to the environment due to salt drift, the Staff utilizes the guidance in section 5.3.3.2 of NUREG-1555, the Environmental Standard Review Plan (ESRP).[5] The ESRP guidance is derived from Sections 4.3.4.1 and 4.3.5.1 of the Generic Environmental Impact Statement for License Renewal of Nuclear Plants, NUREG-1437,[6] for which a review of the scientific literature regarding impacts from salt drift and salt deposition was performed. ESRP at § 5.3.3.2; Salt Drift Affidavit at ¶ 10. The ESRP establishes a threshold of 10 kg/ha/mo for visible impacts to leaves. ESRP at § 5.3.3.2-5; Salt Drift Affidavit at ¶ 9. Visible leaf damage is a meaningful indicator of possible impacts to terrestrial or wetland habitats. Salt Drift Affidavit at ¶ 10.

The total salt deposition offsite of 6.81 kg/ha/mo is below the ESRP threshold for visible leaf damage. Because offsite deposition is below the threshold for visible leaf damage, and

---

[5] Environmental Standard Review Plans for Environmental Reviews for Nuclear Power Plants, NUREG-1555, Rev. 0 (October, 1999). Section 5.3.3.2, "Terrestrial Ecosystems", of the ESRP is attached to this Answer as Attachment 4.

[6] Generic Environmental Impact Statement for License Renewal of Nuclear Plants, NUREG-1437, Rev. 1 (1996). Section 4.3, "Cooling Towers", of the Generic Environmental Impact Statement for License Renewal of Nuclear Plants is attached to this Answer as Attachment 5.

visible leaf damage is a meaningful indicator of possible impacts to terrestrial or wetland habitats, it is unlikely that there would be any noticeable impact to any offsite resource due to salt drift.

The maximum salt deposition rate onsite, 10.75 kg/ha/mo, is slightly greater than the threshold for visible leaf damage established in the ESRP. Salt Drift Affidavit at ¶ 9. Consequently, minor leaf damage is expected onsite. Salt Drift Affidavit at ¶ 9. However, a deposition rate of 10.75 kg/ha/mo is not expected to noticeably impact the terrestrial or wetland habitats onsite. Salt Drift Affidavit at ¶ 9. The calculations of potential salt drift were conservative and the modeling showed that salt deposition would have only exceeded the 10 kg/ha/mo threshold in one of the five years of environmental monitoring used for the ER. Salt Drift Affidavit at ¶¶ 9, 10. Further, the threshold for leaf damage established in the Generic Environmental Impact Statement for License Renewal of Nuclear Plants and the ESRP is conservative because it is based on relatively sensitive plant species. Salt Drift Affidavit at ¶ 10. And visible leaf damage is a meaningful indicator of possible damage to terrestrial or wetland habitats. Salt Drift Affidavit at ¶ 10. Consequently, the overall species composition and ecological function of the affected habitats are unlikely to be noticeably altered. Salt Drift Affidavit at ¶ 9.

The Applicant relies in part on a study done at the Crystal River Energy Complex ("CREC") to support its conclusion that salt drift at the LNP site will not noticeably alter "any aspects of vegetation" at the LNP site. Motion at 10. This 14-year study at CREC found no significant or discernable impacts to vegetation caused by salt drift or salt deposition at the CREC site. The Staff notes that there are some distinctions between the plant communities at the CREC site and the LNP site. Salt Drift Affidavit at ¶ 6. However, the CREC study provides

support for the analysis provided in the DEIS and the analysis stated above. Salt Drift Affidavit at ¶ 6.

Because the contention challenges "impacts to wetlands, floodplains, special aquatic sites, and other waters, associated with salt drift and salt deposition", the Staff also considered whether salt drift could cause any noticeable impacts to freshwater habitats due to increases in soil or water salinity. Regarding soil and water salinity, as noted above, visible leaf damage is a meaningful indicator of possible damage to wetland habitats. Salt Drift Affidavit at ¶ 10. The Staff found that the possibility of noticeable impacts to wetlands due to both soil and water salinity increases was unlikely. Salt Drift Affidavit at ¶¶ 11, 12. For water salinity, given the expected amount of salt deposition, and the average rainfall in the area, a conservative estimate of the increase of salinity in the freshwater wetlands onsite would be 0.026 parts per thousand (ppt). Salt Drift Affidavit at ¶ 12, 16. Because waters up to 1ppt are considered freshwater, the impacts of an increase of salinity of 0.026ppt are not likely to be noticeable. Salt Drift Affidavit at ¶¶ 11, 12.

Given the facts not in dispute, it is unlikely that there will be a noticeable impact to any important attribute of an onsite or offsite resource. At this time, the Staff is unaware of any facts that have been put forth by any party that would make it reasonably foreseeable that an important attribute of a resource would be noticeably altered. Because it is not reasonably foreseeable that there will be noticeable impacts to any important attribute of a resource onsite or offsite due to salt drift or salt deposition, the Applicant is entitled to a decision as a matter of law, and this portion of Contention 4 should be dismissed. 10 C.F.R. § 2.710(d).

B. Passive Dewatering

The passive dewatering portion of Contention 4 was admitted by the Board on the basis

that the Environmental Report "fail[ed] to adequately address, and inappropriately characteriz[ed] as SMALL, . . . [i]mpacts to wetlands, floodplains, special aquatic sites, and other waters, associated with dewatering, specifically . . . [i]mpacts resulting from active and passive dewatering." *Progress Energy Florida*, LBP-09-10, 70 NRC at 109. The Staff agrees with the Motion that summary disposition is appropriate for the issue of passive dewatering impacts because there are no material facts in dispute, and the Applicant is entitled to a decision as a matter of law. Specifically, as discussed below, the Staff agrees with the Applicant that no passive dewatering will occur at Levy.

This Answer is supported by the Affidavit of Lance W. Vail, a Senior Research Engineer in the Hydrology Group of the Energy and Environment Directorate at PNNL. Attachment 3. Mr. Vail's curriculum vitae is attached to his affidavit. Mr. Vail holds a B.S. in Environmental Resources Engineering and an M.S. in Civil Engineering and has worked on projects with a nexus to water and energy since joining PNNL in 1981. Passive Dewatering Affidavit at ¶ 1. He has supervised the PNNL staff review of the Applicant's ER, reviewed the hydrology-related issues in the ER reviewed the hydrology-related sections of the DEIS. *Id*. at ¶¶ 1, 3.

The Staff agrees with paragraph 18 from the Applicant's Statement of Facts that "[n]o passive dewatering is included in the Levy Project" because it "has been designed to specifically exclude passive dewatering features." Applicant's Statement of Facts at ¶ 18; Passive Dewatering Affidavit at ¶ 4. But the Staff does not view the facts included in this list that relate to stormwater management as necessary to support a conclusion that summary disposition is appropriate on the passive dewatering portion of Contention 4. Accordingly, the Staff takes no position on these facts and includes only facts that relate to passive dewatering in its Statement of Material Facts Not in Dispute. Attachment 1 at 3.

Because the Staff observed that the Levy Plant design would preclude passive dewatering, the term "passive dewatering" does not appear in the DEIS. Passive Dewatering Affidavit at ¶¶ 4-5. The Staff understands the term "passive dewatering" to refer to the drainage of groundwater into structures below the adjacent groundwater level (*e.g.*, drain pipes, high-conductivity conduits, and ditches) and the subsequent flow of this water by gravity to lower elevations. *Id*. at ¶ 5. This is distinct from stormwater management, which uses systems to route precipitation over the land surface into landscape features and structures such as detention and recharge basins. *Id*.

The Applicant is entitled to a decision as a matter of law regarding the impacts of passive dewatering. As stated in the Staff's Statement of Material Facts Not in Dispute, passive dewatering will not occur during operations at the Levy site; thus, the impacts of passive dewatering need not be analyzed under NEPA because they are not reasonably foreseeable. Attachment 1 at 3. For these reasons, summary disposition on the passive dewatering portion of Contention 4 is appropriate.

CONCLUSION

For the reasons stated above, the Applicant's Motion should be granted. There are no material facts in dispute regarding the salt drift and passive dewatering portions of Contention 4. Thus this contention may be disposed of as a matter of law. And because the Applicant has demonstrated that it is entitled to a decision as a matter of law, the passive dewatering and salt drift portions of Contention 4 should be dismissed.

CERTIFICATION

I certify that I have made a sincere effort to make myself available to listen and respond to the moving party, and to resolve the factual and legal issues raised in the motion, and that while we disagreed with the Applicant over the wording of some of the material facts not in dispute, we agree that the Motion should be granted.

Respectfully Submitted,

/Signed (electronically) by/
Kevin C. Roach
Counsel for NRC Staff
U.S. Nuclear Regulatory Commission
Mail Stop O-15 D21
Washington, DC 20555-0001
(301) 415-2779
Kevin.Roach@nrc.gov

/Executed in accord with 10 CFR 2.304(d)/
Jody C. Martin
Counsel for NRC staff
U.S. Nuclear Regulatory Commission
Mail Stop O-15 D21
Washington, DC 20555-0001
(301) 415-1569
Jody.Martin@nrc.gov

Dated at Rockville, Maryland
this 25th day of October, 2010

.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
	)	
PROGRESS ENERGY FLORIDA, INC.	)	Docket Nos. 52-029 and 52-030
	)	
	)	
(Levy County Nuclear Site, Units 1 and 2)	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of the NRC Staff Answer to Progress Energy Florida's Motion for Summary Disposition of Contention 4 Concerning the Environmental Impacts of Salt Drift and Passive Dewatering, dated October 25, 2010, have been served upon the following persons by Electronic Information Exchange this 25th day of October, 2010:

Administrative Judge
Alex S. Karlin, Chair
Atomic Safety and Licensing Board Panel
Mail Stop: T-3F23
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
E-mail: Alex.Karlin@nrc.gov

Administrative Judge
Anthony J. Baratta
Atomic Safety and Licensing Board Panel
Mail Stop: T-3F23
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
E-mail: Anthony.Baratta@nrc.gov

Administrative Judge
William M. Murphy
Atomic Safety and Licensing Board Panel
Mail Stop: T-3F23
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
E-mail: William.Murphy@nrc.gov

Office of Commission Appellate Adjudication
Mail Stop O-16C1
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
E-mail:OCAAmail@nrc.gov

Office of the Secretary
ATTN: Docketing and Service
Mail Stop: O-16C1
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
E-mail: HEARINGDOCKET@nrc.gov

Megan Wright
Joshua Kirstein
Law Clerks
Atomic Safety and Licensing Board
Mail Stop: T-3F23
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
E-mail: megan.wright@nrc.gov
josh.kirstein@nrc.gov

Cara Campbell
The Ecology Party of Florida
641 SW 6th Ave
Ft. Lauderdale, FL 33315
E-Mail: levynuke@ecologyparty.org

Michael Canney
The Green Party of Florida
Alachua County Office
PO Box 12416
Gainesville, FL 32604
E-mail: alachuagreen@windstream.net

Michael Mariotte
Executive Director, NIRS
6930 Carroll Ave. Suite 340
Takoma Park, MD 20912
Email: nirsnet@nirs.org

Mary Olson
Southeast Regional Coordinator, NIRS
PO Box 7586
Asheville, NC 28802
Email: maryo@nirs.org

John H. O'Neill, Esq.
Michael G. Lepre, Esq.
Blake J. Nelson, Esq.
Robert B. Haemer, Esq.
Jason P. Parker, Esq.
Stefanie N. George, Esq.
Counsel for Progress Energy Florida, Inc.
Pillsbury, Winthrop, Shaw, Pittman, LLP
2300 N. Street, NW
Washington, DC 20037-1122
E-mail: john.O'Neill@pillsburylaw.com
michael.lepre@pillsburylaw.com
blake.nelson@pillsburylaw.com
robert.haemer@pillsburylaw.com
jason.parker@pillsburylaw.com
stefanie.george@pillsburylaw.com

/signed (electronically) by/
Kevin C. Roach
Counsel for the NRC Staff
U.S. Nuclear Regulatory Commission
Mail Stop O-15 D21
Washington, DC 20555-0001
(301) 415-2779
Kevin.Roach@nrc.gov

ATTACHMENT 1

NRC STAFF'S STATEMENT OF MATERIAL FACTS NOT IN DISPUTE

As stated in the Staff's Answer and Affidavits, the NRC staff generally agrees with the Applicant's "Statement of Material Facts as to Which No Genuine Issue Exists" ("Applicant's Statement of Facts"). But the Staff made clarifications and additions to several of the Applicant's Statement of Facts. Additionally, because some facts included by the Applicant regarding storm water management are unnecessary to decide the passive dewatering portion of the contention, the Staff takes no position on them. The below list uses the general format of the Applicant's Statement of Facts to show those facts with which the Staff agrees, those facts the Staff clarified, and those facts for which the Staff takes no position.

I. General

- The Staff agrees with paragraphs 1-4 from the Applicant's Statement of Facts

For the reasons discussed in the Staff's Answer and the Salt Drift Affidavit, the Staff has reworded paragraph 5 as follows:

5. The source of makeup water to cooling towers at the Levy site would be the Cross Florida Barge Canal. Because of freshwater inflow from springs and the Inglis Lock into the canal, the makeup water obtained from the canal would have a lower salinity than waters of the Gulf of Mexico. Salt Drift Affidavit at ¶ 14.

- The Staff agrees with paragraphs 6-10 from the Applicant's Statement of Facts

A. Salt Deposition Off-Site

- The Staff agrees with paragraphs 11 and 12 from the Applicant's Statement of Facts

B. Salt Deposition On-Site

- The Staff agrees with paragraphs 13 and 14 from the Applicant's Statement of Facts

For the reasons discussed in the Staff's Answer and the Salt Drift Affidavit, the Staff has reworded paragraphs 15, 16 and 17 as follows:

ATTACHMENT 1

15. The maximum predicted on-site salt deposition is within the range of 10 to 20 kg/ha/mo where, according to guidance developed by the NRC in the Environmental Standard Review Plan (ESRP) for evaluating the effects of salt drift from cooling tower operation on vegetation, only minor and infrequent leaf damage would be expected. Salt Drift Affidavit at ¶ 5.

16. A fourteen year study of the potential impacts of salt deposition from saltwater-based cooling towers at the Crystal River Energy Complex ("CREC") showed that salt drift and salt deposition at that facility did not have any discernible impact on vegetation other than minor and infrequent leaf damage. Howroyd Affidavit at ¶ 28. The CREC is located approximately 15.5 km southwest of the Levy Project site, and contains many of the same types of plant communities, such as pine plantations, freshwater cypress and hardwood swamps, and freshwater marshes. However, the CREC site is located closer to the coast and can therefore be expected to also support more salt-tolerant coastal plant communities, such as saltwater tidal wetlands. Salt Drift Affidavit at ¶ 6.

17. Based on the analysis performed, including considering that frequent rainfall at Levy reduces the duration that vegetation is exposed to deposited salt and limits the potential for increasing soil salinization, substantial adverse impacts to vegetation from salt deposition are not expected and other adverse impacts to freshwater wetlands areas of the Levy site and surrounding landscape are unlikely. Salt drift and deposition are not expected to substantially impair freshwater ecosystems at the Levy site or the surrounding landscape. Salt Drift Affidavit at ¶ 7. Based on the conservative analysis performed in the DEIS, frequent rainfall at the Levy site would likely dilute the maximum estimated salt deposit of 10.75 kg/ha/mo to an estimated runoff salinity well below the threshold of brackish water. Therefore, salt drift and deposition at the Levy site are not expected to noticeably alter the salinity of on-site and off-site aquatic features. Salt Drift Affidavit at ¶ 16.

ATTACHMENT 1

III. Passive Dewatering

- The Staff agrees with paragraph 18 from the Applicant's Statement of Facts

For the reasons discussed in the Staff's Answer and the Passive Dewatering Affidavit, the Staff takes no position on paragraphs 19-24 of the Applicant's Statement of Fact, because these facts are not necessary to resolve the Motion.

- The Staff agrees with paragraph 25 from the Applicant's Statement of Facts

ATTACHMENT 2

October 25, 2010

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	Docket Nos. 52-029-COL
Progress Energy Florida, Inc.	)	52-030-COL
	)	
Levy County Nuclear Plant, Units 1 and 2	)	

AFFIDAVIT OF DANIEL W. BABER, LARRY K. BERG,
JOSEPH PEYTON DOUB, AND RAJIV PRASAD CONCERNING THE
THE ENVIRONMENTAL IMPACTS DUE TO SALT DRIFT AND SALT DEPOSITION

Daniel W. Baber (DWB), Larry K. Berg (LKB), Joseph Peyton Doub (JPD), and Rajiv Prasad (RP)[1] do hereby state as follows:

1(a). (DWB) I am a senior wildlife ecologist with more than 25 years experience as an environmental consultant performing natural resource assessments, environmental impact analyses, wildlife and wetlands studies, threatened and endangered species evaluations, and other environmental and ecological investigations. I have been employed by ICF International since its acquisition of Jones and Stokes Associates in February 2008. My employment as an environmental consultant at Jones and Stokes spanned 7 years. Prior to this, I was employed as a senior scientist by Beak Consultants International for 16 years until the Portland office of Beak was acquired by Jones and Stokes in 2001. A statement of my professional qualifications is attached. I am an NRC contractor reviewing terrestrial ecology and wetland issues associated with the LNP application. In this role, I served as the lead author of DEIS sections addressing terrestrial ecology and wetlands issues (Sections 2.4.1, 4.3.1, 5.3.1 and 7.3.1).

1(b). (LKB) I am a scientist on the technical staff of Pacific Northwest National Laboratory (PNNL), Fundamental and Computational Sciences Division. I have studied

[1] In this Affidavit, the identity of the affiant who supports each numbered paragraph is indicated by the notation of his initials in parenthesis.

atmospheric transport and dispersion for nearly 10 years. I have attached a copy of my curriculum vitae, which highlights details of my experience. I reviewed the original application and evaluated sections related to salt deposition in the Applicants Motion and the Intervenors' contention in the DEIS. I am familiar with the bases for the Intervenors' Contention 4, including the Bacchus Declaration, and the Applicant's Motion as they relate to salt drift.

1(c). (JPD) I have been employed since June 2008 as an environmental scientist/terrestrial ecologist in the Division of Site and Environmental Reviews in the NRC Office of New Reactors. Prior to my employment with NRC, I had been employed for more than 20 years as an environmental consultant performing wetland delineations and assessments, environmental impact analyses, forest and vegetation studies, and other environmental and ecological investigations. I am currently serving as the technical reviewer for terrestrial ecology issues on eight combined license (COL) applications and two early site permit (ESP) applications. I am the principal author of Draft Regulatory Guide 4016, which constitutes a proposed Revision 2 to Regulatory Guide 4.11, "Terrestrial Environmental Studies for Nuclear Power Stations." Before coming to NRC, I performed wetland investigations on project sites in more than 15 states since 1988, including wetland delineations for the sites proposed for Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3 in Maryland and the Victoria County Station in Texas. I also served as the principal author of the terrestrial ecology sections of the Environmental Report (ER) for CCNPP Unit 3, and I prepared written testimony on the wetland delineation and functional assessment for submittal to the Maryland Public Service Commission. From 1994 to 1996, I was the lead wetland scientist on a team of consultants preparing land use and land cover maps for the Suwannee River Water Management District, which encompasses areas directly north of Levy County, Florida. A statement of my professional qualifications is attached. I am an NRC technical reviewer assigned to terrestrial ecology and wetland issues associated

with the LNP application. In this role, I directed and reviewed the assessment of impacts to terrestrial ecological resources and wetlands included in the DEIS.

1(d). (RP) I am a scientist in the Hydrology Group of the Energy and Environment Directorate at PNNL. I am currently employed as a Scientist III at PNNL. I have worked as a scientist at PNNL for the last six years. I have been involved in surface water-related reviews of several ESP and COL Applications for the last five years including the Clinton, North Anna, Grand Gulf, and Vogtle ESP EISs and the Levy and South Texas Project COLA EISs. I have reviewed Progress Energy Florida's Environmental Report submitted as part of the Levy COL Application and prepared sections on surface water use and quality for the Levy DEIS. I was also involved in development of surface water guidance in NUREG-1555, Environmental Standard Review Plan. A statement of my professional qualifications is attached. I have reviewed the surface water hydrology-related issues in the ER and prepared the surface water review in the DEIS.

2. (DWB, LKB, JPD, RP) We are familiar with Contention 4 as it relates to salt drift. We have reviewed the bases submitted in support of Contention 4, as presented in the Joint Interveners' filing dated February 6, 2009, which included the Declaration of Sidney Bacchus, Ph.D. We are also familiar with the Applicant's Motion for Summary Disposition of Contention 4 (Environmental Impacts of Dewatering and Salt Drift) with Regard to Salt Drift and Passive Dewatering, filed on October 4, 2010, the attached "Statements of Material Facts as to which Progress Asserts that there is no Genuine Dispute" ("Applicant Statement of Facts") and the Affidavit of Dr. George C. Howroyd.

Description of Cooling Tower and Salt Drift and Deposition

3. (LKB) I contributed to section 5.7.2, Cooling System Impacts, of the DEIS. I have reviewed the applicant's analysis of salt drift and salt deposition from the operation of the cooling

towers at the Levy Nuclear Plant that was presented in the ER. I agree with paragraphs 5 through 11 of the Applicant's Statement of Facts, presented in the Applicant's Motion for Summary Disposition, which are related to Salt Drift and Salt Deposition. These paragraphs include: the source of the cooling water, the drift associated with the operation of the cooling towers, the control of cooling tower drift, flow rate through the cooling system, the components of the drift droplets, the application of the American Meteorological Society/Environment Protection Agency Regulatory model (AERMOD) to estimate deposition, and the on-site and off-site deposition rates.

Ecological Impacts from Cooling Tower Salt Drift and Deposition

4. (JPD, DWB) As part of our official responsibilities as the technical reviewers on terrestrial ecology issues associated with the LNP application, we evaluated the potential incremental and cumulative effects of salt drift on terrestrial habitats, wetlands and their supporting biota resulting from operation of two proposed mechanical draft cooling towers that will service the new reactors. Our assessment is discussed in Sections 5.3 and 7.3 of the DEIS.

5. (JPD, DWB) We have reviewed the statements (paragraphs 1 through 17) made in Sections I and II of the Applicant's Statement of Facts. Paragraphs 1 through 14 are correct with respect to the potential for impacts from salt drift to terrestrial habitats and wetlands. Paragraph 15 should be modified to read as follows (deletions shown in strikeout; insertions shown in italics):

> The maximum predicted ~~worst-case~~ on-site salt deposition is within the range of 10 to 20 kg/ha/mo where, *according to guidance developed by the NRC in the Environmental Standard Review Plan (ESRP) for evaluating the effects of salt drift from cooling tower operation on vegetation*, ~~at, most~~ only minor and infrequent leaf damage would be expected (ESRP at 5.3.3.2-4).

Our changes to paragraph 15 clarify the technical conditions that underlie our acceptance of the statement.

6. (JPD, DWB) Paragraph 16 should be modified to read as follows:

> A fourteen year study of the potential impacts of salt deposition from saltwater-based cooling towers at the Crystal River Energy Complex ("CREC") showed that salt drift and salt deposition at that facility did not have any discernible impact on vegetation other than minor and infrequent leaf damage. The CREC is located approximately 15.5 km south*west* of the Levy Project Site, ~~with vegetation similar to that at the Levy Project site~~ *and contains many of the same types of plant communities, such as pine plantations, freshwater cypress and hardwood swamps, and freshwater marshes. However, the CREC site is located closer to the coast and can therefore be expected to also support more salt-tolerant coastal plant communities, such as saltwater tidal wetlands.*

We clarified this paragraph because not all of the vegetation on the CREC site is similar to that on the Levy site. Nothing stated in our analysis of salt drift impacts in Section 5.3.1.1 of the DEIS implies that all vegetation on the CREC and Levy sites is identical. Instead, we recognize that some of the plant communities on the CREC site are similar to some of the plant communities on the Levy site. However, the CREC site also contains plant communities such as saltwater wetlands that are common directly on the Gulf coast but absent in more inland settings such as the Levy site. We agree that the CREC salt drift study referenced in paragraph 16 provides useful corroborating information supporting the other analyses reported in Section 5.3.1.1 of the DEIS, but our agreement is not premised on identical vegetation at the two sites.

7. (JPD, DWB) Paragraph 17 should be modified to read as follows:

> Based on the analysis performed, including considering that frequent rainfall at Levy reduces the duration that vegetation is exposed to deposited salt *and limits the potential for increasing soil salinization*, *substantial* adverse impacts to vegetation from salt deposition are not expected and other adverse impacts to freshwater wetlands areas of the Levy site *and surrounding landscape* are ~~even less likely~~ *unlikely*. Salt drift and deposition are not expected to *substantially* impair freshwater ecosystems at the Levy site *or the surrounding landscape*.

We consider it necessary to modify paragraph 17 to indicate that potential salt drift impacts on vegetation might be possible but would not be substantial. We cannot rule out the possibility of minor adverse impacts to vegetation. The CREC study referenced in paragraph 16 recognizes minor vegetation damage attributable to salt drift, such as chlorotic leaves or needles (DEIS at 5-22). Our modifications also strengthen paragraph 17 to indicate that adverse vegetation impacts caused by soil salinization are not expected (DEIS at 5-21).

8. (JPD, DWB) The statements of facts not in dispute presented in paragraphs 5, 6 and 7, above, rely on the following assumptions:

- For purposes of salt drift modeling, the salinity of the makeup water supplied to the cooling towers would be 25 parts per thousand (ppt.) under normal operating conditions. ER[2] at 5-38.
- PEF would install drift eliminators on the cooling towers that are effective in reducing drift droplets to less than 0.0005 percent of the drift loss expected without the eliminators. ER at 5-38.
- Operation of the cooling water system (CWS) would be based on 1.5 cycles of concentration. Response to Request for Additional Information 5.3.3.2-1 (June 12, 2009) at Enclosure 1, p. 105 (Attachment 6).
- Use of the model AERMOD and meteorological data from the years 2001 through 2005 to estimate salt deposition rates. ER at 5-40.
- The threshold for visible leaf damage caused by salt drift, as reported in the Environmental Standard Review Plan (ESRP) used by the staff in reviewing environmental elements of applications for nuclear power plant licenses (NUREG-1555), are between 10 and 20 kilogram/hectare/month (kg/ha/mo) of sodium chloride deposited on leaves during the growing season. ESRP at 5.3.3.2-4 (Attachment 4).
- Visible leaf damage constitutes a meaningful surrogate indicator for overall impairment of freshwater wetlands.

9. (JPD, DWB) The maximum predicted offsite deposition rate using meteorological data for any year between 2001 and 2005 would be 6.81 kg/ha/mo, at a location on the property boundary west of the cooling towers. DEIS at 5-20. That rate falls below the threshold of 10 kg/ha/mo for visible leaf damage used by the NRC in the ESRP. Attachment 4 at 5.3.3.2-5. The

[2] Levy County Nuclear Plant, Units 1 and 2 COL Application, Part 3, Applicant's Environmental Report – Combined License Stage, Rev. 1 (October 2, 2009).

maximum predicted onsite deposition rate using meteorological data for any year between 2001 and 2005 would be 10.75 kg/ha/mo. DEIS at 5-20. We recognize that the maximum onsite deposition rate exceeds the threshold of 10 kg/ha/mo for visible leaf damage. Consequently, it is possible that minor leaf injury on individuals of certain sensitive plant species may occur in some years in some onsite uplands and wetlands close to the cooling towers. However, we also recognize that these effects would be limited to the Levy site and that the estimated effects are based on modeling showing that the exceedance of the 10 kg/ha/mo threshold would occur during only 1 out of the 5 years of meteorological data considered. DEIS at 5-20 and 5-21. We further recognize that the overall species composition and ecological function of the affected habitats are unlikely to be noticeably altered.

10. (JPD, DWB) The assumptions used in the Applicant's analysis are conservative. Deposition rate estimates are based on the worst-case meteorological conditions observed for any 1 year over a 5 year period. The threshold for visible leaf damage used by the NRC is based on the responses of relatively sensitive plant species reported in the scientific literature, as summarized in Sections 4.3.4.1 and 4.3.5.1 of the "Generic Environmental Impact Statement for License Renewal of Nuclear Plants", NUREG-1437. Attachment 5. The threshold is based on visible leaf injury, not necessarily injury capable of causing plant mortality or substantial alteration of plant communities. Visible leaf injury constitutes a meaningful indicator of possible damage to terrestrial or wetland habitats.

11. (JPD, DWB) The Applicant's consideration of potential salt drift impacts to freshwater wetlands is based on the potential for salt drift to cause visible leaf injury on vegetation. Applicant's Statement of Facts at ¶ 13. Although we likewise considered visible leaf injury in our independent analysis of salt drift impacts to terrestrial resources and wetlands in Section 5.3 of the DEIS, we also considered the potential for salt drift to cause salinization of wetland soils (DEIS at 5-21) and wetland surface waters. DEIS at 5-23. We determined that soil

salinization was unlikely because the Levy site receives sufficient rainfall (on the order of 53 inches per year) to leach soils from the predominately sandy soil profile. Section 4.3.4.1.3 of the "Generic Environmental Impact Statement for License Renewal of Nuclear Plants", NUREG-1437, describes the effects of drift deposition on soils in humid environments as being at most transitory. Attachment 5 at 4-39.

12. (JPD, DWB) Using the maximum onsite salt drift deposition estimate of 10.75 kg/ha/mo (DEIS at 5-20) and assuming the deposition is subjected to the lowest mean monthly precipitation of 1.62 inches as determined for the region (DEIS at Section 2.3.1.1), we estimated a conservative runoff salinity concentration of 0.026 ppt during cooling tower operation. Although evapotranspiration would contribute to salinization of surface waters on the site, the abundant precipitation would result in even greater dilution; therefore, the concentration estimated above is conservative. The potential for long-term concentration of salt in surface waters is expected to be limited by exchange of water between the surface and groundwater systems, considering the lack of a confining geologic formation between the aquifer systems at the Levy site. DEIS at Section 2.3.1.2. Considering the low additional contribution to surface water salinity from cooling tower drift and the low potential for concentration of salts in surface waters, we do not expect cooling tower drift to noticeably impair freshwater ecosystems on the Levy site.

Impacts to Water Quality from Cooling Tower Salt Drift and Deposition

13. (RP) Water quality impacts from salt drift are described in DEIS Section 5.3.1.1, pages 5-22 and 5-23.

14. (RP) The Applicant states that the source of cooling water will be "saltwater pumped from the Cross Florida Barge Canal." Applicant's Statement of Facts at ¶ 5. As stated in DEIS Section 5.2.2.1 on page 5-5, waters obtained from the Gulf of Mexico and spring flow into the CFBC would be used to supply makeup water for normal plant operations. Because of

the freshwater flow from springs and the leakage from Inglis Lock into the CFBC, the makeup water obtained from the CFBC would have a lower salinity than waters of the Gulf of Mexico. Therefore, paragraph 5 of the Applicant's Statement of Facts should be modified to state: "The source of makeup water to cooling towers at the Levy site would be the Cross Florida Barge Canal. Because of freshwater inflow from springs and the Inglis Lock into the canal, the makeup water obtained from the canal would have a lower salinity than waters of the Gulf of Mexico."

15. (RP) I agree with paragraphs 6, 8, and 9 in the Applicant's Statement of Facts.

16. (RP) The Applicant states in paragraph 17 that "frequent rainfall at Levy reduces the duration that vegetation is exposed to deposited salt" and therefore "adverse impacts to vegetation from salt deposition are not expected and other adverse impacts to freshwater wetland areas of the Levy site are even less likely." The applicant goes on to state that "salt drift and deposition are not expected to impair freshwater ecosystems at the Levy site."

I performed an analysis to conservatively estimate the expected salinity of runoff from areas of the Levy site that may receive the maximum estimated salt deposit of 10.75 kg/ha/mo. As stated in DEIS Section 5.3.1.1, page 5-23, the maximum estimated salt deposit of 10.75 kg/ha/mo was allowed to dilute in the lowest regional mean monthly precipitation of 1.62 inches. The resulting conservatively estimated runoff salinity was 0.026 ppt. Because waters with salinity of 1 ppt can be classified as freshwater (DEIS Section 5.3.1.1, page 5-23), I concluded that runoff from the Levy site experiencing the maximum estimated salt deposition would not result in a noticeable effect on salinity of nearby aquatic features. DEIS at 5-23. The average annual precipitation in the region is about 53 in. *Id*. Even though evapotranspiration could reduce the precipitation available for dilution of deposited salt and therefore increase salinity of runoff, I concluded that the relative abundance of precipitation would result in dilution greater than that estimated above. *Id*. Because of greater dilution under more frequently occurring conditions, the runoff salinity will likely be smaller than that estimated above and therefore would

not result in noticeable effect on salinity of nearby aquatic features. Therefore, paragraph 17 should be partially restated as: “Based on the conservative analysis performed in the DEIS, frequent rainfall at the Levy site would likely dilute the maximum estimated salt deposit of 10.75 kg/ha/mo to an estimated runoff salinity well below the threshold of brackish water. Therefore, salt drift and deposition at the Levy site are not expected to noticeably alter the salinity of on-site and off-site aquatic features.”

17. (DWB) I hereby certify under penalty of perjury that the foregoing is true and complete to the best of my knowledge, information, and belief.

18. (LKB) I hereby certify under penalty of perjury that the foregoing is true and complete to the best of my knowledge, information, and belief.

19. (JPD) I hereby certify under penalty of perjury that the foregoing is true and complete to the best of my knowledge, information, and belief.

20. (RP) I hereby certify under penalty of perjury that the foregoing is true and complete to the best of my knowledge, information, and belief.

Executed in Accord with 10 CFR § 2.304(d)

Daniel W. Baber, PhD
Senior Wildlife Ecologist
ICF International
317 SW Alder, Suite 800
Portland, OR 97204
(503) 525-6167
dabber@icfi.com

Executed in Portland, Oregon
this 25th day of October 2010

Executed in Accord with 10 CFR § 2.304(d)

Larry K. Berg
Research Scientist III
Atmospheric Sciences and Global Change Division
Pacific Northwest National Laboratory
P. O. Box 999, MSIN K9-30
Richland, WA 99352
(509) 375-3916
larry.berg@pnl.gov

Executed in Richland, Washington
this 25th day of October 2010

Executed in Accord with 10 CFR § 2.304(d)

Joseph Peyton Doub, CEP, PWS
Environmental Scientist
U.S. Nuclear Regulatory Commission
Office of New Reactors, Division of Site and
Environmental Reviews
Mail Stop: T7-F27
Washington, DC 20555-0001
(301)415-6703
Peyton.Doub@nrc.gov

Executed in Rockville, Maryland
this 25th day of October 2010

Executed in Accord with 10 CFR § 2.304(d)

Rajiv Prasad, PhD
Senior Research Scientist, Surface Water Hydrology
Hydrology Group
Pacific Northwest National Laboratory
Richland, WA 99352
(509) 375-2096
Rajiv.prasad@pnl.gov

Executed in Richland, Washington
this 25th day of October 2010

Daniel W. (Bill) Baber, PhD

Project Manager and Senior Wildlife Biologist

Dr. Baber specializes in wildlife and wetlands ecology, research and management of game and nongame species, natural resource assessment, mitigation design and implementation, NEPA and ESA compliance, and project management.

Bill's experience includes projects related to aviation, transportation, hydroelectric, landfill, water storage, mining, nuclear energy, destination resort, residential development, right-of-way, forest management and restoration throughout the Pacific West. He has researched and managed game and nongame species, including mule and black-tailed deer, Roosevelt elk, wild boar, bald eagles, raptors, upland game birds, furbearers, and red-legged frogs. Bill has conducted inventories, habitat assessments and monitoring for wildlife and wetland habitats; evaluated wildlife-aviation risk in compliance with FAA requirements including preparation of wildlife hazard assessments and wildlife hazard management plans; prepared NEPA compliance documents such as EAs and EISs; assessed impacts to threatened and endangered plants and animals by means of Biological Assessments (BAs), Biological Evaluations (Bes), survey and manage species reports, and no-effect letters; designed and implemented comprehensive mitigation plans to meet permitting and license requirements including habitat-based forest management programs that maintain long-term forest productivity while enhancing wildlife habitat value; and prepared local permitting/compliance documents (significant natural resource inventories, natural resource assessments). His wetland experience includes wetland delineations, functions and values assessments, Section 404 permit applications, wetland mitigation design, wetland monitoring and wetland mitigation banking.

Bill has managed a wide variety of natural resource-associated projects. His responsibilities include preparing project scopes, budgets and schedules, report preparation, client coordination, subcontractor management, agency coordination, quality control, and product delivery.

Education

PhD, Wildlife Ecology, Oregon State University, Corvallis, 1985

MS, Biology (Ecology emphasis), Florida Institute of Technology, Melbourne, 1978

BS, Biology (Marine emphasis), Florida Institute of Technology, Melbourne, 1976

Total Years of Experience

Professional Start Date: November 1985

Years with ICF

Start Date: 11/11/1985

Registrations, Certifications, and Licenses

Certified Wildlife Biologist, The Wildlife Society, 1990

Qualified Airport Wildlife Biologist 2009

Professional Memberships

The Wildlife Society

American Society of Mammalogists

Special Training

Airport Wildlife Hazard Management

ODOT Biological Assessments

WSDOT Biological Assessments

Habitat Evaluation Procedures

Areas of Expertise

Natural Resource Assessment and Mitigation Planning

Endangered Species Act Compliance

Aviation-Wildlife Hazard Management Planning

Project Management

Project Experience

Levy Nuclear Power Project EIS—Nuclear Regulatory Commission, Levy County, Florida

Terrestrial reviewer. Evaluating the potential environmental effects to terrestrial resources of a proposed nuclear power facility at a 3,105 acre greenfield site located on the north central coast of Florida. Associated offsite facilities also addressed include a heavy haul road, barge slip and barge slip access road, makeup and blowdown pipelines including associated cooling water intake and discharge structures, and approximately 180 mi of transmission lines required to incorporate the power into the Florida electrical grid system. Activities include participation in the acceptance review, site audit, development of requests for additional information (RAIs), review of RAI responses, preparation of draft NEPA EIS text, preparation of a BA, and participation in public scoping and DEIS public comment processes.

Buena Vista Ferry Replacement and Terminal Improvements Project—Oregon Department of Transportation, Marion and Polk County, Oregon

Contract manager. The Buena Vista ferry connects Buena Vista Road on the east and west sides of the Willamette River, and is considered a “mobile bridge” for transportation purposes. The project involves the replacement of the ferry boat and deteriorating car ramps that access the ferry, upgrading the ferry from diesel to electric by installing overhead electric power and support, and installing a low water cable. It is divided into 3 phases: the Design Acceptance Package (DAP), the Performance Standards and Evaluation PS&E package, and Construction Administration/Construction Engineering and Inspection (CA/CEI) services. Phases 1 and 2 have been completed; Phase 3 is currently ongoing. ICF provides overall contract management, and is responsible for wetlands and cultural resources permitting. The Buena Vista project is funded through the American Recovery & Reinvestment Act (ARRA).

Wildlife Hazard Management Plan—San Francisco International Airport, California

Qualified airport wildlife biologist. As part of a collaborative ICF team, assisted SFO in revising its wildlife hazard management plan (WHMP) in compliance with FAA requirements and 14 CFR-Part 139.337. The WHMP delineates the responsibilities, policies, procedures, and regulations to reduce wildlife-aircraft hazards. FAA guidance requires that airports take steps to limit the risk of airplane strikes by creating and following a WHMP. ICF reviewed the current WHMP and assessed current strategies for minimizing bird use of the airport and areas within two miles of the airport. We reviewed the current WHMP, mapped general habitat types within a two-mile radius of SFO, identified habitat types and land uses known to be attractive to species that pose a potential hazard to aviation, and analyzed bird strike and wildlife activity data. Using this information, ICF prepared an update of the WHMP.

Middle Kyle Canyon Complex EIS MIS Report—USDA Forest Service, Clark County, Nevada

Wildlife task leader. Prepared a Management Indicator Species (MIS) report for a 4,000 acre recreational development proposed by the Forest Service within the Spring Mountains National Recreational Area (SMNRA). The proposed development included a visitor center; camping and picnic areas; amphitheater; hiking and biking trails; and Forest Service administrative offices, among other features. The report evaluated the effects of the proposed development on designated MIS wildlife and plants in the SMNRA.

Arbor Lakes Residential Development—West Hills Development, Washington County, Oregon

Terrestrial task leader. Supported West Hills Development with natural resource permitting for a large, multiphase residential development. Services provided include preparing wetland functional assessments, Joint Section 404/Removal-Fill Permit applications, and compensatory wetland mitigation plans for the wetland impacts. Clean Water Services (CWS) natural resource assessments were also prepared to establish and mitigate the loss of protective buffers around the wetlands, and CWS service provider letters were obtained as part of the phased land use applications for the project. As built reviews of wetland and upland buffer mitigation implementation were completed. Phase 1 of the development has been permitted and is currently under construction; Phase 2 is currently being permitted.

Wauna Remediation Site Wetland Mitigation Project— Georgia-Pacific Corporation, Clatskanie, Oregon

Project manager. Assisting Georgia Pacific with permitting issues for a wetland fill required under a joint federal/state remediation plan. Services provided include: 1) developing a conceptual wetland mitigation plan to restore a former wetland along the Columbia River that was degraded when a retaining dike to contain dredged material failed, 2) managing construction activities (excavation, grading, planting and seeding) to restore the 0.6 acre mitigation site; 3) preparing an as-built report documenting wetland restoration efforts; and 4), monitoring the restored wetland in compliance with US Army Corps of Engineers and Oregon Department of State Lands requirements.

Altamont Pass Avian Monitoring Project—Alameda County Community Development Agency, California

The ICF team is conducting long-term avian impact analyses at the Altamont Pass Wind Resource Area (APWRA) in central California. The APWRA supports 5,400 wind turbines distributed over about 50,000 acres. Our team conducts rigorous annual monitoring and robust experimental analysis of seasonal and site-specific shutdown of high-risk turbines to inform strategies for repowering the APRA with new generation wind turbines. Assisted with the preparation of the 2009 annual avian fatality monitoring report, prepared the findings of a study to evaluate the effects of a short-search interval (48-hour) monitoring on the detection of bird fatalities, and prepared the findings of a study to assess the effects of vertebrate scavenging on bird carcass detectibility.

Hillsboro Airport Wildlife Hazard Management Plan and Wildlife Hazard Assessment—Port of Portland, Portland, Oregon

Project manager and wildlife task leader. Assisted the Port of Portland (Port) in assessing potential wildlife hazards at the Hillsboro Airport (HIO) and prepared a WHMP to alleviate or eliminate those hazards. Since HIO is a general aviation airport that does not currently service scheduled air carrier aircraft, it is not obligated to develop and maintain a WHMP. Nonetheless, aviation safety is paramount in the Port's airport management objectives for HIO. The WHMP followed the process completed to address aviation safety concerns at Portland International Airport, and complied with the requirements outline in 14 CFR Part 139.337 regarding wildlife hazard assessment and management. By preparing a WHMP that meets 14 CFR Part 139.337 standards, HIO will be able to readily demonstrate compliance with the standards should air carrier aircraft operations begin at the airport.

Centralia Mine West Field Expansion Project—TransAlta Centralia Mining LLC, Lewis County, Washington

Project manager and wildlife task leader. TransAlta Centralia Mining (TCM) has identified lands immediately west of the Centralia Mine permit area as a potential source of additional coal to supplement the permitted reserves at the mine. In support of future permitting to expand the existing permit area boundary, TCM investigated the environmental resources present in the West Field expansion area that could be affected by any mining operations there. Managed the documentation of the baseline environmental conditions for wildlife resources, fishery resources and wetlands that occur on and around the West Field expansion area, and prepared the baseline wildlife report. For the baseline wildlife effort, existing wildlife habitats on the expansion area were mapped, wildlife expected to occur in the expansion area were identified, and an assessment was made of the likelihood that the expansion area supports candidate, proposed, threatened or endangered wildlife species identified by federal or Washington state agencies.

Portland International Center EA—Port of Portland, Multnomah County, Oregon

Terrestrial task leader. Prepared the terrestrial sections of a NEPA EA for the Portland International Center (PIC), a 458-acre master-planned, mixed-use Plan District located on the west side of Portland International Airport. The PIC includes office, retail, hotel, and a variety of light industrial/employment uses (including aviation-related uses) subject to the agreement between the FAA and the Port of Portland. The FHWA was designated as a cooperating agency for the purpose of identifying the potential effects of the proposed project on federal highways The EA was prepared consistent with FAA Order 1050.1E, Environmental Impacts: Policies and Procedures (FAA 2004), and FAA Order 5050.4A, Airport Environmental Handbook (FAA 1985). In support of the EA, prepared a No Effects Letter documenting project effects on federally listed threatened and endangered species.

Elliott State Forest HCP EIS—Oregon Department of Forestry, Coos and Curry Counties, Oregon

Wildlife task leader. ICF was retained to prepare a NEPA EIS evaluating the potential environmental effects associated with management of forest resources on the Elliott State Forest (ESF). The ESF encompasses approximately 93,000 acres of State-owned forestlands along the south-central Oregon coast. The Oregon Department of Forestry is seeking an Incidental Take Permit in accordance with section 10(a)(1)(B) of the ESA for three listed species and an additional unlisted 17 species over a 50-year period (2008-2058). Prepared the wildlife sections of the EIS evaluating the potential effects to one listed and eight unlisted wildlife species under the proposed HCP and two additional alternatives considered.

Hillsboro Airport Helipad Project—Port of Portland, Hillsboro, Oregon

Project manager. The Port of Portland proposed to build a helicopter training pad on the northeast side of the Hillsboro Airport to alleviate noise problems caused by the current flight pattern of helicopters training at the Hillsboro Airport. In support of this project, directed the preparation of: 1) a wetlands delineation on lands around the helipad, 2) a joint U.S. Army Corps of Engineers and Oregon Department of State Lands Section 404/Removal-Fill Permit application to place fill material into jurisdictional wetlands and other waters, 3) a Clean Water Services (CWS) natural resource assessment to establish and mitigate the loss of protective buffers around wetlands and other water quality sensitive areas, 4) obtained a CWS

service provider letter as part of the land use application for the project, and 5) a no effects letter for NOAA Fisheries documenting that the proposed project would not impact threatened or endangered salmonids.

Arbor Heights and Arbor Crossing Residential Developments—West Hills Development, Washington County, Oregon

Project manager. Supported West Hills Development with natural resource permitting for two residential developments. Services provided included preparing separate wetland delineation reports, wetland functional assessments, and Joint Section 404/Removal-Fill Permit applications for each project, and developing a combined compensatory wetland mitigation plan for the wetland impacts. Clean Water Services (CWS) natural resource assessments were also prepared for each project to establish and mitigate the loss of protective buffers around the wetlands, and CWS service provider letters were obtained as part of the land use application for the projects. Both projects have been permitted and are currently under construction.

Portland International Airport SW Quad Safety Fill Project—Port of Portland, Multnomah County, Oregon

Wildlife task leader. The purpose of this project was to remove from the SW Quad those habitat elements (i.e., wetlands, open water, trees) that were serving as attractants to wildlife species determined to pose a wildlife strike hazard to aircraft operations, in compliance with Federal Aviation Administration regulatory mandates. Specifically, the project involved converting a stormwater conveyance canal to an underground piped structure, filling adjacent wetlands and remnant drainage ditches, removing associated riparian forest patches, and modifying some existing grassland areas. As part of the project, prepared a natural resource assessment for riparian habitat, described and mapped wildlife habitats, numerically assessed wildlife value was using the Wildlife Habitat Assessment rating system, directed a City of Portland environmental review, and prepared a BA addressing impacts to proposed, threatened or endangered species associated with filling 3.94 acres of wetlands and other waters.

Alcoa Wildlife-Aviation Risk Report—Port of Portland, Multnomah County, Oregon

Project manager and wildlife task leader. Evaluated potential restoration opportunities on the former Alcoa/Reynolds Metals Company property with regard to the risk that wildlife expected to use the restored areas could pose to aviation operations at the nearby Troutdale Airport, a general aviation airport. A baseline description of natural resources was prepared for the site that included surface waters, wetlands, fish and wildlife resources, T&E species, and cultural resources. Conceptual restoration treatments were evaluated for potential wildlife-aviation risk based upon a qualitative aggregation of the treatment distance to the airfield, treatment location relative to the runway protection zone, potentially hazardous wildlife likely to be attracted by the treatment, and how the distribution of existing habitats across the landscape could influence movement patterns of potentially hazardous wildlife.

Pit 20 Wetland Mitigation Plan and Planting Plan—TransAlta Centralia Mining LLC, Lewis County, Washington

Project manager. Evaluated the feasibility of creating viable wetland habitat at the Pit 20 site, an old coal mine pit undergoing reclamation. Historic wetland conditions were reviewed, on-site conditions were assessed, bathymetry of the Pit was examined, and water quality was reviewed for potential

contaminants. A detailed wetland mitigation plan was prepared that outlined landscape conditions, grading, hydrology, target wetland/riparian habitats, seeding and planting plans, special habitat features to benefit fish and wildlife, and wetland functions to be achieved. The plan was used by TCM to seek a land use change from the Office of Surface Mining.

Portland International Airport Wildlife Hazard Management Plan, Biological Assessment, and NEPA EA—Port of Portland, Multnomah County, Oregon

Project manager and wildlife task leader. Assisted the Port of Portland in revising WHMP for Portland International Airport (PDX), in compliance with FAA requirements and 14 CFR-Part 139.337. The WHMP presents an integrated and adaptive program to effectively manage risk at PDX by reducing the probability of occurrence of wildlife/aircraft collisions. The risk management techniques and protocols adopted in the WHMP include: 1) Wildlife control procedures to discourage, disperse and remove wildlife species of concern from the airfield vicinity; 2) Habitat modification practices to reduce the attractiveness of lands on and around the airport to wildlife species of concern; 3) Research and development projects to gather data and field test new equipment and techniques; and 4) Information and education programs to articulate the hazards wildlife can pose to the safe operation of aircraft. Implementation of the WHMP is based upon management strategies developed to address the wildlife hazards unique to specific management areas identified at PDX. In support of the WHMP, prepared a BA evaluating plan impacts to proposed, threatened and endangered species, and prepared the wildlife sections of a NEPA EA that addresses the environmental impacts associated with implementing the management strategies developed in the plan.

Mitchell Creek Sedimentation Pond BA— TransAlta Centralia Mining LLC, Lewis County, Washington

Project Manager. Directed the preparation of a BA evaluating effects on sensitive fish species of a mine-related sediment pond proposed in a headwater tributary of Mitchell Creek. Species addressed in the BA were bull trout and coastal cutthroat trout. Conservation measures were designed to mitigate impacts of the proposed action.

Rivergate Sensitive Species Assessment—Port of Portland, Multnomah County, Oregon

Wildlife Task Leader. Conducted wildlife habitat suitability assessments for Western Meadowlark, Streaked Horned Lark and western painted turtle on two sites in the Port's Rivergate Industrial District proposed for development.

Edgewater Development Clean Water Services Natural Resources Assessment—Matrix Development Corp., Washington County, Oregon

Wildlife Task Leader. Prepared this assessment as part of the permitting effort for a 69-acre residential development along the Tualatin River. Developed a detailed mitigation plan to compensate for project encroachments into water quality sensitive areas and vegetated corridors.

Time Oil Road Turtle Underpass Design—Port of Portland, Multnomah County, Oregon

Project Manager. Reviewed available information on the design and construction of small-animal underpasses. Designed a generic underpass system to allow safe passage of western painted turtles and other small animals under Time Oil Road. The underpass system included orientation/exclusion fencing and a single underpass linking wildlife habitat areas.

Short Mountain Landfill BA—Lane County Department of Public Works, Lane County, Oregon

Wildlife Task Leader. Directed terrestrial resource studies and prepared a BA evaluating impacts associated with the proposed 140-acre expansion of the Short Mountain Landfill along the Coast Fork Willamette River. Species addressed in the BA were the Bald Eagle and Oregon chub.

Tract W Red-Legged Frog Assessment—GS Properties, Multnomah County, Oregon

Project Manager. Assessed impacts on northern red-legged frogs from the proposed development of the Tract W site in Forest Heights. Assisted in negotiating an interagency candidate conservation agreement under section 10 of the ESA that would ensure that no additional conservation measures or constraints be imposed should red-legged frogs become federally listed. Conducted annual monitoring (breeding, water quality and vegetation surveys) as required under the agreement.

Portland International Airport Wildlife Hazard Assessment—Port of Portland, Multnomah County, Oregon

Project manager and wildlife task leader. Prepared a Wildlife Hazard Assessment for Portland International Airport (PDX) to fulfill Federal Aviation Administration requirements pursuant to 14 CFR Part 139.337(b). Baseline information on wildlife and wildlife habitats within 10,000 feet of PDX was summarized and assessed in relation to potential aviation safety concerns. Based upon an evaluation of the wildlife observation data and wildlife-aircraft strike records collected at PDX, as well as those factors that contribute to strike probability (e.g., wildlife abundance, habitat use patterns) and harm (e.g., body size, flocking behavior), a list of those wildlife species considered to pose the greatest wildlife strike hazard to aircraft (i.e., wildlife species of concern) was developed. The suitability of wildlife habitats surrounding PDX to support wildlife species of concern was reviewed, and recommendations were provided to aid in wildlife risk management at PDX

Consumers Power, Inc., (CPI) Power Line Upgrade EA—CPI and Siuslaw National Forest; Benton, Lane, and Lincoln Counties, Oregon

Project Manager. CPI proposed to upgrade four power line segments that cross federal, state, municipal, and private lands in the central Oregon Coast Range. Directed project scoping; developed issues and alternatives; prepared supporting BA and BE; conducted surveys for special-status plants and animals; and prepared EA and decision notice. Assessed impacts on biological resources, special-status plants and animals, cultural resources, visual resources, recreation, and public services.

Portland International Airport Airfield Safety Improvement Project BA—Port of Portland, Multnomah County, Oregon

Wildlife Task Leader. Port of Portland proposes to fill 8.25 acres of wetlands adjacent to runways. The wetlands pose operational and safety hazards to aircraft by attracting certain wildlife hazardous to aircraft and by impeding movement of emergency vehicles in event of an aircraft incident. Assisted in preparing a BA that evaluated impacts of proposed action on wildlife and plants.

Pond 3B Natural Resources Assessment—TransAlta Centralia Mining LLC, Lewis County, Washington

Project Manager. Evaluated natural resource value of wetlands associated with Pond 3B, a 115-acre coal fines refuse pond on the Centralia Coal Mine property where a functional wetland community has developed across much of the shallow water portions. Documented wetland, aquatic, and wildlife resources and evaluated overall functional value of developing wetland. Noted opportunities where active

management could be employed to enhance similarly created wetlands and improve habitat conditions for fish and wildlife.

Wildlife Management Prescriptions for the Forest Grove Watershed—City of Forest Grove and ITS Management, Washington County, Oregon

Wildlife Task Leader. Developed a set of forest management prescriptions designed to maintain long-term forest productivity while retaining and enhancing wildlife habitat value in the municipal watershed. These habitat-based prescriptions are intended to be integrated with the overall stewardship of the watershed to ensure that ecosystem functions both within and adjacent to the Forest Grove Watershed are protected and enhanced.

Saltzman Heights Permitting Effort—Venture Properties Inc., Washington County, Oregon

Wildlife Task Leader. Prepared a Washington County Section 422 Significant Natural Resource Inventory and a Clean Water Services Natural Resource Assessment as part of the permitting effort for an 18-acre residential development. Also prepared the wetland mitigation plan for the 404 wetland removal/fill permit application.

Fisheries Support Services Contract—Bureau of Water Works, City of Portland, Oregon

Project Manager. Provides strategy and technical research services regarding recent and anticipated salmonid listings as they relate to City's activities. Strategic services are aimed at addressing ESA, Clean Water Act, and other regulations. Managed BAs and BEs for various projects in compliance with ESA. Technical services include analyses of fish life histories, limiting factors, habitat use/availability, and protection/enhancement actions.

Weyerhaeuser Regional Landfill EIS—Weyerhaeuser Company, Cowlitz County, Washington

Wildlife and Monitoring Task Leader. Directed studies to evaluate baseline wildlife and habitat resources, prepared the wildlife sections of the EIS, and helped design the mitigation plan for siting a 400-acre solid waste facility. Managed the 10-year monitoring effort for the aquatic and terrestrial habitat mitigation plan that included a 5,100 foot stream diversion channel designed to support cutthroat trout, 10 acres of created wetland linked to the diversion channel, three off-channel ponds to provide fish and wildlife habitat, and a landfill cell revegetation plan designed to benefit wildlife.

Lebanon Wastewater Treatment Plant Upgrade Feasibility Assessment—City of Lebanon, Linn County, Oregon

Wildlife Task Leader. Completed the habitat and wildlife sections of a feasibility assessment for the City's plans to discharge secondary treated municipal wastewater into a large stream channel/wetland/gravel pond complex adjacent to the South Santiam River. Prepared a wildlife habitat map, queried the Johnson and O'Neil database for a list of wildlife species that may occur on site, and assessed the effects of the proposed wastewater discharge and other project features on sensitive wildlife (red-legged frogs and northwestern pond turtles) and their habitats.

Centralia Mine Sensitive Species Assessments—TransAlta Centralia Mining LLC, Lewis and Thurston Counties, Washington

Project Manager. TransAlta Centralia Mining is preparing a permit renewal application for submittal to the U.S. Office of Surface Mines (OSM) to renew coal-mining leases at Centralia Mine in western

Washington. OSM requires the 14,450-acre mine, in operation since 1969, to renew its operating permit at a maximum of 5-year intervals through the life-of-mine permit (2025). Prepared a BA (federal) and a biological report (state) to determine whether renewal of mining operations is likely to affect any federal or state proposed, threatened, endangered, or sensitive species, as well as federally proposed or designated critical habitat. Addressed coastal cutthroat trout, bull trout, coho salmon, Olympic mudminnow, Bald Eagle, Oregon spotted frog, mardon skipper, white-topped aster and small-flowered trillium.

Proposed Aggregate Mine—Eugene Sand and Gravel Incorporated, Lane County, Oregon

Wildlife Task Leader. Eugene Sand and Gravel proposes to construct and operate a gravel mine on a 559-acre site along Willamette River north of Eugene, Oregon. Assisted with development of comprehensive project design and permitting package. Prepared wildlife sections of biological report used in county land-use process. Addressed Bald Eagle, western pond turtle, red-legged frog, and Oregon chub.

Jenkins-Kim Significant Natural Resource Inventory—LDC Design Group Inc., Washington County, Oregon

Wildlife Task Leader. Prepared a Washington County Section 422 Significant Natural Resource Inventory (SNRI) as part of the permitting effort for a 20-acre residential development site recently annexed into the urban growth boundary. Described and mapped wetland, riparian, and wildlife habitat types and assessed their resource value to wildlife. Determined project impacts on significant natural resources.

Skookumchuck Gravel Pit Wildlife Resources Report—TransAlta Centralia Mining LLC, Lewis and Thurston Counties, Washington

Project Manager. Assessed the potential impacts of a proposed 41-acre gravel pit expansion on Washington priority species (Bald Eagle, western gray squirrel, Mardon skipper) and habitats (Oregon white oak woodland). Developed a management plan to protect and mitigate important wildlife habitats and species.

Milltown Hill Dam Supplemental EIS—U.S. Bureau of Reclamation and Douglas County Public Works Department, Douglas County, Oregon

Wildlife Task Leader. Douglas County has applied for a loan through the U.S. Bureau of Reclamation (Reclamation) to construct a water storage project on Elk Creek. Prepared wildlife and vegetation sections of supplemental EIS that updated the potential project effects on these resources since the EIS was issued. Addressed rare, threatened, and endangered species (Columbian white-tailed deer, Northern Spotted Owl, northwestern pond turtle); potential risk to wildlife from elevated levels of mercury in reservoir sediments and water; interrelated and interdependent effects; and mitigation.

Larson's Conduit Intertie BE—Portland Bureau of Water Works, Multnomah County, Oregon

Project Manager. The City of Portland is proposing to construct an intertie for the Bull Run water supply conduits that provide municipal water to the Portland metropolitan area. The intertie would be sited in the Mt. Hood National Forest. Managed the preparation of a BE that assessed the construction impacts of the intertie on proposed, endangered, threatened, and sensitive fish, wildlife and plants. Addressed the Northern Spotted Owl, Bald Eagle, red-legged frog, Chinook salmon and steelhead. Directed the

preparation of a survey and manage species report that addressed terrestrial mollusks, aquatic mollusks, fungi, mosses, liverworts and lichens that may occur at the intertie site.

Historic Columbia River Highway BA—Oregon Department of Transportation, Wasco County, Oregon

Project Manager. Oregon Department of Transportation intends to restore the Hood River to Mosier segment of the Historic Columbia River Highway and reopen it for recreational use. Managed preparation of a BA evaluating project effects on Peregrine Falcons. Prepared 3-year monitoring plan for Peregrine Falcon eyrie located near project and conducted baseline monitoring.

Cowlitz Falls Hydroelectric Project—Lewis County Public Utility District, Lewis County, Washington

Project Manager. Prepared and managed implementation of fish and wildlife mitigation at 70-megawatt hydroelectric project constructed in western Washington. Prescribed mitigation measures focused on big game, Bald Eagles, Ruffed Grouse, forest management, wetlands, shoreline/riparian management, and fishery enhancement. Conducted or managed on-ground work including forest management to benefit wildlife, meadow creation, development of diked reservoir subimpoundments, island creation and planting, reclamation and management of reservoir and riverine riparian habitat, forest reclamation, tributary stream habitat improvements, Bald Eagle management, and enhancement of transmission line corridor.

Dry Creek Ridge Timber Harvest EIS—Washington Department of Natural Resources, Klickitat County, Washington

Project Manager. Prepared SEPA EIS analyzing impacts of proposed timber harvest on Dry Creek Spotted Owl pair and on subpopulation of owls within 528,000-acre area on east slope of Cascade Mountains. Considered future effects of federal (Northwest Forest Plan) and state (Washington Forest Practices Rules, Department of Natural Resources Habitat Conservation Plan) owl r. conservation strategies on long-term viability of owl subpopulation in effects analysis.

West Union Meadows Significant Natural Resources Report—West Hills Development Company, Washington County, Oregon

Project Manager. Assessed significant natural resources consistent with Section 222 of Washington County Community Development Code for proposed 90-acre residential development and sewer line right-of-way. Described and mapped wetland, riparian, and wildlife habitat types and assessed their resource value to wildlife. Determined and mitigated project impacts on significant natural resources on-site.

Mt. Hood Corridor Project BA—Oregon Department of Transportation and Federal Highway Administration, Clackamas County, Oregon

Project Coordinator. Prepared wildlife sections and directed preparation of fish and plant sections of combined programmatic BA, BE, and biological analysis that addressed potential impacts of future transportation projects along 13-mile segment of Highway 26 traversing Mt. Hood National Forest. A no-build alternative and three build alternatives, each containing four widening options, were considered. A total of 39 plants and animals were evaluated in programmatic document (7 fish, 24 wildlife, 4 plant and 4 invertebrate species), including the Northern Spotted Owl, Peregrine Falcon, Bald Eagle, bull trout, and steelhead. Included findings on rare, threatened, and endangered species in EIS prepared for project.

Claremont Wetland Mitigation Project—The Marshall Grimberg Group, Washington County, Oregon

Wetland Task Leader. Designed the wetland planting plan and monitored installation of shrubs and trees on 6.6-acre wetland enhancement site along Bronson Creek. Negotiated a modification to joint 404-removal/fill permit that altered portion of upland buffer to mitigation wetland. Oversaw on-site mitigation monitoring and prepared annual monitoring reports (6 years) for submittal to state and federal agencies.

Crown Jewel Mining Project—Okanogan National Forest and Battle Mountain Gold, Okanogan County, Washington

Wildlife Task Leader. Directed analysis and preparation of BE for threatened, endangered, and sensitive wildlife; assisted in preparation of wildlife sections of NEPA EIS; directed preparation of wildlife technical report supporting EIS; responded to public comments concerning wildlife on draft EIS; and participated in permit documentation for proposed gold mining operation in northern Washington.

Sheep Ranch BE—The Campbell Group, Lane County, Oregon

Project Manager. Managed preparation of BE that addressed direct and indirect effects of proposed special-use permit to haul timber from private inholding across Siuslaw National Forest lands in central Oregon Coast Range. Addressed two fish, six wildlife and two plant species, including Northern Spotted Owl, Marbled Murrelet, Bald Eagle, coastal coho salmon, and West Coast steelhead.

Guadalupe Oil Field Remediation Project—San Luis Obispo County, California

Wildlife Ecologist. Assisted in review of CEQA EIR and ecological risk assessment that addressed impacts from remediation of 20-million gallon spill of diluent (a diesel-type liquid) at site along central coast of California.

NEPA EAs—Okanogan National Forest, Washington

Project Manager. Supervised baseline data collection and preparation of EAs for proposed timber harvests on two Forest Service planning areas. Key issues were big game winter range; lynx habitat; fishery resources; rare, threatened, and endangered species; habitat diversity; and range use.

Oregon Special-Emphasis Area Evaluation—Oregon Forest Industries Council, Western Oregon

Project Coordinator. Reviewed key documents pertaining to Northern Spotted Owls and ecosystem management for information addressing federal resource concerns and conservation goals within five special-emphasis areas (SEAs) initially identified by the USFWS in Oregon. The SEAs were identified in a notice of intent to prepare a proposed rule pursuant to section 4(d) of ESA. The rule would redefine federal protective measures for owls on nonfederal lands. Prepared summary report of biological criteria that led the USFWS to propose Oregon SEAs to assist the state in developing an independent strategy for conservation of owls on nonfederal lands.

Conway Ranch Resort EIR—Mono County Planning Department and Conway Ranch Partnership, Mono County, California

Assistant Project Manager. Assisted in preparation of CEQA EIR for proposed destination recreational resort. Prepared and negotiated conceptual mitigation plan to compensate for impacts on migratory mule deer and sage grouse. Participated in county land use hearing to evaluate project.

Garden Bar Dam and Reservoir Water Power Project—Nevada and Placer Counties, California

Wildlife Task Leader. Conducted studies to evaluate impacts on migratory mule deer in foothills of western Sierra Nevada. Developed conceptual wildlife mitigation plan using habitat evaluation procedure (HEP), prepared wildlife section of FERC hydroelectric license application Exhibit E, responded to FERC requests for additional information, and negotiated with resource agencies on client's behalf.

Highway 58 Upgrade Project—Oregon Department of Transportation, Lane County, Oregon

Project Manager. Directed preparation of BAs (Northern Spotted Owl, Peregrine Falcon, Bald Eagle) and Forest Service BEs to assess impacts on threatened, endangered, and sensitive wildlife that may be affected by construction of three passing lane segments between Oakridge and crest of Cascades. Supervised collection of data on Northern Spotted Owls in project vicinity for two years.

Summer Hills Residential Development—Clark County, Washington

Project Manager. Prepared wetland assessment, wildlife assessment, and mitigation plan for proposed cluster residential development in compliance with county land use provisions. Coordinated with natural resource agencies and provided expert testimony before land use hearing officer.

Salt Caves Hydroelectric Project—Klamath County, Oregon

Wildlife Field Investigator. Conducted studies to determine migratory black-tailed deer and bald eagle use of Klamath River Canyon, participated in interagency HEP study to quantify impacts and evaluate mitigation, developed comprehensive wildlife mitigation plan, wrote wildlife section of FERC hydroelectric license application Exhibit E, and responded to FERC requests for additional information.

Bodie Mineral Exploration Program EIR—Bridgeport, California

Wildlife Task Leader. Evaluated effects on wildlife of comprehensive mineral exploration project in compliance with CEQA guidelines.

Kaweah Hydroelectric Project—Tulare County, California

Project Manager. Coordinated study of rare, threatened, or endangered plant and animal species in support of FERC relicensing project. Used wildlife habitat relationships system to assist in evaluation of wildlife habitat suitability. Evaluated golden eagle, goshawk, great gray owl, wolverine, fisher, kit fox, yellow-legged frog, and golden trout.

Various Wetland Delineation Projects, Portland/Vancouver Metropolitan Area, Oregon and Washington

Project Manager. Conducted wetland delineations for 20 proposed residential development sites. Prepared wetland assessment reports, advised clients on applicable wetland regulations, consulted with agencies on client’s behalf, and recommended site-specific mitigation.

Publications

Baber, D.W. and J.G. Morris. 1980. Florida scrub jays foraging from feral hogs. The Auk 97:202.

Baber, D.W. and B.E. Coblentz. 1982. Immobilization of feral pigs with a combination of ketamine and xylazine. Journal of Wildlife Management 46:557-559.

Baber, D.W., M.C. Hansen and B.E. Coblentz. 1983. Preliminary findings of the feral pig project on Santiago Island. Annual Report of the Charles Darwin Research Station 1983:45-47.

Baber, D.W. 1984. Mortality in California mule deer at a drying reservoir: The problem of siltation at water catchments. California Fish and Game 70:248-249.

Baber, D.W. 1985. Ecology of feral pigs on Santa Catalina Island. Ph.D. Thesis, Oregon State University, Corvallis. 91pp.

Baber, D.W. and B.E. Coblentz. 1986. Density, home range, habitat use and reproduction in feral pigs on Santa Catalina Island. Journal of Mammalogy 67:512-525.

Baber, D.W. and B.E. Coblentz. 1987. Diet, nutrition and conception in feral pigs on Santa Catalina Island. Journal of Wildlife Management 51:304-315.

Coblentz, B.E. and D.W. Baber. 1987. Biology and control of feral pigs on Santiago Island, Galapagos, Ecuador. Journal of Applied Biology 24:403-418.

Baber, D.W. 1987. Gross antler anomaly in a California mule deer: the “cactus” buck. The Southwestern Naturalist 32: 404-406.

Environmental Training and Lecturing

Baber, Bill. Endangered species issues in Oregon. Habitat Conservation Planning in Oregon and Southwestern Washington. Portland, Oregon. 2002

Prior Experience

Department of Fisheries and Wildlife, Oregon State University, 1983 to 1985, 1979 to 1982

Conducted a 20-month study on the ecology of wild pigs on Santa Catalina Island, California. Data were collected on population density (capture-recapture), reproduction, home range (radiotelemetry), habitat use, social structure, dietary preference, nutrition, and habitat use of pigs. Methodology leading to control of pigs was tested, cost effectiveness was evaluated, and management strategies were developed. In partial fulfillment of the requirements for Ph.D. in wildlife ecology.

Charles Darwin Research Station, 1982 to 1983

Conducted wildlife research in the Galapagos Archipelago under the auspices of the Charles Darwin Research Station, the Smithsonian Institute, and the Frankfurt Zoological Society. Wildlife studies were conducted on Santiago Island (San Salvadore), a 300-square-mile uninhabited island, and included:

- Feral pigs (*Sus scrofa*). Island-wide distribution was mapped, density was estimated in major habitats, home ranges were measured (radiotelemetry), and data were collected on reproductive patterns, survival of young, food habits, and habitat use. Control methodology (poisoning, snaring, trapping, shooting) was evaluated for effectiveness and cost, and a management control plan was developed to eliminate pigs from areas of habitat critical to giant tortoises and green turtles.
- Galapagos hawks (*Buteo galapagoensis*). Movements and population size of nonbreeding hawks were estimated from observations of banded birds. A theory for dispersal and territory establishment was proposed, based upon changes observed in social-spatial patterns.
- Galapagos oystercatchers (*Haematopus ostralegus galapagensis*). Distributions of territorial pairs were mapped and territory size was measured. The relationship between tidal cycle and behavior was investigated, and food habits were determined.

- Feral goats (*Capra hircus*). Reproductive patterns were estimated from sacrificed female goats, and a fetal aging scheme was developed using both crown-rump length and fetal weight.
- Blue parrotfish (*Scarus ghobban*). The relationship between the parasitic isopod, *Ceratotha gaudichaudii*, and blue parrotfish was examined in waters around Santiago and Santa Cruz Islands.

Institute for Wildlife Studies, Arcata, California, 1980 to 1981

Studied movements (radioelemetry) and biology of bald eagles on Santa Catalina Island as part of a program that resulted in the successful reintroduction of bald eagles to the California Channel Islands.

Department of Biology, Florida Institute of Technology, 1977 to 1978

Conducted a six-month study of the behavior and grouping patterns of feral pigs on Merritt Island National Wildlife Refuge, Florida. In partial fulfillment of the requirements for M.S. degree.

Larry K. Berg

Research Scientist III
Atmospheric Sciences and Global Change Division
Pacific Northwest National Laboratory
P. O. Box 999, MSIN K9-30 (509) 375-3916
Richland, WA 99352 larry.berg@pnl.gov

Adjunct Professor
Department of Earth and Ocean Sciences
University of Wisconsin-Madison

Education

Ph.D.	Atmospheric Sciences	The University of British Columbia	2002
M.S.	Atmospheric Sciences	The University of British Columbia	1996
B.S.	Meteorology, with Distinction	The Pennsylvania State University	1993

Research Experience

Dr. Berg joined the staff at Pacific Northwest National Laboratory in June 2002. His research interests include cloud parameterizations, boundary-layer meteorology, turbulence, cloud-aerosol interactions, mesoscale modeling and atmospheric dispersion. Selected research experience includes the following:

Urban Dispersion. Dr. Berg has helped to coordinate PNNL's contribution to three urban dispersion field studies, one in Oklahoma City and two in New York City. He also managed PNNL's effort to develop a Rapidly Deployable Chemical Detection System for use during special events.

Wind Energy Applications. Dr. Berg is leading the Columbia Basin Wind Energy Study (CBWES) with the goal of developing a multi-season data set that can be used for evaluating predictions of low-altitude winds in mesoscale meteorological models.

Boundary-Layer Cumulus. Dr. Berg has developed a parameterization for boundary-layer cumulus. This parameterization couples the cumuli with turbulence in the convective boundary layer. Dr. Berg has helped plan and lead a U.S. Department of Energy Atmospheric Radiation Measurement field campaign to investigate the relationship of these clouds to the land surface.

Atmospheric Aerosols. Dr. Berg is investigating the effect of fair-weather clouds on atmospheric aerosols. This research is focused on finding changes to the optical properties of the aerosols that can be associated with the passage of the aerosol through clouds. He helped lead the Department of Energy's Cumulus Humilis Aerosol Processing Study (CHAPS), which was designed to investigate the processing of aerosols by clouds.

Publications (including those submitted)

Berkowitz, C. M., **L. K. Berg**, X.-Y. Yu, M. L. Alexander, A. Laskin, R. Zaveri, B. T. Jobson, E. Anadrews, J. A. Ogren, 2010: The influcence of fog and airmass history on aerosol optical, physical and chemical properties at Pt. Reyes National Seashore, *Atmospheric Environment*, Submitted.

Berg, L. K., E. I. Kassiaonv, C. N. Long, and D. L. Mills, 2010: Surface radiative forcing by shallow cumuli at the ACRF SGP. *J. Geophys. Res*., In press.

Kassianov, E. I., M. Ovchinnikov**, L. K. Berg**, S. A. McFarlane, C. J. Flynn, R. Ferrare, C. A. Hostetler, M. Alexandrov, 2010: Retrieval of aerosol optical depth in vicinity of broken clouds from reflectance ratios: Case study. *Atmos. Meas. Tech.*, **3**, 1333-1349.

Berg, L. K., C. M. Berkowitz, J. A. Ogren, C. A. Hostetler, R. Ferrare, M. Dubey, E. Andrews, R. L. Coulter, J. Hair, J. M. Hubbe, Y.-N. Lee, C. Mazzoleni, J. Olfert, and S. R. Springston, 2009: Overview of the cumulus humilis aerosol processing study (CHAPS). *Bull. Amer. Meteor. Soc.,* **90**, 1653-1667.

Kassianov, E. I., M. Ovtchinnikov, **L. K. Berg**, S. A. McFarlane, and C. J. Flynn, 2009: Retrieval of aerosol optical depth in the vicinity of broken clouds from reflectance ratios: Sensitivity study. *J. Quantitive Spect. and Rad. Transfer*, **110**, 1677-1689.

Berg, L. K., and E. I. Kassianov, 2008: Temporal variability of fair-weather cumulus statistics at the ARM SGP site. *J. Climate*, **21**, 3344-3358.

Gustafson, W. I., **L. K. Berg**, R. C. Easter, and S. J. Ghan, 2008: The explicit-cloud parameterized-pollutant hybrid approach for aerosol-cloud interactions in multiscale modeling framework models. *Env. Res. Let*. doi:10.1088/1748-9326/3/2/025005.

Berg, L. K., and R. B. Stull, 2005: A simple parameterization coupling the convective daytime boundary layer and fair-weather cumuli. *J. Atmos. Sci*., **62**, 1976-1988.

Berg, L. K., and S. Zhong, 2005: Sensitivity of MM5 simulated boundary-layer characteristics to turbulence parameterizations. *J. Appl. Meteor*., **44**, 1467-1483.

Berg, L. K., and R. B. Stull, 2004: Parameterization of joint frequency distributions of potential temperature and water vapor mixing ratio in the daytime convective boundary layer. *J. Atmos. Sci.,* **61**, 813-828.

Berg, L. K., and R. B. Stull, 2002: Accuracy of point and line measures of boundary layer cloud amount. *J. Appl. Meteor*., **41**, 640-650.

Stull, R., E. Santoso, **L. Berg**, and J. Hacker, 1997: Boundary Layer Experiment 1996 (BLX96). *Bull. Amer. Meteor. Soc*., **78**, 1149-1158.

Invited Presentations

Representation of Shallow Cumuli in Regional Scale Models. ARM Cloud Modeling Working Group Meeting, 29 September, 2009.

Investigation of Cloud-Aerosol Interactions in Fields of Shallow Cumuli. The University of Wisconsin-Madison, 22 September, 2008.

An overview of Cumulus properties at the ACRF Southern Great Plains Site and the Cumulus Humilis Aerosol Processing Study. The Pennsylvania State University, 25 June, 2008

Funded Proposals

Berkowitz, C. M., and **L. K. Berg**, 2004: The effects of cloud processes on the optical properties of aerosols. *U. S. Department of Energy*, *Atmospheric Science Program*.

Berg, L. K., and S. J. Ghan, 2004: Development, evaluation, and application of a new parameterization framework for boundary layer cumuli. *U. S. Department of Energy, Atmospheric Radiation Measurement Program.*

Berg, L. K., and J. D. Fast, 2003: Turbulent transfer in the stable boundary layer and its representation in mesoscale numerical models. *U. S. Department of Energy, Vertical Transport and Mixing Program*.

Technical Reports

Berkowitz, C. M., **L. K. Berg**, J. A. Ogren, C. A. Hostetler, and R. Ferrare, 2006: Project Overview: Cumulus Humilis Aerosol Processing Study (CHAPS): Proposed Summer 2007 ASP Field Campaign. PNNL-15700, Pacific Northwest National Laboratory, Richland, WA.

Berg, L. K., and K. J. Allwine, 2006: An analysis of wintertime winds in Washington D. C. PNNL-15799, Pacific Northwest National Laboratory, Richland, WA.

Berg, L. K., R. B. Stull, E. Santoso, and J. P. Hacker, 1997: Boundary Layer Experiemnt-1996 (BLX96) airborne scientist flight log. Boundary Layer Research Team Tech. Note BLRT-97-1, 116 pp.

Selected Conference Proceedings

Kassianov, E. I., M. Ovtchinnikov, **L. K. Berg**, S. A. McFarlane, C. J. Flynn, R. Ferrare, C. A. Hostetler, and M. Alexandrov, 2010: A new retrieval of aerosol optical depth from reflectance ratios on partly cloud days: *Development and evaluation. 13th Conference on Atmospheric Radiation, Portland OR*.

Berg, L. K., C. M. Berkowitz, G. Senum, and S. Springston, 2009: Observations of the importance of both cloud dynamics and particle loading in the microphysics of shallow cumuli, *EOS Trans. AGU, 90(52), Fall Meet. Suppl., A13G-0301.*

Yu, X., **L. K. Berg,** C. M. Berkowitz, M. L. Alexander, Y. Lee, A. Laskin, J. A. Ogren, and E. Andrews, 2009: Cloud condensation nuclei in cumulus humilis—Selected case study during the CHAPS campaign, *EOS Trans. AGU, 90(52), Fall Meet. Suppl., A13B-0208.*

Berg, L. K., D. Mills, E. I. Kassianov, C. N. Long, 2009: Three-dimensional effects and shortwave cloud radiative forcing associated with shallow cumuli over central North America. *SPIE Remote Sensing of Clouds and the Atmosphere XIV, Berlin, Germany.*

Ovtchinnikov M., **L. K. Berg**, R. Ferrare, and E. I. Kassianov, 2009: Aerosol-cloud-radiation interactions in the field of cumulus clouds. *International Association of Meteorology and Atmospheric Sciences, Montreal, Canada.*

Kassianov E. I., M. Ovtchinnikov, **L. K. Berg**, S. A. McFarlane, and C. J. Flynn, 2009: On reduction of the 3D cloud-induced radiative effects on aerosol optical depth retrievals. *International Association of Meteorology and Atmospheric Sciences, Montreal, Canada.*

Kassianov E.I., M. Ovchinnikov, **L. K. Berg**, S. A. McFarlane, and C.J. Flynn, 2009: The 3D Radiative Effects of Clouds in Aerosol Retrieval: Can We Remove Them?, *Progress in Electromagnetics Research Symposium, Light Scattering and Radiative Transfer: Theories and Applications, Moscow, Russian Federation.*

Berg, L. K., J. D. Fast, J. E. Flaherty, W. I. Gustafson, and W. J. Shaw, 2009: Application of the Weather Research and Forecasting Model for planning and operation of wind plants. *American Meteorological Society, Eighth Symposium on the Urban Environment*. Phoenix AZ.

Berg, L. K., C. M. Berkowitz, Y.-Y. Lee, X.-Y. Yu, J. Jayne, J. Ogren, B. Andrews, M. L. Alexander, J. Hubbe, A. Laskin, 2009: Observations of aerosol chemical and optical properties during the Cumulus Humilis Aerosol Processing Study. *American Meteorological Society, Special Symposium on Aerosol-Cloud-Climate Interactions*. Pheonix, AZ.

Berg, L. K., C. M. Berkowitz, J. M. Hubbe, J. A. Ogren, B. Andrews, and Y.-N. Lee, 2008: Aerosol optical properties observed during CHAPS. *Eos Trans. AGU, 89(53), Fall Meet. Suppl. Abstract A31F-0178*

Flaherty, J. E., **L. K. Berg**, J. D. Fast, W. I. Gustafson, J. P. Rishel, and W. J. Shaw, 2008: The use of a full-physics atmospheric modeling for wind power plants. *Eos Trans. AGU, 89(53), Fall Meet. Suppl. Abstract A11H-07*.

Mills, D. L., **L. K. Berg**, E. I. Kassinov, C. N. Long, 2008: Shortwave forcing by shallow cumuli over the Southern Great Plains. *Eos Trans. AGU, 89(53), Fall Meet. Suppl. Abstract A11D-0165*.

Kassianov, E. I., M. Ovtchinnkov, **L. K. Berg**, S. A. McFarlane, and C. J. Flynn, 2008: Retrieval of aerosol optical depth in vicinity of broken clouds from reflectance ratios: A novel approach. *Remote Sensing of Clouds and the Atmosphere XIII*. Society of Photographic Instrumentation Engineers. doi: 10.1117/12.801288.

Kassianov, E. I., **L. K. Berg**, S. A. McFarlane, C. J. Flynn, and D. D. Turner, 2008: Long-term statistics of continental cumuli: Does aerosol trigger cumulus variability? *International Radiation Symposium*, Foz do Iguacu, Brazil.

Kassianov, E. I., M. Ovtchinnkov, **L. K. Berg**, S. A. McFarlane, and C. J. Flynn, 2008: A new retrival of aerosol optical depth under partly cloud conditions with multi-spectral measurements of reflectance. *International Radiation Symposium*, Foz do Iguacu, Brazil.

Ovtchinnikov, M., **L. K. Berg**, and E. I. Kassianov, 2008: Dynamical, microphysical, and radiative interactions between aerosols and cumulus clouds. *15th International Conference on Clouds and Precipitation ICCP-2008*, Cancun, Mexico

Berkowitz, C., **L. Berg**, J. Hubbe, J. Ogren, E. Andrews, R. Ferrare, C. Hostetler, J. Hair, S. Springston, G. Senum, and Y.-N. Lee, 2007: An overview of the cumulus humilis aerosol processing study. *American Geophysical Union Fall Meeting*, San Francisco, CA.

Berg, L. K., E. I Kassianov, C. J. Flynn, S. A. McFarlane, 2007: Assessing changes in surface fluxes over land due to linked changes in aerosol and clouds. *American Geophysical Union Fall Meeting*, San Francisco, CA.

Grimit, E., R. C. Foster, C. S. Bretherton, **L. K. Berg**, T. P. Ackerman, C. S. Mass, J. McCaa, 2006: A case for a combined mesoscale and climate boundary layer

parameterization improvement project. 17th Symposium on Boundary Layers and Turbulence, *American Meteorological Society*, San Diego CA.

Berg, L. K., R. M. Reynolds, K. J. Allwine, and A. Blumberg, 2006: Comparisons of measurements made using two sodars in an urban environment. Sixth Conference on Urban Meteorology, Atlanta, GA, *American Meteorological Society*.

Committees

DOE Atmospheric Radiation Measurement (ARM) Cloud Modeling Working Group Steering Committee (2004 to present)

DOE Atmospheric Radiation Measurement (ARM) Cloud and Land Surface Interaction Campaign (CLASIC) Steering Committee

DOE Global Change Education Program (GCEP) Selection Committee (2009 to present)

Collaborators & Other Affiliations

(a) External Collaborators and Co-Editors.

E. Andrews, University of Colorado
A. Blumberg, Stevens Institute of Technology
R. Coulter, Argonne National Laboratory
R. Ferrare, NASA
C. A. Hostetler, NASA
J. A. Ogren, NOAA
R. B. Stull, The University of British Columbia
D. Turner, University of Wisconsin-Madison
S. Zhong, Michigan State University

(b) Graduate and Postdoctoral Advisors.

Roland B. Stull, The University of British Columbia,
K. Jerry Allwine, Pacific Northwest National Laboratory

(c) Graduate Advisees.

E. P. Wagner, The University of Wisconsin-Madison (with D. Turner). Detecting Boundary-Layer Turbulence Structure Using Raman Lidar

T. J. Wagner, The University of Wisconsin-Madison (with D. Turner). A method to retrieve entrainment rate and cloud droplet number concentration in developing cumulus using remote sensing observations

JOSEPH PEYTON DOUB, CEP, PWS

ENVIRONMENTAL SCIENTIST
US NUCLEAR REGULATORY COMMISSION
OFFICE OF NEW REACTORS, DIVISION OF SITE AND ENVIRONMENTAL REVIEWS

EDUCATION: M.S., Botany, University of California at Davis, 1984
B.S., Plant Sciences, Cornell University, 1982

CERTIFICATIONS: Certified Environmental Professional (CEP), No. 96050338; October 1996
Professional Wetland Scientist (PWS), No. 000358; July 1995
Forest Conservation Act Qualified Professional, Md., December 2004
Wetland Delineator, COE Baltimore, WDCP93MD0510029B, June 1993
NRC Certified Environmental Technical Reviewer, April 2009

TRAINING: Cooling Towers 101, SPX Cooling Technologies, Inc., August 26-27, 2010
Current & Emerging Issues in Envirn. Policy, Duke/NRC, Aug. 17-21, 2009
Reactor Concepts, NRC PDC, October 15-16, 2008
Site Access Training, NRC PDC, October 7-8, 2008
Project Management Level 2, Tetra Tech, April 12-14, 2007
ITRC Internet Course, "Jump Starting Ecological Restoration", Sep. 8, 2005
Cornell Home Study Course in Bird Biology, March - August 2005
Principles of DoD Partnering, The Management Edge, June 14-15, 2005
ITRC Internet Course, "Wastewater Treatment Wetlands", March 30, 2004
ITRC Internet Course, "Phytotechnologies", December 9, 2003
OSHA 1910.120 40-Hour HAZWOPER; May 1991 & refreshers to 2008
Due Diligence at Dawn (Phase I ESAs), EDR, Inc.; December 1999
Risk Assessment for Superfund, US EPA; October 1996 and May 2004
Project Management, Brown & Root Environmental, May 1995
Wetlands Identification and Delineation, Penn State C. Ed.; June 1990
Wetlands Delineation, Maryland DNR; July 1988

SECURITY CLEARANCE: L, Active

EXPERIENCE SUMMARY:

Currently serving as a environmental scientist/terrestrial ecologist with the NRC, Mr. Doub has over 20 total years of professional experience in environmental science, environmental planning, and natural resource management. He has performed wetland delineations and other natural resource investigations in over 15 states in all regions of the United States since 1988. He has also prepared wetland mitigation plans for tidal and nontidal wetlands and designed restorations of streams and other sensitive natural habitats in most of the mid-Atlantic, southeastern, and northeastern states and in California. He has lead, or contributed natural resources expertise to, dozens of environmental assessments (EAs) and environmental impact statements (EISs) prepared in accordance with the National Environmental Policy Act (NEPA) by the Air Force, Navy, Coast Guard, Forest Service, and Department of Energy. He has also prepared Phase I environmental site assessments (ESAs) and environmental baseline surveys (EBSs) for Army, Navy, and Air Force installations and for private property proposed for construction of cellular communications towers. He has published or presented more than a dozen papers emphasizing

methods for improving and streamlining NEPA, wetland science, and natural resource management.

PRESENT POSITION: Environmental Scientist/Terrestrial Ecologist
US Nuclear Regulatory Commission, NRO-DSER-RENV
June 23, 2008 – Present
T-7J5, Mail Stop T-7F27; (301) 415-6703

SPECIFIC ACTIVITIES:

Lead Author; Preparation of Revision 2 to Regulatory Guide 4.11, Terrestrial Environmental Studies for Nuclear Power Stations, July 2008 to Present. Expanded and updated Regulatory Guide last revised in 1977 that provides guidance to license applicants on preparing terrestrial ecological studies in support of license applications. Made guide more relevant to terrestrial ecology issues and challenges faced by applicants in today's regulatory environment. Specific topics included mapping and describing terrestrial habitats and wetlands, performing flora and fauna inventories and rare species surveys, and assessing impacts such as salt drift effects on vegetation and noise effects on terrestrial wildlife. Circulated draft revision to other ecologists in NRC and incorporated comments and suggestions. Coordinated with NRC Research to produce Draft Guide (DG) 4016. Presented draft revision to ACRS Radiation Protection and Nuclear Safety Subcommittee on December 16, 2009 and to ACRS Full Committee on March 4, 2010. Presently finalizing document to incorporate ACRS comments.

Terrestrial Ecology Technical Reviewer; Combined License (COL) and Early Site Permit (ESP) Applications for New Reactors; July 2008 to Present. Serving as NRC technical reviewer for Terrestrial Ecology for the following applications (the dates in parentheses refer to my involvement in the application review):

- VC Summer Units 2 and 3 COL (September 2008 to Present)
- Levy Units 1 and 2 COL (September 2008 to Present)
- Comanche Peak Units 3 and 4 COL (December 2009 to Present)
- Bell Bend (September 2008 to Present)
- WS Lee Units 1 and 2 (September 2008 to Present)
- Shearon Harris Units 2 and 3 (September 2008 to Present)
- Turkey Point Units 6 and 7 (July 2009 to Present)
- Fermi Unit 3 (November 2008 to Present)

Activities involve participation in the acceptance review, site audit, development of requests for additional information (RAIs), review of RAI responses, review of contractor-prepared draft EIS text, participation in public scoping and DEIS public comment processes, and issuance of final EISs.

Land Use Technical Reviewer; Combined License (COL) and Early Site Permit (ESP) Applications for New Reactors; July 2008 to Present. Serving as NRC technical reviewer for Land Use for the following applications:

- VC Summer Units 2 and 3 COL (September 2008 to Present)
- Comanche Peak Units 3 and 4 COL (December 2009 to Present)

- Bell Bend(September 2008 to Present)
- WS Lee Units 1 and 2 (September 2008 to Present)
- Shearon Harris Units 2 and 3 (September 2008 to Present)
- Turkey Point Units 6 and 7 (July 2009 to Present)
- Fermi Unit 3 (November 2008 to Present)

Activities involve participation in the acceptance review, site audit, development of requests for additional information (RAIs), review of RAI responses, review of contractor-prepared draft EIS text, participation in public scoping and DEIS public comment processes, and issuance of final EISs.

Instructor; NRC Wetlands Orientation Session to Pacific Northwest National Laboratory; November 14, 2008. Prepared one-day presentation addressing wetland issues relevant to new reactor licensing. Topics included wetland delineation, wetland mitigation, wetland functional assessment, Clean Water Act jurisdiction and Section 404 permits, Rivers and Harbors Act, and recent changes in wetland jurisdiction under the Clean Water Act. Delivered all topics with a focus on nuclear power plant licensing.

PAST POSITION: Senior Environmental Scientist
Tetra Tech NUS, Inc. (Formerly Halliburton NUS Corp. and NUS Corp.)
August 19, 1989 – June 20, 2008

SPECIFIC ACTIVITIES:

Terrestrial Ecology Task Leader; Environmental Report for Proposed UniStar Nuclear Calvert Cliffs Units 3 and 4; Lusby, Maryland; UniStar Nuclear Energy (Subcontract to Bechtel); May 2006 to June 2008. Planned and conducted field investigations, wrote supporting background papers, and prepared terrestrial ecology text sections for Environmental Report (ER) supporting Constellation's combined license application (COLA) to the Nuclear Regulatory Commission (NRC). Field investigations included a wetland delineation, flora survey, fauna survey, and rare plant survey for an undeveloped tract of approximately 500 acres on the 2,200-acre Calvert Cliffs Nuclear Power Plant (CCNPP) Site. The wetland delineation was followed the methodology for a routine onsite delineation in the 1987 Corps of Engineers (COE) Wetlands Delineation Manual. Mapped and characterized plant communities and generated comprehensive plant list. Listed each mammal, bird, reptile, amphibian, and insect species observed over more than 10 site visits spread over the entire 2006 growing season as well as the 2006-2007 winter season. Investigated potentially suitable habitats at appropriate times during the growing season for more than 30 rare plants identified as occurring in Calvert County by the Maryland Natural Heritage Program. Identified locations of 4 rare plants discovered by the survey efforts. Prepared mitigation plan for restoring approximately 2,000 square feet of forest to compensate for the disturbance of forest-interior bird (FIB) habitat in the Chesapeake Bay Critical Area. Accompanied Baltimore District COE to site to obtain Clean Water Act Jurisdictional Determination.

Wetlands Permitting Task Leader; Environmental Services for Proposed Exelon Nuclear Texas Project; Matagorda and Victoria Counties, Texas; Exelon Nuclear, Inc.; June 2007 to June 2008. Planned and conducted wetland delineation to support environmental permitting and combined license application (COLA) to the Nuclear Regulatory Commission (NRC) for new

nuclear generation facility proposed for coastal Texas. Performed delineations at 7,000-acre primary site in Victoria County in January 2008 and at 600-acre alternate site in Matagorda County in August 2007. The wetland delineations followed the methodology for routine onsite delineation in the 1987 Corps of Engineers (COE) Wetlands Delineation Manual. Mapped and characterized plant communities and listed each wildlife species observed over two site visits to the Matagorda County site in June and August 2007 and the Victoria County Site in December 2007 and January 2008. Prepared wetland report and draft Jurisdictional Determination forms addressing issues raised in *SWANCC v. United States* and *Rapanos v. United State*s.

Task Leader; Community Environmental Response Facilitation Act (CERFA) Reports for BRAC PMO Northeast Closing Bases; Various Locations; US Navy BRAC Project Management Office Northeast, Philadelphia, Pennsylvania; September 2006 to June 2007). The project involved preparing reports identifying and documenting uncontaminated real property environmentally suitable for immediate transfer out of Government ownership within 6 Navy or Marine Corps bases identified for closure in the 2005 Base Realignment and Closure Act (BRAC) list. Served as lead author for reports for the Naval Air Station Joint Reserve Base (NAS JRB) Willow Grove, Pennsylvania and the Instructor-Inspector Staff, Marine Corps Reserve Center West Trenton, New Jersey. Directed team of 3 scientists visiting Willow Grove for a week to review file data, conduct visual site inspections, and conduct interviews. Inspected over 50 buildings on more than 910 acres, including hangars, laboratories, runways, administrative buildings, on-base and off-base military housing, and raw land. Conducted research independently for smaller West Trenton property. Prepared preliminary draft reports on expedited 6-week schedule following the site visits and draft reports on expedited 2-week schedule to meet fast-track schedule established in the 2005 BRAC round.

Task Leader; Phase I Environmental Baseline Survey (EBS)/Environmental Condition of Property Survey (ECOP) for GM-38 Tract; Bethpage, New York; NAVFAC Atlantic; January 2007 to February 2007). Prepared report characterizing the environmental condition of a tract of approximately 1 acre in a residential area situated down-gradient of the former Naval Weapons Industrial Reserve Plant (NWIRP) Bethpage. The Navy proposed to construct and operate a groundwater pump and treat facility on the site for 10 years to remediate a plume of contaminated groundwater originating at NWIRP Bethpage and other aircraft manufacturing facilities formerly operated by Northrop Grumman Corporation. Conducted visual site inspection on January 12, 2007; searched environmental databases, conducted interviews, and wrote report.

Project Manager; Forest Stand Delineation and Forest Conservation Plan for Fort George G. Meade Uncontrolled Waste Site; Anne Arundel County, Maryland; January 2007 to February 2007). Prepared forest stand delineation (FSD) and forest conservation plan (FCP) for the Uncontrolled Waste Site, which was formerly associated with Fort Meade and is now located within the North Tract of the Patuxent Research Refuge (on land excessed by Fort Meade in early 1990s). Measured basal area, stem density, canopy closure, and shrub and groundcover cover in representative tenth-acre circular plots in forest areas subject to clearing in order to excavate and remove debris and contaminated soils. Used plot data as basis for designing plans and specifications for restoring forest vegetation to disturbed areas. Restoration involved soil stabilization, seeding, and planting tubelings of native trees and shrubs.

Task Manager; Wetland Delineation of Raven Rock Mountain Complex; Adams County, Pennsylvania; U.S. Army; February 2006 to June 2006. Delineated wetlands under jurisdiction of the Federal Clean Water Act on a tract of approximately 720 acres in the Blue Ridge Physiological Province in south-central Pennsylvania. Followed procedures for a routine onsite wetland delineation in the 1987 *Corps of Engineers Wetlands Delineation Manual*. Flagged the boundaries of 10 wetland occurrences. Collected vegetation, soil, and hydrology data needed to complete field data forms documenting the rationale for placement of each wetland boundary. Used hand-held GPS unit to record coordinates of points on each wetland boundary for entry into GIS layer. Also wrote two EAs for minor construction projects on RRMC.

Task Manager; Ecological Communities Survey and Terrestrial Mammal Survey; Engineer Proving Ground, U.S. Army Garrison, Fort Belvoir, Virginia; Baltimore District, U.S. Army Corps of Engineers; June 2006 to September 2006. Quantitatively characterized ecological communities (terrestrial habitats) by measuring basal area, stem density, canopy cover, and other forest metrics in more than 100 random twentieth-acre circular quadrats on a forested tract of more than 600 acres. Calculated importance values for each tree and shrub species by summing relative dominance, relative density, and relative frequency data. Recorded sightings and sign (e.g., scat, calls, or distinctive vegetation chewing) of terrestrial mammals at ten monitoring stations. Wrote reports summarizing data and management recommendations.

Task Leader; Ecological Risk Assessment for Aberdeen Proving Ground (APG) Open Burn (OB) and Open Detonation (OD) Units; Aberdeen, Maryland; US Army Corps of Engineers, Mobile District; February 2005 to December 2007. Wrote Ecological Risk Assessment for inclusion in application for RCRA Subpart X Permit. Reviewed available ecological documentation for APG and selected 15 representative locations where emissions from OB and OD operations could adversely affect sensitive ecological receptors. Described ecological conditions at each location, which included estuarine aquatic, tidal wetland, forested wetland, and forested upland habitats. Developed problem formulation and presented it to APG and regulatory staff. Directed modelers using software to generate emissions, fate and transport, and exposure data. Developed risk characterization and presented data and tentative conclusions to APG and regulatory staff.

Task Manager; Monitoring of Wetland Mitigation Projects on Naval District Washington, West Area, Dahlgren Site; J.M. Waller Associates; Dahlgren, Virginia; November 2003 to June 2008. Monitored wetlands constructed on six Installation Restoration (IR) Program sites cleaned up by the Navy. Developed monitoring plan in 2002 in consultation with the EPA Region III Biological Technical Advisory Group (BTAG). The plan called for annual Spring and Fall site visits, beginning in November 2003 and continuing until October 2007, to evaluate how the constructed wetlands are meeting specific performance criteria. Accompanied by biologists from J.M. Waller, visited each site in November 2003, April and October 2004, and April and October 2005 to record vegetation data (percent cover and woody stem counts), hydrology data (soil inundation or saturation), and wildlife use observations. Proposed interim recommendations to control patches of the invasive plant Phragmites (*Phragmites australis*). Prepared annual reports and oral briefings summarizing data from each of 2003, 2004, and 2005.

Wetlands Task Leader; Wetland Delineation and Mitigation Design for Installation Restoration (IR) Program Site 37 on Naval Support Facility Dahlgren; Engineering Field Activity Chesapeake, Naval Facilities Engineering Command; Dahlgren, Virginia; July 2004 to December 2005. Delineated wetlands on more than 1,000 feet of tidal shoreline. Gun butt sand used at an adjoining ammunition firing range had been deposited over many years on the shoreline. Followed routine wetland delineation procedures in the *Corps of Engineers Wetlands Delineation Manual* (1987), completed field data sheets, and flagged the boundary for survey. Characterized the vegetation, soils, and hydrology of the delineated wetlands and evaluated the functions and values of the wetlands using the *Highway Methodology* developed by the U.S. Army Corps of Engineers (July 2004). Designed plan to restore approximately 2,600 square feet of temporarily disturbed tidal wetlands and to establish approximately 12,800 square feet of tidal wetland vegetation over the top of a polymeric marine mattress and within interstices of riprap used to cover and stabilize the gun butt sand.

Task Manager; Environmental Baseline Surveys for Transfer (EBSTs) for IR Parcels on Former Naval Weapons Industrial Reserve Plant (NWIRP) Calverton; Calverton, New York; November 2004 to December 2005. Wrote EBST reports addressing the environmental condition of multiple parcels of real property that were retained by the Navy for purposes of environmental investigation and remediation following the transfer of the remainder of NWIRP Calverton to non-federal ownership. Followed guidance in ASTM D 6008-96. Conducted visual site inspections, interviewed persons involved in environmental activities, and reviewed environmental documentation. Updated information relevant to the parcels from the Basewide EBS completed in 1997. Completed reports for the Zone II agricultural area (approximately 5.8 acres) in December 2004, for Parcel D (IR Sites 1 and 9, approximately 145 acres) in January 2005, and for Site 10A (approximately 1 acre with former Jet Fuel Systems Laboratory Building) in December 2005.

Task Manager; Benthic Macroinvertebrate Investigation of Constructed Wetlands at Naval Support Facility Dahlgren; Dahlgren, Virginia; April 2005 to June 2006. Compared benthic macroinvertebrate communities in four constructed tidal wetland projects against those in adjoining undisturbed tidal wetlands (reference wetlands). Collected sediment samples from random representative locations in each constructed wetland and corresponding reference wetland and passed the samples through a 500-micron mesh to collect benthic macroinvertebrates. Shipped the organisms overnight on ice to a laboratory for taxonomic analysis (to the lowest practicable taxonomic level). Prepared tables quantifying the numbers of each taxon at each site and calculated similarity indices (SIs) comparing each constructed wetland against its corresponding reference site. Reported the findings in a written report and in an oral briefing to the Navy Partnering Team.

Task Leader, Ecological Characterization of NASA Wallops Island Flight Center Site 15; Engineering Field Activity North; Wallops Island, Virginia; October 2003 to December 2004. Described natural habitats on site contaminated by photographic solution tank. Developed a comprehensive list of plants and wildlife and identified jurisdictional wetland boundaries. Habitats included upland pine-oak forest, tidal high marsh, and tidal low marsh. Performed functional assessment of the wetlands using the Highway Methodology and the Wetland Evaluation Technique, Version 2.0.

Task Leader; Wetland Delineation and Mitigation Plan for NCBC Gulfport Site 8 and Off-Base Properties; Southern Division, Naval Facilities Engineering Command; Gulfport, Mississippi; October 2002 to September 2005. Conducted wetland delineation of 50 acre forested site situated down-gradient to the installation. The site, which supported a mixture of pine flatwoods and cypress-gum forest, had experienced pesticide contamination originating on the base and is slated for cleanup under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Staked the wetland boundary, completed data sheets, and reported the delineation in a report (December 2002). Prepared a mitigation plan describing restoration of natural forest habitat in the wetlands following the cleanup (April 2003). Met with local representatives of conservation parties in June 2005 to discuss wetland mitigation.

Instructor; Tetra Tech NUS Internal Brown Bag Seminars on Environmental Topics; Germantown, Maryland; March 2002 to February 2005. Delivered five one-hour seminars to co-workers in multiple Tetra Tech office using multimedia technology. Topics include Phytoremediation (March 25, 2002); Phase I Environmental Site Assessments and Environmental Baseline Surveys (August 5, 2002); NEPA (June 16, 2003); Wetland Delineation and Mitigation (December 1, 2003); and Non-Native Invasive Plants (February 28, 2005).

Environmental Scientist; Visual Site Inspection of Solid Waste Management Units on Fort Belvoir; Fort Belvoir, Virginia; US Army Corps of Engineers, Mobile District; September 1, 2005 to October 31, 2005. Conducted visual site inspections of 44 contaminated sites on the 800-acre former Fort Belvoir Engineer Proving Grounds as well as 20 inactive landfill sites on the Fort Belvoir Main Base. Prior to each inspection, reviewed previous environmental documentation for each site, including available information from earlier RCRA Facility Assessments and RCRA Facility Investigations as well as agency correspondence. Summarized current environmental status of each SWMU, described the potential for remaining contamination, and developed specific recommendations for further investigation. Developed inspection protocol and trained other Tetra Tech personnel to conduct similar visual site inspections for over 250 other SWMUs on the Fort Belvoir Main Base. Work performed on an expedited basis so that the Army could address environmental contamination throughout Fort Belvoir in anticipation of receiving missions called for under the 2005 round of the Base Realignment and Closure Act (BRAC).

Environmental Scientist; Phase II Environmental Baseline Survey for Abandoned Military Structure on Fort Detrick – Site R; U.S. Army; Undisclosed Location; March 2005 to May 2005. Conducted Phase II sampling activities to investigate potential environmental concerns identified in Phase I report prepared in 2004. Specific concerns addressed by the sampling included potential POL contamination in groundwater in the basement of the structure, potential lead-based paint on interior and exterior walls, potential lead contamination in soil adjoining exterior painted surfaces, and potential asbestos-containing material in interior pipe wrap. Prepared sampling work plan, directed sampling crews, and prepared report.

Instructor; Introductory Risk Assessment Guidance for Superfund (IRAGS); U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response; Various Locations; May 2004 to May 2005. Served as a member of a team of instructors offering a three-day class introducing students to the principles of performing risk assessments for

contaminated sites following guidance developed by the EPA. Classes were offered free of charge monthly to EPA employees and employees of other federal and state agencies and for a fee to other personnel (e.g., contractor employees). Two instructors plus the Course Director were assigned to teach at each course offering; Mr. Doub was assigned to classes on June 22-24, 2004; October 19-21, 2004; February 1-3, 2005; and April 19-21, 2005. Presented lectures on data collection and evaluation and ecological risk assessment, exposure assessment, toxicity assessment, and risk characterization.

Task Leader; Wetland Design for Site 5 (L-04) – Old Batch Plant at Marine Corps Base (MCB) Quantico; Naval Facilities Engineering Command Washington; Quantico, Virginia; April 2004 – September 2005. Prepared plans and specifications for a 4,000-square foot tidal wetland where a ditch carrying stormwater runoff entered the tidal Potomac River. The ditch carried surface runoff from the former location of a concrete mixing plant as well as discharges from several storm sewers draining adjoining developed areas. Electrical transformers had been stored on an exterior pad at the concrete mixing plant in the 1970s and had released low concentrations of PCBs to the storm sewers. The wetland was designed to capture and treat the runoff before it reaches the Potomac River. Assessed the geometry of the ditch and its watershed; evaluated chemical and physical parameters of water samples; estimated bankfull flow and other hydraulic properties of the ditch, and prepared a white paper summarizing the results and proposing a wetland to treat the runoff. Developed a grading and planting plan and specifications for the wetland. Inspected the wetland following construction and planting to evaluate whether design objectives were met.

Wetland Scientist; Technical Review of Durakon Industries Wastewater Treatment Wetland; Durakon Industries, Inc. (Subcontract to Geotrans, Inc.); Flint Muchigan; May 2005. Reviewed operational assessment of wastewater treatment wetland and developed recommendations for improving treatment performance. The wetland, which was constructed in 2000, receives process and sanitary wastewater from a facility that manufactures truck bed liners and discharges the water to the Flint River via an NPDES-permitted outfall. The chief problem with the wetland has been poor treatment performance during winter months. Recommended reducing the water depth to allow replacement of non-persistent wetland vegetation whose tops decompose over the winter with persistent wetland vegetation whose tops remain standing (and hence capable of detaining and filtering wastewater) over the winter.

Wetland Scientist; Conceptual Design for Treatment Wetlands and Phytoremediation at Ammunition Burning Ground at NSWC Crane; Southern Division, Naval Facilities Engineering Command; Crane, Indiana; November 2004 to January 2005. Developed concepts for establishing treatment wetlands and phytoremediation plantings to treat RDX-contaminated groundwater originating at ammunition burial ground. Visited the site, developed four treatment alternatives, and presented sketches depicting each alternative to Navy personnel. Some of the alternatives involved constructing wetlands directly over springs that discharge contaminated groundwater, and others involved directing stream flow into adjoining wetland treatment cells. All alternatives were based on combining the ability of wetland plants to detain and filter surface water (as in traditional treatment wetlands) with the ability of certain plant species reported in the scientific literature as capable of accumulating and sequestering RDX molecules (a form of phytoremediation termed phytoaccumulation).

Curriculum Developer; Ecological Risk Assessment Lectures for Introductory Risk Assessment Guidance for Superfund (IRAGS); U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response; No Specific Location; December 2004. Worked with Course Director to revise ecological risk assessment lecture modules in the course, which is offered monthly to EPA employees and other interested individuals. The course previously included an overview lecture module on ecological risk assessment and two consecutive 1.5-hour lecture modules covering specifics of EPA's Ecological Risk Assessment for Superfund (ERAGS) document. The revision consisted of replacing the latter two modules with three one-hour lecture modules. The first new module focused on ERAGS Steps 1 and 2, the Screening Level Ecological Risk Assessment (SLERA). The second focused on ERAGS Steps 3, 4, 5, and 6, consisting of refining the contaminants of potential ecological concern followed by the design and conduct of a Baseline Ecological Risk Assessment (BERA). Specific BERA activities discussed included toxicity tests, bioaccumulation and field tissue residue studies, and population and community evaluations. The third new module focused on ERAGS Steps 7 and 8, including risk characterization and risk management.

Environmental Scientist; Phase I Environmental Baseline Survey for Abandoned Military Structure on Fort Detrick – Site R; U.S. Army; Undisclosed Location; August 2003 to December 2005. Served as lead author of report investigating the environmental condition of a Cold War era military structure at an undisclosed location in Pennsylvania. The investigation followed ASTM D 6008-96 using environmental condition of property classifications in ASTM D 5746-98. Conducted a visual site inspection of the structure and surrounding property on August 12, 2004 and interviewed personnel familiar with the operational history of the structure. Reviewed historical as-built drawings of the structure. Because of the structure's history of classified operations, few other relevant records were available. The report outlined specific recommendations for further environmental investigation and management activities, including formal closure of an undocumented underground storage tank, closure of a septic system, and sampling of the structure's interior for asbestos, lead-based paint, and radon.

Wetland Scientist; Design of Treatment Wetlands for Landfill A at Westover Air Reserve Base; Air Force Center for Environmental Excellence; Chicopee, Massachusetts; June 2003 to September 2003. Prepared plans and specifications for establishing approximately 1.0 acre of wetlands designed to treat runoff and leachate from a capped landfill and to restore approximately 1.9 acres of forested wetland disturbed by capping activities. The treatment wetland was designed to pass water through a series of basins densely planted with common cattail (*Typha latifolia*), separated by baffles planted with regionally indigenous grasses, trees, and shrubs. The restored wetlands were designed to be planted with indigenous wetland trees and shrubs and seeded with a mix of regionally indigenous wetland grasses, sedges, and rushes.

Ecologist; Conceptual Design of Truxton Park Marina; City of Annapolis; Annapolis, MD; May 2004 to July 2004. Served as wetland scientist on multidisciplinary Tetra Tech team reviewing conceptual plans for upgrading a public marina in a city park on Spa Creek (part of the Chesapeake Bay). Summarized required natural resource permits, including permits under Section 404 of the Clean Water Act, the Maryland Tidal Wetlands Act, the Maryland Non-Tidal Wetlands Protection Act, the Maryland Forest Conservation Act, the City of Annapolis

Chesapeake Bay Critical Area, and the City of Annapolis Tree Ordinance. Prepared matrix comparing permit requirements and ease of permitting for three conceptual design alternatives.

Deputy Project Manager; Updated Environmental Baseline Survey for Naval Industrial Reserve Operations Plant (NIROP) Fridley; Southern Division, Naval Facilities Engineering Command; Minneapolis, Minnesota; July 2004 – October 2004. Lead professional for updating an environmental baseline survey for a weapons manufacturing facility operated by United Defense, Inc. Reviewed Navy records since the previous EBS (1997), performed an updated visual site inspection of the property, and interviewed United Defense personnel who had managed shops on the property since 1997. Evaluated environmental cleanup actions completed since 1997, including closure and cleanup of an electroplating shop, excavation of contaminated surface soils from an exterior storage area, and pumping and treatment of groundwater. Assigned updated environmental condition of property ratings to each part of the property following ASTM D 5746-98. Prepared report following ASTM D 6008-96.

Deputy Project Manager; Environmental Condition of Property Report; U.S. Navy Nebraska Avenue Complex; Naval Facilities Engineering Command Washington; Washington, DC; January 2004 – June 2004. Lead team of three environmental professionals assessing the environmental condition of property on the former Naval Security Station campus, which was slated for transfer to the Department of Homeland Security. Reviewed environmental records, interviewed site employees, and conducted a visual site inspection of over 30 buildings. Evaluated completed cleanup actions, including excavation of PCB-contaminated sediments in two stream reaches and lead-contaminated soil at one location. Assigned environmental condition of property ratings to each part of the campus using ASTM D 5746-98.

Project Manager; Environmental Assessment (EA) for Non-Native Invasive Plant Control on the Ottawa National Forest; U.S. Forest Service; Bessemer, Michigan; October 2003 to March 2005. Served as Project Manager for a subcontract to a small business, Environmental Planning and NEPA Services, Inc. (EPNS), who was tasked by the Forest Service to write an EA for controlling non-native invasive plants on approximately 987,000 acres of federal forest land. The Proposed Action consisted of mechanical, chemical (herbicide), and biological control of invasive plants such as garlic mustard (*Alliaria petiolata*), glossy buckthorn (*Rhamnus frangula*), purple loosestrife (*Lythrum salicaria*), and introduced honeysuckles (*Lonicera* spp.). Researched the ecological and toxicological impacts from specific mechanical, chemical (herbicide), and biological control agents; wrote sections of the EA addressing biological resources; and served as lead author for a biological evaluation (assessment) assessing impacts on rare, threatened, and endangered species. The biological evaluation served to comply with Section 7 of the federal Endangered Species Act as well as Forest Service internal directives. It addressed 3 mammal, 10 bird, 1 amphibian, 1 reptile, 3 fish, 4 mollusk, 7 insect, 54 plant, and 4 lichen species.

Wetlands Task Leader; Remedial Design for NSWC Indian Head Sites 12 and 42; Engineering Field Activity Chesapeake, Naval Facilities Engineering Command; Charles County, Maryland; July 1999 to February 2004. Performed wetland evaluation and design taks for investigation and remedial design for two landfill sites on military base on the Potomac River near Washington, DC. Tasks included wetland delineation, Joint Permit Application, and design of onsite wetland mitigation. Both wetland mitigation projects consisted of planting regionally

indigenous grasses, graminoids, and forbs along the water-ward edge of the landfills following installation of the caps. The wetlands were designed to help stabilize the landfill cap edges, slow and filter surface runoff, and provide enhanced aquatic and terrestrial wildlife habitat.

Wetland Scientist; Wetland Delineation of NAS Cecil Field Site 15; Southern Division, Naval Facilities Engineering Command; Jacksonville, Florida; September 2003 to December 2003. Delineated wetlands under Federal and state jurisdiction on a roughly 100-acre site in the pine flatwoods of a closed military base. Used methodologies recognized by the U.S. Army Corps of Engineers and the St. John's Water Management District. Flagged six wetland occurrences and prepared wetland delineation report. The report included an assessment of the delineated wetlands using Florida's Wetland Rapid Assessment Procedure (WRAP).

Co-Instructor; NEPA Advanced Tools Training Class; 28th Annual Conference of the National Association of Environmental Professionals (NAEP), San Antonio, Texas; Volunteer; June 22, 2003. Assisted Mr. Charles Eccleston in teaching a class introducing innovative tools and techniques to streamline and improve the NEPA decision-making process. Examples included the Sufficiency Test, a flowchart-like process for determining whether adding additional detail to a NEPA document is appropriate, and the Smithsonian Solution, a process for determining whether a NEPA document must be supplemented when elements of the action are changed subsequent to the Record of Decision. A key concept in the course is "Decision-Based Scoping", a process that uses Value Engineering principles to define the decisions that must be made and the range of reasonable alternatives. Mr. Doub used the class as an opportunity to introduce a proposed new tool, the Specialized Expertise Tool, developed for ascertaining the need for specialized expertise when addressing issues in a NEPA document. The tool was published in the December 2003 issue of *Environmental Practice*.

Task Leader; Environmental Baseline Survey (EBS) of Military Family Housing Area, Fort Drum, New York; U.S. Army Corps of Engineers, Mobile District; Watertown, New York; July 2003 to September 2003. Served as task leader for evaluating 15 parcels of undeveloped land totaling over 1,000 acres of mostly forested undeveloped land slated for new privately-sponsored residential development under the Army's Residential Communities Initiative (RCI) to privatize military housing. Reviewed historical aerial photographs and environmental records, conducted interviews with base personnel, and wrote EBS sections.

Wetland Scientist; Wetland Delineation and Mitigation for Naval Weapons Station Earle Site 13 – Defense Property Disposal Office Yard; Engineering Field Activity North, Naval Facilities Engineering Command; Colts Neck, New Jersey; April 2003 to July 2003. Conducted wetland delineation of 20-acre site slated for cleanup under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Followed the *Federal Manual for Identifying and Delineating Jurisdictional Wetlands* (1989), which is still required by the New Jersey Department of Environmental Protection (NJDEP). Identified two wetland features, including a seasonally saturated palustrine forested wetland dominated by red maple and black gum and a ditch qualifying as a state open water. Staked wetland boundaries and completed field data sheets and report. Developed recommendations for re-vegetating the wetlands and adjoining transition areas following disturbed during implementation of the remedy.

Ecologist, Level I Ecological Risk Assessment (ERA) for Naval Weapons Industrial Reserve Plant (NWIRP) Toledo; Southern Division, Naval Facilities Engineering Command, Toledo, Ohio; March 2003 to April 2003. Wrote report characterizing ecological habitats, receptors, stressors, and exposure pathways on 29-acre industrial site in Toledo. Although the facility consisted only of buildings, paved areas, and lawns, it adjoined forested habitats to the north. Documented the absence of potentially significant exposure pathways affecting ecological receptors.

Deputy Project Manager; Route Selection for Proposed Oakland Park-Conservation 230kV Electric Transmission Line; Florida Power and Light; Broward County, Florida; February 2003 to May 2003. Used aerial photographs, field observations, and published geographic and environmental data to develop candidate routes for constructing a 230kV electric transmission line across a predominantly suburban landscape. Developed a network of nearly 150 "links", linear segments potentially suitable for transmission line construction, across a study area of more 30 square miles. Each sequence of links connecting the proposed endpoint substations constituted a potential route. Tetra Tech used the links to compile a geographic information system (GIS) identifying specific environmental opportunities and constraints throughout the study area.

Project Manager; Environmental Assessment (EA) for Managing Flight Obstructions To Preserve Safety at Andrews AFB; U.S. Air Force Air Mobility Command (AMC); Prince Georges County, Maryland; November 2000 to January 2003. Developed and evaluated alternative actions for removing trees encroaching into imaginary flight surfaces at the ends of two runways. Most of the trees requiring attention were located on the Suitland Parkway, a scenic roadway into Washington, DC that is administered by the National Park Service (NPS). Worked with AMC and the NPS to prepare a statement of purpose and need and a description of the proposed action and alternatives (DOPAA). The alternatives differed with respect to various vegetation management strategies and possible reconfigurations of the runways. Assisted in the preparation of a script, slides, and visuals for a public scoping hearing to foster public involvement in the Air Force environmental impact analysis process. Wrote Draft EA for publication. Prepared responses to comments received on the Draft EA during a 30-day comment period. Coordinated a subcontractor preparing a Phase IA archaeological survey.

Task Leader; Functional Assessment and Permit Application for Wetlands at West Gate Landfill and Rubble Disposal Area; Engineering Field Activity North, Naval Facilities Engineering Command; South Weymouth, Massachusetts; December 2002 to August 2003. Prepared written assessment of the functions and values of wetlands at two sites undergoing cleanup of hazardous materials on a former naval installation closed under the Base Realignment and Closure Act (BRAC). Used the *Wetland Functions and Values Descriptive Approach* developed as part of the Highway Methodology by the New England District of the U.S. Army Corps of Engineers. Functions assessed included groundwater recharge and discharge, floodflow abatement, shoreline stabilization, sediment/toxicant retention, nutrient removal, production export, and wildlife habitat. Values assessed included aesthetics, recreation, educational/scientific value, uniqueness/heritage, and endangered species habitat. Visited the wetlands in January 2003 to collect field observations and review of published data sources.

Task Leader, Screening-Level Ecological Risk Assessment (ERA) for Valmont Trichloroethylene (TCE) Site; US Environmental Protection Agency Region III; Hazleton, Pennsylvania; September 2002 to April 2004. Inspected the site of suspected TCE contamination and prepared a technical memorandum describing terrestrial, wetland, and aquatic habitats. Obtained written consultations from the US Fish & Wildlife Service and state agencies responsible for threatened and endangered species. Prepared screening level ecological risk assessment (Steps 1 and 2, and the screening refinement stage of Step 3 of the EPA ecological risk assessment process). Addressed terrestrial plant, soil invertebrate, terrestrial wildlife, sediment invertebrate, and small fish endpoints. Performed food chain modeling addressing mammalian and avian herbivorous and insectivorous wildlife.

Task Leader; Environmental Baseline Survey (EBS) of Harry S. Truman Animal Import Center on NAF Key West; Southern Division, Naval Facilities Engineering Command; Key West, Florida; June 2002 to October 2002. Wrote EBS report following ASTM D 6008-96 and Navy guidance for a 15-acre animal quarantine facility on Fleming Key, a man-made island. The facility had been leased from the Navy to the U.S. Department of Agriculture Animal and Plant Health Inspection Service (APHIS). Researched the environmental history of the property, reviewed historic aerial photographs, interviewed current and past Navy and APHIS employees, reviewed Navy and APHIS files, and conducted a visual site inspection of buildings and grounds.

Task Leader; Ecological Risk Assessment (ERA) for Northeast Ordnance Site; U.S. Environmental Protection Agency, Region 3; Northeast, Maryland; February 1998 to October 2002. Inventoried ecological resources on roughly 60-acre site formerly used by ordnance manufacturing operation. The site included three streams, forested areas, widely scattered small buildings, and overgrown fields. Mapped and characterized values and functions of wetlands and upland habitats on the site and generated plant and wildlife species lists. Performed food chain modeling to estimate contaminant doses to mammals and birds. Wrote screening-level ERA identifying ecological receptors and exposure pathways and comparing exposure data against ecotoxicological benchmarks.

Wetland Scientist and Ecologist; Design of Landfill Consolidation Remedial Action at Operable Unit 2 (Sites 1 and 2) at Former NSWC White Oak; Engineering Field Activity Chesapeake, Naval Facilities Engineering Command; February 2001 to September 2002. Prepared plan to restore approximately 500 feet of a first-order, nontidal stream channel adjoining two abandoned landfills. Characterized baseline conditions such as channel geometry, watershed, bank condition, and substrate (using a Wohlman pebble count). Outlined use of live stakes, rooted cuttings, seedlings, and other bioengineering techniques (February 2001 to March 2001). Developed similar plan for restoring approximately 1,000-feet of another first-order, nontidal stream on NSWC White Oak (Site 47) that required excavation of contaminated sediments (November 2001 to December 2001). Inspected the planted sites in September 2002 as part of a follow-up monitoring program.

Task Leader; Wetland Delineation of Town of Dudley, Massachusetts Wastewater Treatment Plant Site; Boyle Engineering; Dudley, Massachusetts; May 2002 to July 2002. Conducted wetland delineation of a 15-acre tract occupied by sewage treatment facilities and undeveloped buffer grounds. Followed Federal and Commonwealth of Massachusetts wetland

delineation guidance. Staked the boundaries of wetlands and ordinary high water marks, completed wetland delineation data sheets, and wrote wetland delineation report. Investigated wetlands permitting requirements for upgrading and expanding the sewage facilities.

Environmental Scientist; Review of Environmental/NEPA Compliance Checklists; U.S. Air Force; August 2001 to February 2002. Served on a team of environmental scientists tasked to review electronic checklists developed to standardize environmental and NEPA compliance at two Department of Defense (DoD) installations. Proposed recommendations for expanding the scope of the checklists for national application. The two checklists selected for the review had each been developed independently by the Patuxent Naval Air Station in Maryland and Warner-Robbins Air Force Base in Georgia. The checklists prompted users for "yes" or "no" responses to a chain of electronic questions and uses the responses to automatically identify specific environmental compliance requirements. Where appropriate, questions include links to geographic information system (GIS) map layers containing data on wetlands, cultural resources, rare or endangered species locations, and other environmentally sensitive resources. The team interviewed the personnel who developed the checklists, conducted "dry runs" of the checklists, and proposed approaches for transforming the checklists into a "national checklist" that could be implemented at any military installation within the United States.

Task Leader; Tier I Ecological Risk Assessment (ERA) for Fort Knox Open Burn/Open Detonation (OB/OD) Site; U.S. Army Corps of Engineers, Mobile District; Fort Knox, Kentucky; January 2002 to February 2002. Wrote Tier I (screening level) ERA in accordance with guidance developed by Region IV of the U.S. Environmental Protection Action (EPA) and national guidance developed by the EPA Office of Solid Waste for hazardous waste combustion facilities.

Task Leader, Screening Level Ecological Risk Assessment (ERA) for Open Burn/Open Detonation (OB/OD) Site, Tooele Army Depot; U.S. Army Corps of Engineers, Mobile District; Tooele, Utah; June 1999 to March 2002. Reviewed draft screening-level ERA prepared by another author in 1999 and responded to EPA comments. Wrote final SLERA following guidance provided by EPA. Used computer model to estimate chemical concentrations in soils, sediment, and water affected by emissions from OB/OD operations and to predict exposures through the food chain to various functional feeding guilds of birds and mammals.

Task Leader; Environmental Baseline Survey for Transfer (EBST) and Finding of Suitability to Transfer (FOST) for Plant 20 Transportation Maintenance Facility at NWIRP Bethpage; Engineering Field Activity North, Naval Facilities Engineering Command; Bethpage, New York; December 2001 to February 2002. Wrote an EBST and FOST supporting the transfer of a 4.5-acre vehicle maintenance facility from the U.S. Navy to Nassau County, New York in accordance with CERCLA Section 120(h). Conducted new visual site inspection of Plant 20 and updated relevant information in Phase I and Phase II Basewide EBS reports for NWIRP Bethpage.

Task Leader; Joint Permit Application for Installation Restoration (IR) Program Sites on Naval Surface Warfare Center Dahlgren Site; Engineering Field Activity Chesapeake, Naval Facilities Engineering Command; Dahlgren, Virginia; July 2001 to December 2002. Prepared Joint Permit Application for wetland impacts resulting from remediation of 6 contaminated sites on a Navy base in Northern Virginia. Four of the sites contained tidal wetlands bordering tributaries of the Potomac River and two of the sites contained nontidal wetlands. The application summarized wetland impacts and the proposed mitigation projects for each site in the permit application. The permit application quantitatively tracked losses and gains of wetlands. Contributed to Habitat Equivalency Analysis (HEA) performed by the National Oceanographic and Atmospheric Administration (NOAA) to model the appropriate level of wetland mitigation accounting for past and projected future losses of wetland services.

Project Manager; Freshwater Wetlands Permit Application for Remediation of Former Calgon Corporation Metasol Plant; Merck and Company; Hawthorne, New Jersey; April 2001 to October 2001. Prepared application to the New Jersey Department of Environmental Protection (NJDEP) for statewide general freshwater wetlands permit and stream encroachment permit for impacts resulting from excavation of contaminated soils on abandoned industrial site. The project involved temporary disturbance of approximately 0.4 acre of freshwater wetlands and approximately 2.5 acres in the 100-year floodplain. Completed forms, coordinated drawings and public notification, documented compliance with applicable terms and conditions established by NJDEP for Statewide General Freshwater Wetland Permit #4, and wrote an environmental report supporting the request for a stream encroachment permit. Permit received 2002.

Task Leader; Biological Assessment (BA) for Lower Meramec Basin Wastewater Management Plan; St. Louis, Missouri; U.S. Environmental Protection Agency Region 7; February 2001 to April 2001. Prepared BA under Section 7 of the Endangered Species Act for a proposed regional wastewater treatment plant project. The BA addressed the proposed right-of-way for a 1-mile buried water discharge line crossing the floodplains of the Meremac and Mississippi Rivers. The BA specifically addressed the running buffalo clover, Indiana bat, bald eagle, and American bittern (the latter is not federally listed but is designated as endangered by the State of Missouri). Conducted pedestrian survey, described habitats, assessed habitat suitability for each species considered, and developed recommendations for minimizing impacts.

Project Manager, Multiple Environmental Baseline Survey (EBS) Reports for Andrews AFB; Air Force Center for Environmental Excellence; Prince Georges County, Maryland; September 2000 to March 2001. Wrote five EBS reports for five properties on Andrews AFB that were scheduled for leases to other government agencies. Properties addressed included a hangar, a garage, a credit union, an office building, and a tract of land in an area containing wetlands and several rare, threatened, and endangered plants. Followed procedures in AFI 32-7066, which included conducting visual site inspections, interviews, and records reviews.

Task Leader; Conceptual Plan for Landfill Shoreline Stabilization Using Constructed Tidal Marshes; Portsmouth Naval Shipyard; Northern Division, Naval Facilities Engineering Command; Kittery, Maine; March 2000 to September 2000. Developed conceptual plan for using constructed tidal marshes to stabilize the shoreline where a landfill abuts the estuarine Piscataqua River. The conceptual plan evaluated the feasibility, advantages, and disadvantages of using tidal wetlands alone, tidal wetlands plus a rock breakwater, or riprap to stabilize the subject areas. Presented the conceptual plan at a public meeting on August 3, 2000.

Botanist; Preliminary Phytoremediation Analysis of Contaminated Site at NIROP Fridley; Fridley, Minnesota; Southern Division, Naval Facilities Engineering Command; September 2000 to October 2000. Evaluated the possible use of phytoremediation to clean up groundwater contaminated by trichloroethylene (TCE). Concluded that phytoremediation may not be a good alterative to traditional remedies for this site because of the high depth to groundwater and small land area available for planting phreatophytic trees and other plants.

Task Leader; Land Suitability Studies for Davidsonville Transmitter Station and Brandywine GLOBECOM Receiving Station; Mobile District, Corps of Engineers; Anne Arundel and Prince Georges Counties, Maryland; October 1999 to June 2000. Prepared letter reports assessing the environmental suitability of two tracts for outleasing for purposes such as grazing, agriculture, mining, urban development, and recreation. The tracts were outparcels containing communications facilities associated with nearby Andrews AFB. The various towers and other facilities were clustered in fields in the center of each parcel surrounded by large buffers of forestland. The sizes of the parcels were approximately 1,100 and 1,600 acres, respectively. Sensitive environmental resources on each parcel included wetlands, threatened and endangered plants, and steep and erodible soils.

Task Leader; Design of Interim Removal Action for Site 3 at Former NSWC White Oak; Engineering Field Activity Chesapeake, Naval Facilities Engineering Command; December 1999 to December 2001. Prepared plan for restoring approximately 250 feet of first-order, nontidal stream channel adjoining abandoned landfill. The stream had been temporarily diverted through a diversion ditch or pipe to allow for excavation of a landfill directly abutting the channel. The plan called for returning the stream to a reconfigured channel stabilized using live stakes, rooted cuttings, seedlings, and other bioengineering techniques. The Navy implemented the plan in November 2000.

Wetlands Discipline Lead; EA for Disposal and Reuse of Grand Junction Office; U.S. Department of Energy (DOE); Grand Junction, Colorado; September 1999 to January 2000. Wrote sections addressing wetlands, floodplains, and ecological resources. Conducted ecological risk assessment (ERA) using DOE procedures. The EA was included as one of three sample EA reports presented as appendices in the textbook *Effective Environmental Assessments: How to Manage and Prepare NEPA EAs* by Charles H. Eccleston.

Task Leader; Wetland Delineation and Permit Application for Drum Burial Sites on Martin State Airport; Lockheed Martin, Inc.; Baltimore, Maryland; June 1999 to September 1999. Performed wetland delineation and completed permit application for grading necessary to investigate possible contamination from buried drums on an active airfield. The delineation

identified the boundaries of nontidal and tidal wetlands and other regulated areas. Completed Joint Permit Application for submittal to the US Army Corps of Engineers and Maryland Department of the Environment. Prepared an application for a variance under Baltimore County codes dealing with Chesapeake Bay critical areas.

Task Leader; Environmental Assessments (EAs) for Station Port Huron and Station Ashtabula; U.S. Coast Guard; Port Huron, Michigan and Ashtabula, Ohio; April 1999 to August 1999. Assisted preparing an EA for construction of a new station building at Station Port Huron and served as the lead author of a separate EA covering the closure of existing station facilities at Station Ashtabula and construction of a new modular station at a nearby location. Key issues in both EAs included potential impacts to aquatic and benthic biota, threatened and endangered species, historic and archaeological resources, and urban planning issues. Coordinated consultations with the U.S. Fish & Wildlife Service, State Natural Heritage Programs, and State Historic Preservation Officers.

Task Leader; Phytoremediation Design for NSWC Dahlgren Site 17; Engineering Field Activity Chesapeake, Naval Facilities Engineering Command; King George County, Virginia; January 1999 to November 2000. Developed phytoremediation plan addressing groundwater contaminated with mercury at abandoned landfill facility on a Navy base in northern Virginia. The plan involved planting hybrid poplar and other trees on a capped landfill to increase transpiration of groundwater contaminated by mercury. The intent was to thereby reduce the migration of mercury-contaminated groundwater into adjoining streams and wetlands. Reviewed the phytoremediation literature to identify tree species that are deep-rooted, fast-growing, and have high rates of transpiration. In contrast to phytoremediation projects that use uniform stands of a single species, designed a planting scheme that utilized mixed stands of high-transpiration species that also simulated the ecological structure and functions of natural forests. Also performed a wetland delineation of the site and integrated wetland mitigation into the phytoremediation design. Formed basis of presentation titled “Integration of Phytoremediation, Wetland Mitigation, and Ecological Restoration” at the 26th Annual Conference of the National Association of Environmental Professionals.

Environmental Scientist; Environmental Baseline Survey (EBS) for Naval Weapons Industrial Reserve Plant (NWIRP) St. Louis; Southern Division, Naval Facilities Engineering Command; St. Louis, Missouri; November 1998 to February 1999. Served on six-member team of professionals preparing an EBS following methodology in ASTM D 6008 and associated Navy guidance. Spent two weeks at the plant reviewing environmental records, conducting visual site inspections, and interviewing current and former Navy and contractor (Boeing) staff who worked at the plant. The EBS addressed a large aircraft manufacturing plant and several ancillary structures owned by the Navy within a larger manufacturing complex owned by Boeing, Inc. The Navy planned to transfer the plant to Boeing. Contributed to writing the EBS report, especially sections addressing the main aircraft manufacturing plant. The Phase I EBS was completed in compliance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 120(h), as amended by the Community Environmental Response Facilitation Act (CERFA).

Wetland Scientist; Clean Water Act Assessment for Golf Course Addition on Andrews AFB; Mobile District, Corps of Engineers; Prince Georges County, Maryland; June 1998 to October 1999. Mapped and characterized ten wetland occurrences on a recently completed 18-hole extension to the Andrews golf course, conducted functional assessment of each wetland, and developed management recommendations for each wetland. The recommendations focused on minimizing bird-aircraft strike hazards (BASH) in addition to the normal objectives of wetland management, such as water quality protection and improving wetland habitat. The Air Force ultimately included the plan as a component volume to the Integrated Natural Resources Management Plan (INRMP) for Andrews AFB.

Task Leader; Ecological Risk Assessment (ERA) for Crossley Farm Site; U.S. Environmental Protection Agency, Region 3; Huffs Church, Pennsylvania; June 1998 to June 2001. The Crossley Farm site consists of over 200 acres of agricultural land and deciduous forests on highlands adjoining a series of sloping springs. Drums of organic solvents had been buried on the site and had resulted in groundwater contamination. Visited the site, described and sketched the approximate boundaries of natural habitats, and wrote a technical memorandum that inventoried ecological resources on roughly 200-acre site formerly used to bury drums of industrial solvents (completed September 1998). As part of the field effort, mapped and characterized the values and functions of wetlands associated with springs and seepages on the site. Mapped ecological habitats on the site and generated species of plants and wildlife. Used data from the technical memorandum to identify ecological receptors and exposure pathways. Performing food chain modeling for representative mammalian and avian herbivores, insectivores, and carnivores. Wrote screening-level ERA report using soil, sediment, and surface water data generated by Tetra Tech for a Remedial Investigation (RI) of the site.

Environmental Scientist; National Pollutant Discharge Elimination System (NPDES) Permit Application for AES Warrior Run Cogeneration Plant; AES Warrior Run, Inc.; Cumberland, Maryland; May 1998 to August 1998. Prepared application to the Maryland Department of the Environment for AES to discharge wastewater generated by operation of a 180-MW coal-fired electric power plant. Wastewater sources included cooling tower blowdown water, demineralizer system regeneration wastes, and industrial and coal pile runoff. All wastewater was to be recycled to the extent possible and any remaining wastewater was to be extensively pretreated in new, state-of-the-art facilities prior to discharge.

Environmental Scientist; Environmental Baseline Surveys for Transfer (EBSTs) for Naval Air Station Dallas; Southern Division, Naval Facilities Engineering Command; Dallas, Texas; January 1998 to December 1999. Served on a team of environmental professionals evaluating the environmental condition of property on a Navy base closed under the Base Closure and Realignment Act (BRAC). The base included an airfield, flight line operations buildings, construction and maintenance shops, and administration buildings. The team wrote separate EBSTs for each of six areas of the base termed “Categories A through F”. Assisted the team in reviewing environmental records, conducting visual site inspections, and interviewing base personnel. Each EBST served to update portions of a basewide EBS prepared by another contractor in 1994; thus the emphasis of the EBSTs was on the period from 1994 to 1999.

Ecologist; Ecological Risk Assessment (ERA) for Former Naval Ordnance Station Louisville; Southern Division, Naval Facilities Engineering Command; Louisville, Kentucky; January 1998 to January 1999. Prepared a report documenting the lack of significant ecological receptors at the densely developed industrial station. Reviewed information on threatened and endangered species and obtained verification from US Army Corps of Engineers that there are no wetlands on the station. Evaluated the potential for transmission of contaminants through the food chain to predators that incidentally visit a series of drainage ditches on the station.

Task Leader; Ecological Validation Study for Aerojet Open Burn Facilities; GenCorp Aerojet, Inc.; Sacramento, California; December 1997 to June 1999. Conducted ecological risk validation study for open burn activities on 8,000-acre Aerojet facility. Evaluated a preliminary (Tier I) ERA prepared by another contractor, identified assumptions requiring validation, and designed and implemented a field sampling program to generate data validating the assumptions. Wrote report presenting the findings of the validation effort.

Task Leader; Phase I Environmental Site Assessments (ESAs) for Fort Wingate Depot Activity; Bureau of Land Management; Gallup, New Mexico; November 1997 to March 2000. Wrote Phase I ESAs for discreet parcels within former Army depot closed under the Base Closure and Realignment Act (BRAC). Parcels included a 5,600-acre tract of forest land formerly used for missile test launches, an area of former workshops used to service explosives, clusters of explosives storage igloos, and several tracts of buffer land. Followed procedures from ASTM E 1527-97 to identify recognized environmental conditions for the parcels. Presented a paper titled *Conducting Environmental Baseline Surveys for Large Manufacturing Facilities and Large Tracts of Undeveloped Land* at the 1999 Annual Meeting of the National Association of Environmental Professionals based, in part, on experiences from this project.

Environmental Scientist; Phase I Environmental Site Assessment (ESA) Reports for Telecommunications Sites in Philadelphia Metropolitan Area; Sprint PCS; August 1997 to December 1997. Completed Phase I ESAs on selected sites in southeastern Pennsylvania and central New Jersey proposed for construction of monopoles and other telecommunications equipment. Conducted visual site inspections, interviews, and record searches following ASTM E 1527-94. Obtained and reviewed series of historical aerial photographs covering each site.

Task Leader; Ecological Risk Assessment (ERA) of Naval Weapons Industrial Reserve Plant (NWIRP) Calverton; Northern Division, Naval Facilities Engineering Command; Calverton, New York; May 1997 to October 1997. Characterized habitats at four Installation Restoration (IR) sites in naturally vegetated areas of a closed Navy base in eastern Long Island. Delineated and characterized wetlands on each site. Described ecological receptors and exposure pathways at each site and prepared screening-level ecological risk analyses. Collected and screened sediment samples for benthic macroinvertebrates, preserved and shipped organisms to a laboratory for taxonomic identification, and evaluated diversity of the benthic macroinvertebrate community.

Wetlands Task Leader; Remedial Design for NSWC Dahlgren Site 9; Engineering Field Activity Chesapeake, Naval Facilities Engineering Command; King George County, Virginia; June 1997 to January 1999. Designed a wetland mitigation plan for creating approximately 0.9 acres of tidal wetlands in an area adjoining an abandoned landfill (Site 9) on the banks of Gambo Creek, a tidal tributary to the Potomac River. The wetlands served to offset the loss of approximately 2.3 acres of tidal wetlands that had to be permanently filled in order to cap contaminated sediment. The plan also called for planting native warm season grasses and shrubs on the cap to enhance wildlife habitat. Investigated a series of alternative locations on NSWC Dahlgren that could potentially suitable for restoring or creating additional wetlands. Wrote a technical memorandum proposing a wetland mitigation bank to cover wetland losses on Site 9 and other contaminated sites requiring remediation. The memorandum presented a short-list of sites that could potentially be used to restore or create wetlands.

Task Manager; Basewide Environmental Baseline Survey (EBS) of Naval Weapons Industrial Reserve Plant (NWIRP) Bethpage; Northern Division, Naval Facilities Engineering Command; Bethpage, New York; February 1997 to January 1998. Coordinated the preparation of an EBS following methodology in ASTM D 6008, which includes a review of public records, interviews with site and agency representatives, and visual site inspection. The EBS addressed over 100 industrial and administrative buildings on NWIRP Bethpage, including a large aircraft manufacturing building, various warehouses and laboratories, an industrial wastewater treatment plant, a vehicle maintenance facility, and other buildings and land areas. The EBS was completed in compliance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 120(h), as amended by the Community Environmental Response Facilitation Act (CERFA). As Task Manager, planned and coordinated field work by a four-person team and served as primary author of draft and final reports.

NEPA Analyst; Telecommunications Sites in Philadelphia Metropolitan Area; Sprint PCS; Philadelphia, Pennsylvania; February 1997 to December 1997. Visited selected sites in southeastern Pennsylvania and central New Jersey to assess whether construction of monopoles and other telecommunications equipment complied with siting criteria established by the Federal Communications Commission under the National Environmental Policy Act (47 CFR 1.1307 et seq.). Wrote letter reports addressing each site. The reports provided information on wilderness areas, wildlife preserves, threatened and endangered species; cultural resources; floodplains and wetlands, surface waters; Indian religious sites; and high-intensity lighting.

Project Manager; Design of Fernald Ecological Restoration Park; Fluor-Daniel Fernald, Inc.; Cincinnati, Ohio; January 1997 to December 1998. Prepared plans and specifications for establishing a 1-acre park demonstrating the types of natural vegetation that could be established following remediation of contaminated soils at a closed U.S. Department of Energy nuclear materials production facility undergoing environmental cleanup. The park consists of a mulched nature trail passing through small areas of restored vegetation types indigenous to southwestern Ohio, including tallgrass prairie, old field scrub, deciduous forest, and nontidal wetlands. Following completion of the plan, Assisted Fluor-Daniel Fernald in overseeing construction of the park. Voluntarily developed an unofficial website to publicize the park: http://members.aol.com/jpeytond/fernpark.html. Also contributed to conceptual plan for

ecological restoration of the entire Fernald site and updated an ecological risk assessment (ERA) started by other staff in 1994.

Wetlands Task Leader; PCB Removal Action Design for Naval Security Station; Engineering Field Activity Chesapeake; Washington, DC; December 1995 to August 1996. Sesigned a plan for restoring riparian vegetation to two freshwater stream segments in a forested stream valley east of the Naval Security Station in northwest Washington, DC. The stream valley was within Glover Archbold Park, administered by the National Park Service. Sediments in both stream segments were contaminated by PCBs originating from the Naval Security Station. Delineated wetlands and waters of the United States and obtained Jurisdictional Determination from the U.S. Army Corps of Engineers. Mapped trees over 4 inches in diameter at breast height in accordance with National Park Service procedures. Prepared plans and specifications for reconstructing the stream channel and replanting native trees and shrubs.

Task Manager; Mapping of Wetlands, Playas, and Other Waters of the United States on Sierra Army Depot; HAZWRAP; Herlong, California; September 1995 to April 1996. Developed sitewide map of areas regulated under the Clean Water Act on 96,421-acre installation. Analyzed 1:10,000 color infrared aerial photographs and then organized two 2-man field teams to ground truth the photographs over a 2-week period. The teams collected data necessary to complete field data forms from the 1987 Corps of Engineers Wetlands Delineation Manual. Features delineated included a desert saltgrass dominated wetland bordering the seasonally dry Honey Lake, several riparian areas, a seep, and numerous salt-encrusted playas (seasonally inundated depressions). Assisted Depot staff in obtaining a Jurisdictional Determination from Sacramento District of U.S. Army Corps of Engineers. Subsequently developed a publication in a peer-reviewed journal based on this work.

Environmental Scientist; Basewide Environmental Baseline Survey (EBS) of Naval Ordnance Station Louisville; Southern Division, Naval Facilities Engineering Command; September 1995 to May 1996. Served as one of eight professionals who reviewed records, conducted interviews, and visually inspected real property to prepare an EBS following methodology in ASTM D 6008. The EBS addressed over 100 industrial and administrative buildings on an intensively developed 144-acre site. The EBS was completed in compliance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 120(h), as amended by the Community Environmental Response Facilitation Act (CERFA).

Ecologist; Marine Mammal Incidental Take Permit Application for Rocket Launches at Vandenberg AFB; Air Force Center for Environmental Excellence; June 1995 to September 1995. Contributed to permit application for "incidental take" of marine mammals due to noise impacts from rocket launching activities. The trajectories of launches from Vandenberg AFB sometimes pass over offshore islands that provide habitat for large numbers of marine mammals. "Incidental take" referred to indirect impacts to the populations from noise, not to direct efforts to kill or remove individual specimens.

Task Leader; Burton Mesa Chaparral (BMC) Restoration Plan; Air Force Center for Environmental Excellence; Lompoc, California; May 1995 to January 1996. Developed a conceptual plan for restoring rare chaparral vegetation to compensate for losses due to expansion

of military family housing. BMC harbors several rare, threatened, and endangered species. Analyzed preliminary plans for the military housing project and recommended adjustments to the construction footprint that reduced impacts to BMC by several acres. Researched the scientific literature to assess the potential for success for planting BMC plant species in areas of disturbed annual grassland. Developed a conceptual plan and planting specifications for restoring over 40 acres of BMC.

Task Manager; Basewide Environmental Baseline Survey (EBS) of Naval Weapons Industrial Reserve Plant (NWIRP) Calverton; Northern Division, Naval Facilities Engineering Command; Calverton, New York; March 1995 to January 1997. Coordinated preparation of an EBS following methodology in ASTM E 1527, which includes a review of public records, interviews with site and agency representatives, and visual site inspection. The EBS addressed over 80 industrial and administrative buildings and over 6,000 acres of mostly wooded lands. It was completed in compliance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 120(h), as amended by the Community Environmental Response Facilitation Act (CERFA). As Task Manager, planned and coordinated field work by a six-person team and served as primary author of draft and final reports.

Wetland Scientist; Land Use and Land Cover Mapping for Suwannee River Water Management District; subcontract to WOOLPERT; Live Oak, Florida; February 1995 to October 1996. Served as the lead wetland scientist and technical reviewer on a team responsible for mapping land cover and land uses throughout more than 7,000 square miles in northern Florida. The project involved delineating and classifying residential, commercial, industrial, agricultural, and natural vegetation land uses and land cover using 1:40,000-scale color infrared aerial photography. Led the completion of a pilot area to identify usable photosignatures and refine project procedures. Assisted in administering a training program for a team of 8 photointerpreters tasked with completing the project. Served as one of two senior technical reviewers for the project.

Ecologist; Ecological Risk Assessment (ERA) for Charleston Air Force Base; Air Force Center for Environmental Excellence; Charleston, South Carolina; February 1995 to January 1997. Characterized ecological resources at two dumping sites near the base's airfield designated as Solid Waste Management Units (SWMUs) 74 and 144. Visited both sites to inspect for threatened and endangered species, develop a list of ecological receptors, and identify wetland boundaries. Wrote screening-level ERA. Submitted consultation letters to natural resource trustees and designed a mitigation plan for restoring wetland soils and vegetation after excavation of partially buried drums and other debris.

Wetlands Scientist and Ecologist; Remedial Design for Dump Site, Marine Corps Air Station Cherry Point; Northern Division, Naval Facilities Engineering Command; Cherry Point, North Carolina; February 1995 to June 1995. Delineated existing wetlands and designed a wetland mitigation plan for restoring a roughly 10-acre dump site following cleanup. The site bordered a tidal tributary to the Neuse River. The mitigation design emphasized restoration of zoned natural vegetation including bald cypress swamp, mixed wetland hardwood swamp, Atlantic white cedar swamp, and a pine flatwood buffer. Prepared plans and specifications for the wetland restoration.

Wetlands Scientist and Ecologist; Remedial Design for Site 4 Landfill, Marine Corps Combat Development Command at Quantico; Engineering Field Activity Chesapeake, Naval Facilities Engineering Command; Quantico, Virginia; November 1994 to August 1995. Mr. Doub delineated existing wetlands and designed a wetland mitigation plan for remediation of an abandoned landfill bordering a tidal reach of the Potomac River. Wrote wetland delineation report and prepared a Joint Permit Application to the U.S. Army Corps of Engineers. Prepared plans and specifications for restoring over an acre of tidal wetlands as part of the remedy. Inspected the completed wetland in September of 2002 as part of Tetra Tech's 5-year review of the remedy and noted that the wetlands had developed in general accordance with the design. Inspected the wetlands again in November of 2003 to inspect for possible damage from a hurricane and noted that the wetlands had successfully weathered several feet of temporary inundation from a tidal storm surge.

Ecologist and Wetland Scientist; EAs for Military Construction Projects on Vandenberg AFB; Air Force Center for Environmental Excellence; Lompoc, California; September 1994 to January 1996. Prepared sections addressing wetlands and vegetation for eight EAs for minor construction projects. The projects included several road upgrades, pipeline replacements, a combat training facility, a consolidated firehouse, and reconstruction of military family housing. Inspected and characterized vegetation on each project site, mapped the locations of rare or endangered plants, and delineated wetlands and other waters of the United States.

Ecologist and Wetlands Scientist; Remedial Investigation and Feasibility Study (RI/FS) for Melville North Landfill; Northern Division, Naval Facilities Engineering Command; Newport, Rhode Island; September 1994 to January 1995. Delineated tidal and nontidal wetlands at abandoned landfill on Narragansett Bay. Mapped and characterized wetland and upland vegetation and completed functional assessment of wetlands using the WET 2.0 computer model.

Environmental Scientist; Environmental Assessment (EA); Riverbank Stabilization at Landfill, Philadelphia Naval Shipyard; Northern Division, Naval Facilities Engineering Command; Philadelphia, Pennsylvania; April 1994 to September 1994. Served as project ecologist for an EA outlining potential environmental impacts from alternative practices for stabilizing an eroding riverbank at a landfill site on a tidal reach of the Schuylkill River. Practices considered included use of rock armor, gabions, a concrete retaining wall, metal sheet piles, and vegetative stabilization. Key issues were protection of tidal mudflats and nearby habitat used by the (then) Federally-listed peregrine falcon (*Falco peregrinus*). Visited the site, characterized habitats and species present, reviewed key records, and contributed related sections to the EA. The Navy ultimately issued the EA as an "Environmental Permits Report".

Project Manager; Wetland Delineation and Forest Inventory of National Security Agency Campus; National Security Agency; Fort George G. Meade, Maryland; March 1994 to December 1995. Flagged the boundaries of 37 wetland occurrences on the 660-acre campus; coordinated a land survey of the wetland boundaries; and coordinated the establishment of an electronic database depicting regulated wetlands on the campus. The wetlands included several forested wetlands bordering streams and a series of forested hillside seeps. For the forest inventory, collected data from over 200 representative tenth-acre quadrats, one per acre of forest

cover on the site. Wrote the forest inventory report in the form of a comprehensive baseline inventory of flora and fauna on the site. Developed vegetation management recommendations for the campus.

Environmental Scientist; Environmental Assessment (EA) for Ship Scrapping Operations; U.S. Department of Transportation, Maritime Administration; Various International Locations; January 1994 to September 1994. The EA addressed potential environmental impacts from moving mothballed ships in Fort Eustis, Virginia; Port Aurthur, Texas; and Suisan Bay, California to scrapping operations in Mexico, India, and China. Wrote sections assessing potential impacts to biological and water resources. The EA was written on the basis of literature research and interviews only; the scope of work did not involve visiting the affected sites.

Environmental Scientist; Basewide Environmental Baseline Survey (EBS) of Williams Air Force Base; Air Force Center for Environmental Excellence; Mesa, Arizona; July 1993 to November 1993. Served on a team of six environmental professionals preparing a basewide EBS using methodology in ASTM E 1527 (the more directly relevant ASTM D 6008 for EBSs had not yet been published). The EBS addressed over 100 industrial and administrative buildings on the 4042-acre base. Collected and reviewed environmental records, interviewed base employees, and conducted visual site inspections of buildings and land areas on the base. The EBS was completed in compliance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 120(h), as amended by the Community Environmental Response Facilitation Act (CERFA).

Environmental Scientist; Environmental Impact Statement (EIS) for Waste Management Facilities at Oak Ridge Reservation; U.S. Department of Energy (DOE); Oak Ridge, Tennessee; March 1993 to January 1994. Authored land use sections of EIS addressing alternative practices and locations for the disposal and management of low-level radioactive waste. Reviewed proposed action and alternatives for consistency with land use plans and policies developed by DOE and the City of Oak Ridge. Inspected visited multiple sites on the reservation to map and characterize wetlands to support biological analyses in the EIS.

Ecologist; Supplemental Environmental Impact Statement (EIS) for Indiana Harbor and Canal Maintenance Dredging and Disposal Activities; U.S. Environmental Protection Agency, Region 5; Chicago, Illinois; January 1993 to May 1993. Authored biological resources sections of a Supplemental EIS addressing maintenance dredging operations in a navigable canal near Lake Michigan. The key potential for biological impacts involved resuspension of contaminated sediments in aquatic habitats.

Deputy Project Manager; Sitewide Environmental Assessment (EA) for Continued Development of Naval Petroleum Reserve No. 3; Fluor-Daniel, Inc.; Casper, Wyoming; December 1992 to March 1993. Led preparation of an EA addressing alternatives for continued oil extraction activities on a 9,000-acre site jointly administered by the U.S. Navy and U.S. Department of Energy. Authored sections dealing with wetlands and floodplains, vegetation, soils, and water resources. Directed authors of other sections. The EA was included as one of three sample EA reports presented as appendices in the textbook *Effective Environmental Assessments: How to Manage and Prepare NEPA EAs* by Charles H. Eccleston.

Environmental Scientist; Programmatic Environmental Impact Statement (EIS) for Ballistic Missile Defense Program; Ballistic Missile Defense Organization (BMDO); November 1992 to June 1994. Authored water resources sections of an EIS addressing alternatives for establishing a national missile defense program. As a programmatic EIS, the EIS focused primarily on general issues and controversies associated with establishment of the program. It was intended to serve as a basis for future tiered NEPA documentation for specific actions under the program. Also served as Environmental Consequences Chapter Lead. Authored an introduction to the chapter and assembled input from team of 14 separate technical authors.

Task Manager; Delineation of Wetlands at Runoff Basin, Palo Verde Nuclear Generating Station; Arizona Public Service Company; May 1992 to August 1992. Delineated and characterized wetlands that had formed in a runoff basin resulting from surface runoff from the power plant. Completed wetland delineation data sheets and wrote wetland delineation report.

Deputy Project Manager; Environmental Assessment (EA) for Hartwell Power Plant Complex; Transco, Inc.; Lake Hartwell, Georgia; May 1992 to October 1992. Managed a team tasked to prepare an EA for a Federal water allocation and land easement for a proposed power plant project on a reservoir on the Savannah River in northern Georgia. The EA was funded by the private developer of the power plant project, but the EA was prepared for publication by the Savannah District of the Corps of Engineers. Served as the wetland specialist and terrestrial ecologist on the team and supervised other team members including a hydrologist, aquatic ecologist, soil scientist, archaeologist, planner, architect, and engineer. Served as the primary author of the EA. Performed a wetland delineation of the 215-acre site and obtained a Section 404 permit for construction impacts to wetlands.

Wetland Scientist; Remedial Investigation/Feasibility Study for Kearsarge Metallurgical Site; U.S. Environmental Protection Agency, Region 1; South Conway, New Hampshire; May 1992 to October 1992. Delineated wetlands and inventoried vegetation on a 10-acre site in central New Hampshire that had been contaminated by an abandoned metallurgical facility. Modeled wetland values and functions using the Wetland Evaluation Technique (WET 2.0).

Ecologist and Wetland Scientist; Environmental Assessment (EA) for Astrotech Payload Processing Facility on Vandenberg AFB; Astrotech Space Operations Limited Partnership; Lompoc, California; March 1992 to December 1992. Served as the wetlands and vegetation lead on an EA for construction of a privately funded facility on federal property on Vandenberg AFB. Reviewed alternative sites on and off the base to assist in siting facility to avoid or minimize impacts to wetlands, vernal pools, and other sensitive natural resources. Delineated two vernal pools on the selected site and assisted in positioning the footprint of the facility to avoid encroachment and minimize runoff into the vernal pools. Wrote EA sections on wetlands and biological resources.

Project Manager; Wetland Delineation of Transmission Line for Beaver Falls Cogeneneration Plant; Commonwealth Associates, Inc.; March 1992 to January 1993. Under subcontract to Commonwealth Associates, Inc., performed a wetland delineation for a 7.3-

mile right-of-way for a 115 kV electric transmission line. Wrote wetland delineation report. Suggested routing adjustments to reduce wetland impacts. The right-of-way was mostly forested.

Ecologist; Ecological Risk Assessment (ERA) for Storage Yard 2, Annapolis Naval Station; Engineering Field Activity Chesapeake, Naval Facilities Engineering Command; Annapolis, Maryland; March 1992 to January 1993. Delineated tidal and nontidal wetlands and mapped forest stands on a roughly 75-acre site on the Severn River. Collected sediment samples to characterize benthic macroinvertebrate populations.

Ecologist; Environmental Assessment (EA) for Consolidation of Nonnuclear Manufacturing Operations; U.S. Department of Energy; January 1992 to April 1993. Wrote sections on biological resources, threatened and endangered species, and wetlands for an EA addressing the proposed consolidation of non-nuclear manufacturing activities within the U.S. nuclear weapons complex. The EA addressed alternatives for consolidating activities at the Kansas City Plant, the Mound Plant in Ohio, the Pinellas Plant in Florida, the Rocky Flats Plant in Colorado, the Savannah River Site in South Carolina, the Oak Ridge Reservation in Tennessee; the Pantex Plant in Texas; and the Los Alamos National Laboratory in New Mexico.

Ecologist and Wetlands Scientist; Environmental Impact Statements (EISs) for Disposal and Reuse of Williams and Lowry Air Force Bases; Air Force Center for Environmental Excellence; Mesa, Arizona and Denver, Colorado; December 1991 to June 1993. Mapped vegetative cover, performed rare plant survey, and completed delineation of wetlands (and other waters of the United States) for each base and wrote EIS sections addressing vegetation and wetlands in the EISs. Obtained wetland Jurisdictional Determinations for each base.

Task Leader; Environmental Permiting for AES Warrior Run Electric Transmission Line; AES Warrior Run, Inc.; Cumberland, Maryland and Carpendale, West Virginia; September 1991 to June 1992 and December 1997 to January 1998. Prepared applications for environmental permits required for 6-mile, 230 kV electric transmission line connecting proposed 180 MW power plant to the Allegheny Power grid. Assisted the client in selecting a route that would minimize environmental impacts and facilitate permit acquisition. Performed wetland delineation of the selected route. Completed applications and environmental analyses for Public Service Commission approval, a Joint Permit Application for wetlands impacts and a Potomac River crossing, and applications for local approvals (1991-1992). Performed tree inventory of the proposed right-of-way where it traversed Carpendale, West Virginia to comply with municipal ordinance. Designed tree screen for where the transmission line would cross a public road in Carpendale (1997-1998).

Wetland Scientist; Appraisal of Wetland Protection on Savannah River Site (SRS); U.S. Department of Energy; Aiken, South Carolina; June 1991 to September 1991. Served on a six-member panel of experts evaluating wetland protection policies and procedures on a nuclear weapons site encompassing over 300 square miles. The panel interviewed selected contractors responsible for construction activities on the SRS. Co-authored report documenting the panel's findings, observations, and recommendations.

Wetland Scientist; Wetland Delineation of Saco Tannery Waste Pit Site; U.S. Environmental Protection Agency, Region 1; Saco, Maine; May 1991 to April 1992. Delineated wetlands and described plant communities on a 200-acre forested site in southeastern Maine containing a series of abandoned waste pits that had been contaminated with chromium and other metals from a past tanning operation. Contributed to planting plan for establishing 2 acres of forested wetlands to offset wetlands unavoidably lost during the remediation of the site.

Environmental and Wetland Scientist; Site Evaluation Study for Proposed Cogeneration Facility; Duke Energy Corporation; Kent County, Delaware; May 1991 to March 1992. Contributed to a site selection study for a proposed power plant in coastal Delaware. Researched permitting requirements. Performed wetland delineation of the selected site and obtained a Jurisdictional Determination from the U.S. Army Corps of Engineers. Assisted in performing a drain field analysis of the selected site.

Task Leader; Wetland Mitigation Plan for AES Warrior Run Cogeneration Plant; AES Warrior Run, Inc.; Cumberland, Maryland; February 1991 to January 1993. Designed wetland mitigation plan for constructing approximately 4.1 acres of palustrine emergent and palustrine forested wetlands on the site of a proposed 180-MW power plant on a floodplain terrace of the North Branch Potomac River. The plan outlined efforts to avoid, minimize, and compensate for wetland impacts. Developed plans and specifications. Assisted the client in obtaining approval of the wetland mitigation plan from the Baltimore District of the Corps of Engineers and Maryland Department of the Environment. Assisted the client in selecting a landscape contractor to construct and plant the wetlands. Inspected the finished wetlands in 1996 and 1997 and determined that they were developing in general accordance with the design.

Wetlands Task Leader; Environmental Permitting for AES Warrior Run Cogeneration Plant; AES Warrior Run, Inc.; Cumberland, Maryland; November 1990 to May 1992. Completed applications for permits related to wetlands, floodplains, and biological resources for proposed 180-MW power plant in western Maryland. Delineated wetlands on proposed 65-acre power plant site and proposed water discharge pipeline right-of-way. Applied for and obtained individual Section 10/404 permit for 1.8 acres of wetland impacts and reconfiguration of a discharge structure in the channel of the North Branch Potomac River. Inspected river floodplain area for white trout lily (*Erythronium albidum*), a rare plant species in Maryland (to assess potential impacts to rare, threatened, and endangered species).

Deputy Project Manager; Environmental Assessment (EA) for Commonwealth Cogeneration Plant; Commonwealth Cogeneration Limited Partnership; Hurt, Virginia; April 1990 to May 1991. Led the writing of an EA for an EA for construction of a 130-MW power plant on the Roanoke River in southcentral Virginia. Served as the wetland specialist and terrestrial ecologist on the EA team and coordinated work by other team members including a hydrologist, aquatic ecologist, soil scientist, archaeologist, planner, architect, and engineer. Served as the primary author of EA. Performed wetland delineation of the proposed 160-acre power plant site and a proposed 2-mile pipeline right-of-way and obtained Jurisdictional Determination from the U.S. Army Corps of Engineers. Inspected the site for the presence of *Nestronia umbellata*, a rare plant known to occur in close proximity (to assess impacts to rare, threatened, and endangered species). Coordinated a subcontractor performing a Phase I

archaeological survey of the power plant site and Phase II deep trenching where pipeline right-of-way crossed the Roanoke River floodplain.

Wetlands Task Leader; Environmental Permitting for AES Cohansey Cogeneration Plant; AES Cohansey, Inc.; Bridgeton, New Jersey; March 1990 to April 1992. Completed applications for permits related to wetlands, floodplains, and biological resources for the proposed site for a 300-MW power plant and an associated 230 kV transmission line. Delineated wetlands on 100-acre power plant site and 10-mile transmission line right-of-way. Applied to the New Jersey Department of Environmental Protection and Energy (NJDEPE) for a Transition Area Waiver and Statewide General Freshwater Wetlands Permit. Inventoried existing trees and standing timber on the site and transmission line right-of-way to assist AES in complying with the City of Bridgeton tree ordinance. Designed a reforestation plan for the site using indigenous tree and shrub species to compensate for tree losses during construction of the power plant. Inspected the site for the presence of the rare plant Swamp Pink (*Helonius bullata*). The project was ultimately tabled by the client for reasons not related to environmental planning.

Deputy Project Manager; Environmental Assessment (EA) for Mecklenburg Cogeneration Plant; Mecklenburg Cogeneration Limited Partnership; Clarksville, Virginia; January 1990 to December 1991. Led the writing of an EA for a Federal water allocation and land easement for a proposed power plant project on a reservoir on the Roanoke River in southcentral Virginia. The work was funded by a limited partnership of private developers who were building the project, but the EA was written for publication by the Wilmington District of the Corps of Engineers. Served as the wetland specialist and terrestrial ecologist on the team. Directed a project team comprising a hydrologist, aquatic ecologist, soil scientist, archaeologist, planner, architect, and engineer. Mr. Doub served as the primary author of EA. Completed a wetland delineation of the proposed 65-acre power plant site and 1.5-mile pipeline right-of-way in support of the EA.

Wetlands Task Leader; Wetland Delineation of Proposed Amoco Cogeneration Plant; Amoco, Inc.; Yorktown, Virginia; December 1989 to January 1990. Conducted wetland delineation of a 30-acre forested site in tidewater Virginia proposed for a power plant project. The project was subsequently cancelled due to non-environmental factors.

Wetlands Task Leader; Environmental Permitting for Proposed Meade Paper Cogeneration Plant; O'Brien Energy, Inc.; South Lee, Massachusetts; January 1990 to July 1990. Prepared applications for permits related to wetlands, floodplains, and biological resources for a proposed 60-MW power plant in Berkshire County, Massachusetts. Contributed to selection of routes for a 1-mile steam line and 1.5-mile, 69 kV transmission line that minimized environmental impacts and permitting difficulties. Wrote sections of an Environmental Impact Report (EIR) addressing biological resources and wetlands impacted by the power plant project. Presented wetland impacts to the Town of Lee Conservation Committee.

Wetland Scientist; Wetland Assessment of Nyanza Dye Works Site; U.S. Environmental Protection Agency, Region 1; Framingham, Massachusetts; October 1989 to January 1990. Visited, and described the physical and biological characteristics of, each wetland occurring on a 10-mile reach of the Sudbury River downstream of an abandoned dye works in the western

suburbs of Boston. Sediments in the river were suspected of being affected by heavy metals and other contaminants originating at the dye works. Wrote qualitative functional assessment.

Environmental Scientist; Siting/Permitting Assessment for New Jersey Cogeneration Projects; Fluor-Daniel, Inc.; Various Locations in New Jersey; August 1989 to December 1989. Participated in site selection study for proposed power plant projects in New Jersey. The study analyzed permitting problems associated with four sites in various parts of the state. Interacted with regulators from the New Jersey Department of Environmental Protection and Energy (NJDEPE) and U.S. Army Corps of Engineers.

PUBLICATIONS:

Doub, J. P. 2007. Wetland Mitigation and Monitoring on Hazardous Waste Remediation Sites. US Environmental Protection Agency (USEPA)/US Army Corps of Engineers (USACE) 2007 Conference on Design and Construction Issues at Hazardous Waste Sites, April 4 - 5, 2007, Philadelphia, Pennsylvania.

Doub, J. P. and C. H. Eccleston. 2003. A Systematic Tool for Determining the Need for Specialized Expertise in NEPA. Environmental Practice 5(4): 288-289.

Stribley, T, D. F. Barone, and J. P. Doub. 2003. Case Studies Demonstrating a Systematic Process for Integrating the National Environmental Policy Act with Regulatory Agency Consulation. Environmental Practice 5(4): 371-378.

Doub, J. P. 2002. Book Review of *Environmental Impact Statements: A Comprehensive Guide to Project and Strategic Planning* by Charles H. Eccleston. Environmental Practice 4(4): 47-48.

Doub, J. P. 2002. The National Environmental Policy Act – Challenges and Controversy. Proceedings of the 22nd Annual Meeting of the Association for Politics and the Life Sciences, Montreal, Quebec, August 11 – 14, 2002.

Doub, J. P. 2001. Integration of Phytoremediation, Wetland Mitigation, and Ecological Restoration. Proceedings of the 26th Annual Conference of the National Association of Environmental Professionals - Watershed & Land Management: 5.

Doub, J. P. 2001. NEPA Compliance and Environmental Planning for Airfield Vegetation Management at Andrews Air Force Base. Proceedings of the 26th Annual Conference of the National Association of Environmental Professionals – Environmental Policy in the Department of Defense: 4.

Doub, J. P. 1999. A Proposed Method of Professional Practice for Addressing Wetlands in Environmental Impact Statements. Environmental Practice 1(1): 37-47.

Doub, J. P. 1999. Conducting Environmental Baseline Surveys for Large Manufacturing Facilities and Large Tracts of Undeveloped Land. Proceedings of the 24th Annual Conference of the National Association of Environmental Professionals: Environmental Assessment 27-37.

Doub, J. P. 1997. Improving Biological Resources Impact Assessment. Proceedings of the 22nd Annual Conference of the National Association of Environmental Professionals: 139-155.

Doub, J. P. and R. K. Hastie. 1997. Wetland Assessment for Hazardous Waste Sites under Superfund. Proceedings of Wetlands 97 Conference of Association of State Wetland Managers: 22-24.

Doub, J. P. and J. Colberg. 1996. Delineation of Playa Features in the Western Great Basin. Wetland Journal 8(2) 8-14.

Doub, J. P. 1995. Nationwide Wetland Delineation: Identifying Wetland Boundaries Anywhere in the United States. Wetland Journal 7(1): 8-9.

Doub, J. P. 1995. The Maryland Forest Conservation Act. Arboricultural Consultant 28(1): 6.

Doub, J. P. and J. A. Sechen. 1994. Wetlands Protection and Permitting for Industrial Development in Virginia. Proceedings of Environment Virginia '94: 69-76.

Doub, J. P. 1992. Wetland Delineations and Mitigation Plans. 1992 Annual Meeting of American Society of Consulting Arborists.

RESUME

(October 2010)

RAJIV PRASAD
Scientist III, Surface Water Hydrology, Hydrology Group
Pacific Northwest National Laboratory, Richland, Washington 99352
(509) 375-2096 (Voice)
(509) 372-6089 (Fax)
rajiv.prasad@pnl.gov

EDUCATION

Doctor of Philosophy in Civil and Environmental Engineering
Utah State University, Logan, Utah (2001)
Master of Technology in Civil Engineering
Indian Institute of Technology, Madras, India (1992)
Bachelor of Engineering in Civil Engineering
Regional Engineering College, Durgapur, India (1990)

JOB EXPERIENCE

Scientist, Surface Water Hydrology, Hydrology Group
Pacific Northwest National Laboratory, Richland, Washington (September 2004 onwards)

Postdoctoral Research Associate, Hydrology Group
Pacific Northwest National Laboratory, Richland, Washington (February 2002 – August 2004)

Postmasters Research Associate, Hydrology Group
Pacific Northwest National Laboratory, Richland, Washington (October 2001 – January 2002)

Postdoctoral Research Associate, Associated Western Universities, Richland, Washington (August 2000 – September 2001)

Graduate Research Assistant, Water Division, Utah Water Research Laboratory, Utah State University, Logan, Utah (September 1993 – August 2000)

AFFILIATIONS

Member, American Geophysical Union
Member, American Water Resources Association

PROFESSIONAL EXPERIENCE

Early Site Permit reviews (safety and environmental issues) for the U.S. Nuclear Regulatory Commission

Since 2003, I have helped carry out four concurrent (Clinton, North Anna, Grand Gulf, and Vogtle) **early site permit (ESP) reviews** for safety as well as environmental reviews for the U.S. Nuclear Regulatory Commission (USNRC). These reviews are being carried for the first time under new USNRC regulations as described in Title 10 of Code of Federal Regulations. This work involved hydrologic site assessment including hazards from external flooding events such as probable maximum precipitation (PMP), local intense precipitation, dam failures including cascading dam failures, storm surges, tsunami, and icing. Water availability was evaluated under current and post-plant conditions to determine water-use impacts including natural variability, plant-induced water use, channel migration, and blockages due to icing.

I have helped establish critical technical expertise at PNNL to support ESP and Combined Operating License (COL) reviews for the USNRC.

I am currently involved in hydrology reviews of **COL applications at multiple sites** in the United States including Levy County and South Texas Project. These reviews cover both the environmental and the safety aspects. These efforts include reviews of applicant's analyses as well as performing independent analyses conforming to USNRC guidelines to verify the conclusions presented by the applicants in the respective applications. I am the lead surface water reviewer for the Levy and South Texas COL applications. I prepared the surface water sections of the Levy and South Texas Draft Environmental Impact Statements.

Updating Standard Review Plans for the U.S. Nuclear Regulatory Commission

I was involved in the development of guidance related to review of surface water-related environmental issues that must be evaluated for preparation of USNRC's Environmental Impact Assessments for ESP and COL applications. The guidance includes evaluation of water use, water rights, and water quality-related issues in current as well as altered future environment.

There is renewed concern in the public regarding tsunamis and recognition at the USNRC that guidelines related to assessment of flooding hazard due to tsunamis at nuclear power plant sites located at or near a coastline are outdated. I presented the current technical approach for site assessment for flooding hazard at nuclear power plant sites in the United States at an International Atomic Energy Agency (IAEA) workshop. This workshop was organized by the IAEA in the aftermath of the December 26, 2004 Indian Ocean earthquake and subsequent tsunami that

devastated coastlines in southeastern Asia. Under a contract from USNRC, I led the updates to the hydrologic engineering sections of the Standard Review Plan (SRP), Sections 2.4.1-2.4.14. The updated SRP Sections were published by the USNRC in March, 2007.

Updating the review methodology for tsunami hazard assessment at U.S. nuclear power plant site

Under a contract from the USNRC, I led the effort to put together a technical team to revise review criteria and guidance related to hazards due to tsunamis. PNNL teamed with the Pacific Marine Environmental Laboratory (PMEL) to produce two documents for the USNRC. The PNNL authored document focused on the review aspects of the tsunami hazards at nuclear power plant sites, primarily to assist the USNRC staff in updating their SRP. The second document was authored by PMEL and describes the data collection, theory, and modeling aspects of tsunami. The SRP section that describes tsunami hazards was updated and published in March, 2007. The PNNL-authored report, NUREG/CR-6966, was published in April, 2009.

Updating the design-basis flood estimation methods for the USNRC

Currently, under a contract with the USNRC, I am working to update the guidance and methodology for estimation of design-basis flood at nuclear power plant sites in the United States. The methods and recommendations will be published in a NUREG/CR report later this year. The NUREG/CR will be used by the USNRC to update its Regulatory Guide 1.59.

Experience working with the International Atomic Energy Agency (IAEA)

I participated in an international workshop organized by the IAEA, the Atomic Energy Regulatory Board of India, and the Nuclear Power Corporation of India Ltd. in Kalpakkam, India during August 29 – September 2, 2005. I presented a review and a summary of the experiences gained during the NRC ESP reviews related to site characterization for flooding. In May 2006, I was invited by the IAEA to participate in a follow-up meeting in Trieste, Italy to review IAEA Safety Guide NS-G-3.5 for possible updates. I participated in another IAEA sponsored workshop in Trieste, Italy in May 2007 and presented an overview of the tsunami guidance development that I led at PNNL. The resulting report from the effort, NUREG/CR-6966 was published in April, 2007. The IAEA is currently updating its Safety Guide NS-G-3.5.

Water-Energy Nexus

Although there is abundant hydroelectric power available in the Pacific Northwest, the energy system and the water resources system have traditionally been optimized decoupled from each other. I am a co-Principal Investigator on a Laboratory Directed Research and Development (LDRD) funded project that will

demonstrate the advantages of water and energy integrated resources systems optimization approach. This project will leverage **ensemble streamflow forecasting** techniques and **multi-scale modeling** approaches that I helped develop at PNNL to implement a water resources module for the Integrated Energy Operations Center (IEOC). The IEOC is envisioned as a central control and operations center for system-wide information gathering, processing, optimization, and scheduling. The water resources module will be integrated into the IEOC framework to provide simultaneous optimization of the water resources and the energy systems for more efficient use of hydropower resources while meeting the aquatic and instream flow demands.

Ensemble streamflow forecasting

Ensemble streamflow forecasting capability was developed over the last two years. The **PNNL Streamflow Ensemble Generation System (PNNL-SEGS)** is a control program that drives the PNNL Watershed Model (PWM) to generate a set of possible future streamflow scenarios starting from a common initial condition but corresponding to alternate meteorologies. The alternate meteorologies may be specified from historical observations where a sequence of meteorological conditions over a given time period during all available water years on record are considered equally probable. Another approach may involve specifying alternate meteorologies under changed climate scenarios generated from regional climate models such as MM5. Each alternate meteorology produces a single streamflow trace or hydrograph. The complete set of these streamflow traces represents the streamflow ensemble, with explicit characterization of uncertainty in streamflow forecasts. This streamflow ensemble can then be used for optimal operation of the water resources system.

Watershed characterization

I was involved in watershed characterization work for the Corps of Engineers' Seattle Office, Grays Harbor County, and Washington Department of Fish and Wildlife, and Washington Department of Ecology for the Chehalis watershed located in southwestern Washington. The goal of the project is to provide information for decision-making to improve flood control and restoration of degraded ecosystem functions. The watershed was delineated automatically from digital terrain data, and PWM was calibrated using historical meteorologic and streamflow datasets. Streamflow for all subbasins on a spatial resolution approximately equal to that of level 6 hydrologic unit codes (HUC) were modeled. A sediment generation model, the Hillslope Erosion Model (HEM) was adapted to estimate steady state sediment delivery to the stream network from the subbasins. A simple stream temperature model was also developed to help predict stream temperature. Results from these models were used to estimate environmental indicators based on the Ecosystem Diagnosis and Treatment (EDT)

approach. These indicators are expected to help characterize habitat suitability for fish in these watersheds under undisturbed and current conditions for restoration.

A similar project was also carried out in the Snohomish watershed. Initial delineation of the watershed and setup of PWM is complete. PWM was modified during this phase to include a snow component. GIS data layers are being built in to help improve hydrologic characterization of the watershed.

Watershed delineation quality control

Watershed characterization for acid total maximum daily load (TMDL) work was also performed for more than 140 forest preserve lakes in New York as part of work for the EPA. The objective was to evaluate the levels of pH, aluminum, and acid neutralizing capacity in these lakes in response to atmospheric deposition. This work involved adapting terrain analysis and hydrologic algorithms implemented in ESRI Arc/Info geographic information system (GIS) software to help delineate watersheds that contribute surface and subsurface flow to these alpine lakes.

Special care was needed for developing these procedures because of two concerns: (1) limitations of digital terrain data even at the finest available resolution (10 m) because of the small size of these watersheds, and (2) presence of special cases like closed drainages (watersheds draining to lakes without an outlet), multiple outlet lakes (lakes that had more than one stream existing at different locations), and nested lakes. In addition to these issues with the automated delineation procedures, it was required that the delineated watersheds be accurate at 1:24,000 scale as per requirements of Federal Geographic Data Committee draft proposal that lays out standards for delineation of HUCs. This requirement translated into a ground accuracy of 12 m for all watershed and lake boundaries. In order to address this requirement, a protocol was developed that used manual checking of all boundaries on USGS digital raster graphs (DRG) of 1:24,000 and 1:25,000 scale topographic maps. The automatically generated watershed and lake boundaries were overlaid on the DRGs. Each boundary was manually checked to ensure that it was consistent with topographic contours. Where needed, the points constituting the polygon representing the boundaries were moved to follow topographic ridges.

PROGRAMMING AND SOFTWARE DEVELOPMENT EXPERIENCE

Computing Languages

FORTRAN, C, C++, Perl, S, R, Java

Software Development

Most of my programming is carried out in C, C++, FORTRAN, R, and Perl in order to develop algorithms for data processing and hydrologic modeling. This includes data analysis including the USGS DEMs, streamflow, river reach files, HUCs, interpretation of results of GAP analysis, interpretation of STATSGO and SSURGO soils data for input to hydrologic models. I use terrain processing algorithms to automatically delineate subbasins and generate the corresponding stream network. Postprocessing of terrain analysis results is used to automatically set up watersheds for hydrologic modeling using DHSVM.

RESEARCH PUBLICATIONS

JOURNAL PAPERS

Prasad, R., D. G. Tarboton, G. E. Liston, C. H. Luce, and M. S. Seyfried, "Testing a blowing snow model against distributed snow measurements at Upper Sheep Creek, Idaho, United States of America," *Water Resour. Res.*, *37*(5), 1341-1356, 2001.

Chandler J., S. Jain, R. Prasad, and J. Eischeid, "Projected Hydroclimatic Change In Western North America: Adaptation Considerations For Water Resources Management," manuscript under preparation, 2009.

CONFERENCE PRESENTATIONS

Prasad, R., D. G. Tarboton, and C. H. Luce, "Application of a Spatially Distributed Hydrologic Model to Semi-Arid Mountainous Watersheds," 17th Annual AGU Hydrology Days, Fort Collins, Colorado, April 14-18, 1997.

Prasad, R., D. G. Tarboton, G. N. Flerchinger, K. R. Cooley, and C. H. Luce, "Understanding the hydrologic behavior of a small semi-arid mountainous watershed," *Eos Trans. AGU*, Fall Meet. Suppl., *80*(46), Abstract H21B-19, 1999.

Prasad, R., D. G. Tarboton, G. E. Liston, C. H. Luce, and M. S. Seyfried, "Testing a Blowing Snow Model Against Distributed Snow Measurements at Upper Sheep Creek," *Eos Trans. AGU*, Fall Meet. Suppl., *80*(46), Abstract H11E-07, 1999.

Prasad, R. and M. S. Wigmosta, "Scalability issues in process-based hydrologic modeling," *Eos Trans. AGU*, Fall Meet. Suppl., *82*(47), Abstract H12C-0312, 2001.

Jain, S., J. Eischeid, and R. Prasad, "Tailored hydroclimatic information for water resources management in the western United States," Proceedings of the

EWRI World Water and Environmental Resources Congress, Philadelphia, Pennsylvania, June 23-26, 2003.

Prasad, R., L. W. Vail, C. B. Cook, and G. Bagchi, "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 upcoming Proceedings of the International Workshop on External Flooding Hazards, August 29 – September 2, Kalpakkam, India, International Atomic Energy Agency, Vienna, Austria, 2005.

Bagchi, G., E. V. Imbro, K. Manoly, and R. Prasad, "U.S. Nuclear Regulatory Criteria on Nuclear Power Plant Protection against External Flooding," in upcoming Proceedings of the International Workshop on External Flooding Hazards (tentative title), August 29 – September 2, Kalpakkam, India, International Atomic Energy Agency, Vienna, Austria, 2005.

Prasad, R., "Evaluation of External Flooding Hazard at Nuclear Power Plant Sites in the United States of America," Presentation at the Topical Consultancy on Tsunamis and Other External Flooding Hazards at Nuclear Power Plant Sites jointly organized by International Center for Theoretical Physics and International Atomic Energy Agency, May 8 – 12, Trieste, Italy, 2006.

Prasad, R., "Guidance for Tsunami Hazard Assessment at Nuclear Power Plant Sites in the United States of America", Presentation at the Workshop on the Physics Tsunami, Hazard Assessment Methods & Disaster Risk Management (Theories and Practices for Implementing Proactive Countermeasures), jointly organized by International Center for Theoretical Physics and International Atomic Energy Agency, May 14 – 18, Trieste, Italy, 2007.

REPORTS PRODUCED FOR THE USNRC

Prasad, R, "Tsunami Hazard Assessment at Nuclear Power Plant Sites in the United States of America," NUREG/CR-6966, U.S. Nuclear Regulatory Commission, Office of New Reactors, Washington, D.C., 2009.

Prasad, R. and others, "Design-Basis Flood Estimation at Nuclear Power Plant Sites," NUREG/CR under preparation, Pacific Northwest National Laboratory, Richland, Wash., 2009.

PNNL REPORTS

Vail, L. W., M. S. Wigmosta, and R. Prasad, "Impact of Climate on Aquatic Habitat in the Yakima River," PNNL-SA-35194, Pacific Northwest National Laboratory, Richland, WA, 2001.

Vail, L. W., M. S. Wigmosta, R. Prasad, and C. K. Knudson, "Accelerated Climate Prediction Initiative," PNNL-SA-36759, Pacific Northwest National Laboratory, Richland, WA, 2002.

Scott M. J., L. W. Vail, C. O. Stockle, A. Kemanian, K. M. Branch, R. Prasad, M. S. Wigmosta, and J. A. Jaksch. "Adapting Irrigated Agriculture to Climate Variability and Change," PNWD-SA-6848, Battelle—Pacific Northwest Division, Richland, WA, 2005.

Scott M. J., L. W. Vail, C. O. Stockle, A. Kemanian, K. M. Branch, R. Prasad, M. S. Wigmosta, and J. A. Jaksch. "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-6980, Battelle—Pacific Northwest Division, Richland, WA, 2005.

Scott M. J., L. W. Vail, and R. Prasad. "Managing Water for Irrigated Agriculture Under Extended Climate-Related Drought." Presented by Michael J. Scott (Invited Speaker) at American Water Reopurces Association 2005 Annual Conference, Seattle, WA on November 8, 2005.

BOOK CHAPTERS

Wigmosta, M. S. and R. Prasad, "Upscaling and Downscaling – Models," Contributed Chapter to upcoming Encyclopedia of Hydrological Sciences, John Wiley and Sons, 2004.

ATTACHMENT 3

October 25, 2010

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	Docket Nos. 52-029-COL
Progress Energy Florida, Inc.	)	52-030-COL
	)	
Levy County Nuclear Plant, Units 1 and 2	)	

AFFIDAVIT LANCE W. VAIL CONCERNING THE STAFF'S ANALYSIS OF THE ENVIRONMENTAL IMPACTS DUE TO PASSIVE DEWATERING

Lance W. Vail does hereby state as follows:

1. I am a Senior Research Engineer in the Hydrology Group of the Energy and Environment Directorate at the Pacific Northwest National Laboratory (PNNL). I have worked as a scientist at PNNL for nearly thirty years. My research focus has been on the nexus of water and energy resources management. I have been involved in water-related reviews of many Early Site Permits (ESPs) and Combined Operating Licenses (COLs). I have supervised the review of Progress Energy Florida's Environmental Report submitted as part of the Levy COL Application. A copy of my curriculum vitae, which highlights my professional qualifications, is attached.

2. I am familiar with Contention 4 as it relates to passive dewatering. I have reviewed the bases submitted in support of Contention 4, as presented in the Joint Interveners' filing dated February 6, 2009, which included the Declaration of Sidney Bacchus, Ph.D. I am also familiar with the Applicant's Motion for Summary Disposition of Contention 4 (Environmental Impacts of Dewatering and Salt Drift) with Regard to Salt Drift and Passive Dewatering, filed on October 4, 2010, the attached "Statements of Material Facts as to which Progress Asserts that there is no Genuine Dispute" ("Applicant's Statement of Facts"), and the Affidavit of Dr. Mitchell L. Griffin.

3. I have reviewed the hydrology-related sections in the Environmental Report submitted by Progress Energy Florida and reviewed the hydrology-related sections of the Draft Environmental Impact Statement.

4. I concur with paragraph 18 in the Applicant's Statement Facts that no passive dewatering is included in the Levy Project; therefore, impacts from passive dewatering are not plausible.

5. The Staff uses the term "passive dewatering" to refer to the drainage of groundwater into structures below the adjacent groundwater level (*e.g.*, drain pipes, high-conductivity conduits, and ditches) and the subsequent flow of this water to lower elevations under the influence of gravity. This is in contrast to "active dewatering" which involves drainage of groundwater into structures, such as sumps and wells, from which it is removed by active pumping using an external source of power. In the DEIS, the Staff did not mention passive dewatering because the Applicant did not propose to employ passive dewatering structures in its design.

6. In the Applicant's Statement of Facts ¶¶ 19-24, statements related to the stormwater management system are also provided. The Staff considers stormwater management to be separate from active or passive dewatering. Stormwater management systems route precipitation over the land surface away from structures and into landscape features and structures such as detention and recharge basins. While these stormwater management features and impervious surfaces may reduce recharge to the subsurface in the immediate vicinity of the plant structures, they do not drain water from the subsurface environment, in particular because all elements of the stormwater management system will be at too high an elevation to drain groundwater passively.

7. I hereby certify under penalty of perjury that the foregoing is true and complete to the best of my knowledge, information, and belief.

Executed in Accord with 10 CFR § 2.304(d)

Lance W. Vail
Senior Research Engineer
Hydrology Group
Pacific Northwest National Laboratory
Richland, WA 99352
(509) 372-6237
Lance.Vail@pnl.gov

Executed in Richland, Washington
this 25th day of October 2010

LANCE W. VAIL

Senior Research Engineer
Hydrology Group
Environmental Technology Division
Pacific Northwest National Laboratory

Since joining Pacific Northwest National Laboratory 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, regulatory compliance assessments, and project management. His areas of expertise cover a broad spectrum of areas related to water resources and the nexus of water and energy.

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
- 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 AFFILITATIONS

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

CURRENT PROJECTS

- ***Hydrological Environmental and Safety Reviews of Combined Construction and Operating Licenses Applications (COLA) for New Commercial Nuclear Plants***. Technical Resource Manager and Task Manager. Mr. Vail leads hydrology reviews for many of the ongoing COLA reviews and provides mentorship to other site reviews. Mr. Vail is currently leading the hydrology reviews for Calvert Cliffs, Bellefonte, Lee, North Anna, Vogtle, and Grand Gulf. Additionally, Mr. Vail is supervising staff on Levy, Harris, South Texas and Summer. These reviews include a diverse set of water resources considerations including: sustainable water management; conjunctive surface and water management; flooding from extreme precipitation and wave action; thermal impacts on fisheries; etc.

- ***Water and Energy Management for Agriculture in the Pacific Northwest.*** Principal Investigator. An adequate and reliable supply of water and electricity is essential to all modern societies. Nowhere in the United States is the connection between water and electricity more obvious than in the Pacific Northwest and in no sector of the Pacific Northwest's regional economy is this interdependence of water and electricity clearer than agriculture. Water is the driver that powers the region's vast hydropower resources. The agriculture sector is also a large consumer of the region's electrical power supply, spending over $150 million per year for electrical power to pump water alone. Water is also a valuable way to store energy. The effective capacitance of water as a power demand shifting resource means that significant demand-side and supply-side improvements in both water and energy resources are possible for sectors such as agriculture with its reliance on an adequate, affordable and reliable supply of both water and energy. While newly emerged technologies are available to dramatically improve water and energy management, institutional barriers have slowed the development of such conjunctive management systems. The vision of adaptive management has generally

failed to be realized in practical resource management due to limitations of information infrastructure and institutional constraints. Mr. Vail is developing an information management infrastructure that will improve the conjunctive management of water and energy for the agriculture sector.

PAST PROJECTS

- ***Electrical Infrastructure Operation Initiative.*** Co-Principal Investigator. This LRDR project made significant advances in three critical science challenges that currently obstruct the functioning of a "water and energy control room of the future". These challenges were the three key themes of this project. The three themes of this project were:
  Water budget characterization. Managing any resource requires knowledge of the amount of the resource, the distribution of the resource, the rates at which the resource will increase, decrease, or redistribute. By linking physically-based process models with remotely-sensed spatial data, this project demonstrated the ability to significantly improve the accuracy and reliability of water budget estimates.
  Water supply and demand forecasting. Resource management actions are based on an estimate of the current state of the resource and forecasts of the likely future state of the system. Forecasts, by their nature, are subject to a degree of uncertainty. By generating and providing to the decision making process large ensembles of streamflow and energy demand projections, the resource management paradigm will shift from one focused nearly exclusively on reducing uncertainty to one more focused on managing uncertainty. By creating ensembles of streamflow forecasts based physical process models uncertainty is addressed explicitly. Generation and management of large ensembles generally results in significant computational capabilities. This project demonstrated a viable approach to generating and managing large ensembles of hydrological forecasts.
  Water and energy optimization. Modern natural resource managers are constantly required to balance multiple, conflicting, incommensurate objectives in an environment characterized by high levels of uncertainty, varying data quality and availability, and competing models and approaches. In attempting to sift through the vast number of feasible management options it is generally infeasible to evaluate each possible action evaluated for each feasible conceptual model through exhaustive enumeration. Optimization techniques provide an intelligent process to sift through the set of possible options. Optimization for control of water and energy resources requires a cautious, probing, adaptive approach, the success of which depends upon improved understanding, predictive accuracy, and iterative performance assessment. This project demonstrated a novel optimization approach based on evolutionary computing methods.

- ***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.*** Principal Investigator. 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.

- ***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, and Hatch., McGuire, Catawba, North Anna, Robinson, Ginna, and St. Lucie

PAST PROJECTS

- ***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.

- ***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 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 provide 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.

- ***Linking Physical and Biological Models***. Principal Investigator and Project Manager. The objective of this three-year Laboratory Directed Research and Development project 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 a significant obstacle to successful linking of physical and biological models was identified to be the fundamental structural differences between such 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.

- 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 multi-objective 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 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 Uncertainty 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 couple 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.

Book Chapter

Skaggs R, LW Vail, and SA Shankle. 2002. "Adaptive Management for Water Supply Planning: Sustaining Mexico City's Water Supply ." Chapter 15 in *Urban Water Supply Handbook*, ed. Larry W. Mays, pp. 15.3 - 15.24. McGraw Hill, New York, NY.

Conference Proceedings

Scott MJ, LW Vail, and A Kemanian. 2002. *INTEGRATED IMPACT OF CLIMATE WARMING ON YAKIMA VALLEY WATER DEMAND AND AVAILABILITY* . Washington Water Research Center, Pullman , WA.

Conference Papers

Kincaid CT, MP Bergeron, CR Cole, MD Freshley, VG Johnson, DI Kaplan, RJ Serne, GP Streile, DL Strenge, PD Thorne, LW Vail, GA Whyatt, and SK Wurstner. 2000. "Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site, Southeast Washington." In *Environmental Toxicology and Risk Assessment: Recent Achievements in Environmental Fate and Transport Vol. 9; STP 1381*, ed. Fred T. Price, Kevin V Brix, and Nancy K. Lane, pp. 104 - 117. Am. Soc. For Testing and Materials, West Conshohocken, PA.

Burke JS, GR Danielson, DA Schulz, and LW Vail. 2002. "Parallel computing for automated model calibration." In *SCI 2002 : ISAS : the 6th World Multiconference on Systemics, Cybernetics and Informatics : July 14-18, 2002, Orlando, Florida, USA : proceedings* , vol. XVIII, pp. 424-429. International Institute of Informatics and Systemics, Orlando, FL.

Scott MJ, LW Vail, CO Stockle, and A Kemanian. 2004. "Climate Change and Adaptation in Irrigated Agriculture—A Case Study of the Yakima River." In *UCOWR/NIWR Conference. Water Allocation: Economics and the Environment*, p. 7 pages. Universities Council on Water Resources, Carbondale, IL.

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. [Unpublished]

Wigmosta MS, K Gill, A Coleman, R Prasad, and LW Vail. 2007. "A Distributed Modeling System for Short-Term to Seasonal Ensemble Streamflow Forecasting in Snowmelt Dominated Basins." In *Proceedings of the 75th Annual Western Snow Conference, April 16-19, 2007, Kona, HI.* Western Snow Conference, Kona, HI.

Formal Reports

Bergeron MP, CR Cole, MD Freshley, NL Hassig, DI Kaplan, CT Kincaid, RJ Serne, GP Streile, DL Strenge, PD Thorne, LW Vail, GA Whyatt, and SK Wurstner. 1998. *Composite Analysis for Low-Level Waste Disposal in the 200-Area Plateau of the Hanford Site* . PNNL-11800, 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.

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.

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. [Unpublished]

Parelius AG, and LW Vail. 2006. *Using Neural Network Procedures to Classify Spatial Data from the Columbia River Basin* . PNNL-16027, Pacific Northwest National Laboratory, Richland, WA. [Unpublished]

Wigmosta MS, K Gill, A Coleman, DL Ward, and LW Vail. 2007. *Watershed Hydrologic Modeling and Water Temperature/Flow Optimization of the Dworshak Reservoir/Lower Snake River System* . PNWD-3876, Battelle—Pacific Northwest Division, Richland, WA.

Vail LW, and MK Gill. 2008. *Water and Energy Management for Agriculture in the Pacific Northwest* . PNNL-17377, Pacific Northwest National Laboratory, Richland, WA.

Journal Articles

Leung LYR, MS Wigmosta, SJ Ghan, JL Epstein, and LW Vail. 1996. "Application of a Subgrid Orographic Precipitation/Surface Hydrology Scheme to a Mountain Watershed." *Jounrnal of Geophysical Research* 101:12,803-12,817.

Rosenberg NJ, DJ Epstein, D Wang, LW Vail, R Srinivasan, and JG Arnold. 1999. "Possible Impacts of Global Warming on Hydrology of the Ogallala Aquifer Region." *Climatic Change* 42(4):677-692.

Scott MJ, LW Vail, JA Jaksch, CO Stockle, and A Kemanian. 2004. "Water Exchanges: Tools to Beat El Nino Climate Variability in Irrigated Agriculture." *Journal of the American Water Resources Association* 40(1):15-31.

Skaggs R, LW Mays, and LW Vail. 2001. "Application of Enhanced Annealing to Ground Water Remediation Design." *Journal of the American Water Resources Association* 37(4):867-875.

Skaggs R, LW Mays, and LW Vail. 2001. "Simulated Annealing With Memory and Directional Search for Ground Water Remediation Design." *Journal of the American Water Resources Association* 37(4):853-866.

Gill MK, MS Wigmosta, A Coleman, LW Vail, and R Prasad. 2008. "Short-Term to Seasonal Ensemble Streamflow Forecasting through Data Assimilation ." PNNL-SA-60196, Pacific Northwest National Laboratory, Richland, WA. [Unpublished]

Other Publications

Vail LW, EA Jenne, HL Diefenderfer, WR Barchet, and LF Hibler. 2001. "Assessment of pH-Impaired Lakes for TMDL Development in New York State." PNWD-SA-5234 Battelle—Pacific Northwest Division, Richland, WA.

Presentations

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.

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, CO Stockle, A Kemanian, LW Vail, and R Prasad. 2006. "Climate Change Impact on Eastern Washington Agriculture ." Presented by Michael J. Scott (Invited Speaker) at Symposium on the Economic Impacts of Climate Change in Washington, Seattle, WA on May 4, 2006. PNNL-SA-49802.

Scott MJ, LW Vail, and R Prasad. 2006. "Managing Water for Irrigated Agriculture Under Extended Climate-Related Drought." Presented by Michael J. Scott at Pacific Northwest Regional Economic Conference, Portland, OR on May 12, 2006. PNNL-SA-49961.

Cook CB, R Skaggs, LW Vail, and MS Wigmosta. 2006. "Water Resources Management within the Electricity Infrastructure Operations Center." Presented by Christopher Cook at Internal (SEDP), Richland, WA on August 24, 2006. PNNL-SA-51480.

Scott MJ, LW Vail, CO Stockle, and A Kamenian. 2006. "Some Observations on Climate Change Impact on Eastern Washington Agriculture." Presented by Michael J Scott (Invited Speaker) at Seminar at WSU Biological Systems Engineering Department, Pullman, WA on November 3, 2006. PNNL-SA-52632.

Scott MJ, LW Vail, CO Stockle, and A Kemanian. 2007. "Some Observations on Climate Change Impact on Eastern Washington Agriculture ." Presented by Michael J. Scott (Invited Speaker) at Energy and Global Climate Change Series, Cashmere, WA on March 23, 2007. PNNL-SA-54489.

Vail LW. 2007. "The Snohomish Coastal Watershed Demonstration." Presented by Lance Vail (Invited Speaker) at Georgia Basin/Puget Sound Research Conference, Vancouver, BC, BC on March 29, 2007. PNNL-SA-54604.

Coleman A, and LW Vail. 2007. "An Adaptive Multi-Scale Watershed Characterization Approach Utilizing Geoinformatics and Self-Organizing Maps ." Presented by Andre M. Coleman at American Geophysical Union Fall Meeting, San Francisco, CA on December 10, 2007. PNNL-SA-58474.

Gill K, MS Wigmosta, A Coleman, R Prasad, and LW Vail. 2007. "Ensemble Streamflow Forecasting via data assimilation ." Presented by M. Kashif Gill at American Geophysical Union, Fall 2007, San Francisco, CA on December 13, 2007. PNNL-SA-58554.

Vail LW, K Gill, MS Wigmosta, A Coleman, and R Prasad. 2007. "Implications of climate change on Waters in the Pacific Northwest: a stochastic approach." Presented by M. Kashif Gill at American Geophysical Union, Fall 2007, San Francisco, CA on December 12, 2007. PNNL-SA-58555.

Leung LYR, MS Wigmosta, SJ Ghan, and LW Vail. 1994. "Regional Modeling of Climate-Hydrology Interactions." Presented by L. R. Leung at 1994 AGU Fall Meeting, San Francisco, CA on December 5, 1994.

Scott MJ, LW Vail, JA Jaksch, KK Anderson, and CO Stockle. 2000. "Climate Forecasts and Water for Regional Irrigated Agriculture ." Presented by Michael Scott at Pacific Northwest Regional Economic Conference, Bellingham, WA on April 28, 2000. PNWD-SA-5050.

Scott MJ, LW Vail, JA Jaksch, and KK Anderson. 2000. "Considerations for Management of Irrigation Water with Climate Variability ." Presented by Michael Scott at American Geophysical Unionn 2000 Spring Meeting, Washington, DC on June 1, 2000. PNWD-SA-5069.

Vail LW. 2000. "Application of Fuzzy Logic in Estimating Impact of Water and Land use Practices on Aquatic Habitat Diversity ." Presented by Lance W Vail (Invited Speaker) at Society for Environmental Restoration, Bellevue, WA on April 5, 2000. PNNL-SA-34213.

Vail LW. 2001. "Drought 2001 Water Management Implications for the Yakima River Basin." Presented by Lance W Vail (Invited Speaker) at Climate and Water Outlook for the PNW - Spring 2001 Drought Update, portland, OR on April 10, 2001. PNWD-SA-5326.

Vail LW, JA Jaksch, and CO Stockle. 2001. "Regional Climate Forecasts and Water Markets in Irrigated Agriculture." Presented by Michael J. Scott at Pacific Northwest Regional Economic Conference, Victoria, BC, CANADA on May 18, 2001. PNWD-SA-5375.

Scott MJ, LW Vail, A Kemanian, and CO Stockle. 2001. "Integrated Impact of Climate Warming on Irrigated Crop Production." Presented by Michael J. Scott (Invited Speaker) at American Geophysical Union, 2001 Fall Meeting, San Francisco, CA on December 10, 2001. PNWD-SA-5468.

Vail LW, MS Wigmosta, and R Prasad. 2001. "Impact of Climate on Aquatic Habitat in the Yakima River." Presented by Lance W Vail at American Geophysical Union Fall Meeting, San Francisco, CA on December 5, 2001. PNNL-SA-35194.

Vail LW. 2000. "Adapting to Climate Change in the Yakima Basin." Presented by Lance W Vail (Invited Speaker) at Heritage College, Toppenish, WA on December 10, 2000. PNWD-SA-5488.

Vail LW. 2000. "Impact of Climate on the Lower Yakima Basin." Presented by Lance W Vail (Invited Speaker) at 2001 STAR Global Change Progress Review, Washington, DC on December 20, 2000. PNWD-SA-5489.

Scott MJ, LW Vail, JA Jaksch, CO Stockle, and A Kemanian. 2001. "Integrated Impact of Climate Warming on Irrigated Crop Production." Presented by Michael J Scott (Invited Speaker) at American Geophysical Union 2001 Fall Meeting, San Francisco, CA on December 11, 2001. PNWD-SA-5596.

Vail LW. 2002. "Adaptive Management in Nooksak River, Wa Flow Selection." Presented by Lance W Vail (Invited Speaker) at Nooksack River Watershed Planning Project - IFSM Symposium, Bellingham, WA on May 29, 2002. PNNL-SA-36605.

Skaggs R, and LW Vail. 2002. "Adaptive Management Platform: Approach and Application." Presented by Richard Skaggs and Lance Vail (Invited Speaker) at Adaptive Management Sympoium at the Spokane Transboundary , Spokane, WA on April 30, 2002. PNNL-SA-36755.

Scott MJ, LW Vail, CO Stockle, and A Kemanian. 2003. "CLIMATE CHANGE AND ADAPTATION IN IIRRIGATED AGRICULTUREA CASE STUDY OF THE YAKIMA RIVER ." Presented by Michael J. Scott at UCOWR NIWR 2004 Conference, Portland, OR on July 20, 2003. PNWD-SA-6297.

Scott MJ, LW Vail, R Prasad, and JA Jaksch. 2004. "Can WE Use Long-Lead Climate Forecasts to Operate the PAcific Northwest Rivers Better?" Presented by Scott, Michael J (Invited Speaker) at Pacific Northwest Regional Economic Confernce, Tacoma, WA on May 19, 2004. PNWD-SA-6512.

Pennell WT, LYR 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, 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 American Association for the Advancement of Science Annual Meeting, Washington, DC on February 20, 2005. PNWD-SA-6743.

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.

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. "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.

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 Conference, Seattle, WA on November 7, 2005. PNWD-SA-6946.

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.

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.

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.

NUREG-1555

U.S. NUCLEAR REGULATORY COMMISSION

ENVIRONMENTAL STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

5.3.3.2 TERRESTRIAL ECOSYSTEMS

REVIEW RESPONSIBILITIES

Primary—Appendix B

Secondary—Appendix B

I. AREAS OF REVIEW

This environmental standard review plan (ESRP) directs the staff's identification and evaluation of impacts to terrestrial ecosystems induced by the operation of heat dissipation systems, especially cooling towers and cooling ponds. The scope of the review directed by this plan will be limited to consideration of the operational aspects of heat dissipation systems in sufficient detail to form a basis for assessing potential operational impacts.

Review Interfaces

The reviewer for this ESRP should obtain input from or provide input to reviewers for the following ESRPs, as indicated:

- ESRP 2.4.1. Obtain descriptive material on the terrestrial ecology of the site and vicinity to support the analyses made in ESRP 5.3.3.2.
- ESRP 3.4.2. Obtain specific information about the cooling system necessary to assess impacts to the terrestrial environment.
- ESRP 5.3.3.1. Obtain information about heat dissipation to the atmosphere necessary to determine impacts to the terrestrial environment.

- ESRP 5.10. Provide a list of measures and controls to limit adverse impacts to terrestrial biota that are to be evaluated in regard to the licensing process and a list of applicant commitments to limit these impacts.

- ESRP 6.5.1. If potential adverse impacts due to heat-dissipation are predicted, then provide preoperational baseline monitoring program elements.

- ESRP 9.4.1. Provide a list of adverse environmental impacts that could be mitigated or avoided through use of alternative heat dissipation system designs or operational procedures, and assist in determining appropriate alternatives.

- ESRP 10.1. Provide a summary of the unavoidable impacts to terrestrial ecosystems that are predicted to occur as a result of operation of heat-dissipation systems.

- ESRP 10.2. Provide a summary of irreversible and irretrievable commitments of terrestrial biota that are predicted to occur as a result of the operation of heat-dissipation systems.

Data and Information Needs

The type of data and information needed will be affected by site- and station-specific factors, and the degree of detail should be modified according to the anticipated magnitude of the potential impacts. The following data or information should be obtained:

- concentration and chemical composition of dissolved and suspended solids in cooling tower basins or spray canals on a seasonal basis (from ESRP 3.4.2)

- isopleths of deposition at ground levels on a seasonal basis. Isopleths should extend to values at least as low as 1 kg/ha/mo (from the environmental report [ER] and ESRP 5.3.3.1).

- a list and description of the “important” terrestrial species and habitats that may be affected by the heat-dissipation system (from ESRP 2.4.1)

- descriptions of natural and managed plant communities on the site and within offsite isopleths above 20 kg/ha/yr (from ESRPs 2.4.1, 5.3.3.1, and the site visit)

- annual precipitation and its dissolved solid concentration within the drift field (from the ER)

- prediction of increased frequency and distribution of fog and icing (from ESRP 5.3.3.1)

- shoreline vegetation expected to develop along the shore of new cooling lakes and ponds (from the ER and consultation with Federal, State, and local agencies)

- proposed other uses of cooling ponds and reservoirs (from the ER).

II. ACCEPTANCE CRITERIA

Acceptance criteria for the review of impacts on terrestrial ecosystems from the heat dissipation system are based on the relevant requirements of the following:

- 10 CFR 51.45 with respect to ERs and the analysis of potential impacts contained therein
- 10 CFR 51.75 with respect to analysis of impacts on the terrestrial environment affected by the issuance of a construction permit
- 10 CFR 52, Subpart A, with respect to analysis of impacts on the terrestrial environment affected by the issuance of an early site permit
- 10 CFR 51.95 with respect to the preparation of supplemental environmental impact statements (EISs) in support of the issuance of an operating license
- Endangered Species Act of 1973, as amended, with respect to identifying threatened or endangered species and critical habitats and formal or informal consultation with the U.S. Fish and Wildlife Service and/or National Marine Fisheries Service
- Fish and Wildlife Coordination Act of 1958 with respect to consideration of fish and wildlife resources and the planning of development projects that affect water resources

Regulatory guidelines and specific criteria to meet the regulations and identified above are as follows:

- Regulatory Guide 4.2, Rev. 2, *Preparation of Environmental Reports for Nuclear Power Stations* (NRC 1976), contains guidance for the preparation of ERs. With respect to the heat-dissipation system, it specifies that detailed descriptions of the expected effects of the system on the local environment with respect to fog, icing, precipitation modifications, humidity changes, cooling-tower blowdown and drift, and noise should be included in the ER. The reviewer should ensure that the appropriate data and analyses are provided in the ER.
- Regulatory Guide 4.7, Rev. 2, *General Site Suitability for Nuclear Power Stations* (NRC 1998), contains guidance on factors that should be considered in the site-selection process. In specific regard to cooling-tower drift, this guide states “The potential loss of important terrestrial species and other resources should be considered.”
- Regulatory Guide 4.11, Rev. 1, *Terrestrial Environmental Studies for Nuclear Power Stations* (NRC 1977), contains technical information for the design and execution of terrestrial environmental studies, the results of which may be appropriate for inclusion in the applicant’s ER. The reviewer should ensure that the appropriate results concerning potential effects of the heat-dissipation system on the terrestrial environment are included in the ER.

Technical Rationale

The technical rationale for evaluating the applicant's impacts from heat-dissipation systems to terrestrial ecosystems is discussed in the following paragraph:

> The EIS needs to include the results of an analysis that considers the environmental effects of the proposed heat dissipation system and the alternatives available for reducing or avoiding adverse environmental effects. Any environmental benefits that may result from the operation of the heat dissipation system should also be included. Following the acceptance criteria listed above will help ensure that the environmental impacts of the proposed heat-dissipation system are considered with respect to matters covered by such standards and requirements.

III. REVIEW PROCEDURES

The depth and extent of the input to the EIS will be governed by the environmental characteristics of the terrestrial ecology that could be affected by operation of the station's heat dissipation systems and by the magnitude of the expected impacts to the terrestrial environment.

The most apparent effects of heat dissipation systems on terrestrial ecosystems are those associated with cooling-tower or spray pond operation. These include the effects of vapor plumes, icing, and salt drift on the terrestrial ecosystems. The potential for bird collision with cooling towers should be addressed by the reviewer for ESRP 4.3.1. To date, at stations using once through cooling systems, no adverse impacts to terrestrial ecosystems have occurred that require mitigating actions. In circumstances where once through cooling is proposed, the analysis may terminate without further consideration unless unusual environmental circumstances make more analysis necessary.

(1) Consider the impacts of drift deposition on plants.

- Drift deposition has the potential for adversely affecting plants, but the tolerance levels of native plants, ornamentals, and crops are not known with precision.

- General guidelines for predicting effects of drift deposition on plants suggest that many species have thresholds for visible leaf damage in the range of 10 to 20 kg/ha/mo of NaCl deposited on leaves during the growing season.

- These effects can be altered by the frequency of rainfall, humidity, type of salt, and sensitivity of species.

- Use maps of the site and vicinity showing drift isopleths that were produced by recognized drift-dispersion models to define areas of possible botanical injury.

- Use an order-of-magnitude approach, as follows, to analyze operational impacts from salt drift:

  - Deposition of salt drift (NaCl) at rates of 1 to 2 kg/ha/mo is generally not damaging to plants.

  - Deposition rates approaching or exceeding 10 kg/ha/mo in any month during the growing season could cause leaf damage in many species.

  - Deposition rates of hundreds or thousands of kg/ha/yr could cause damage sufficient to suggest the need for changes of tower-basin salinities or a reevaluation of tower design, depending on the amount of land impacted and the uniqueness of the terrestrial ecosystems expected to be exposed to drift deposition.

(2) Consider the detrimental effects increased fogging could have on local vegetation if the increase in humidity induces an increase in fungal or other phytopathological infections. Increased icing can cause physical damage to vegetation due to increased structural pressure on tree branches or by damaging fruit or leaf buds.

- Use an order of magnitude approach as follows to analyze operational impacts from fog or ice:

  - Fogging or icing of vegetation on the order of a few hours per year is generally not severe.

  - Fogging or icing on the order of tens of hours per year may cause detectable damage to vegetation.

  - Fogging or icing occurring for hundreds of hours per year could be severe enough to suggest the need for design changes, depending on the amount of land impacted and the uniqueness of the terrestrial ecosystems expected to be exposed to drift deposition.

- Consider soil salinization:

  - The risk from this source is generally considered to be low.

  - In arid areas (deserts), salts could accumulate in soils over long time intervals and cause damage.

(3) Consider the impact to terrestrial biota when new shoreline habitats are created along ponds and reservoirs built for cooling purposes. Riparian tree/shrub communities that form around these new ponds or reservoirs may attract “important” species.

If endangered or threatened species could be affected, agency level formal or informal consultation with the U.S. Fish and Wildlife Service under Section 7 of the Endangered Species Act is required.

IV. EVALUATION FINDINGS

Input to the EIS should accomplish the following objectives: (1) public disclosure of any expected impact to the terrestrial ecosystem as a result of the operation of the heat dissipation system, (2) presentation of the basis of staff analysis of the project, and (3) presentation of staff conclusions, evaluations, and conditions regarding terrestrial ecosystems. These conclusions should include

- a list of adverse impacts of cooling-system heat dissipation to terrestrial ecosystems
- a list of the impacts for which there are measures or controls to limit adverse impacts and associated measures and controls
- the applicant's commitments to limit these impacts
- the staff's evaluation of the adequacy of the applicant's measures and controls to limit adverse impacts.

This information should be summarized by the reviewer for ESRP 5.10.

Evaluation of impacts should result in one of the following conclusions:

- *The impact is minor, and mitigation is not warranted.* If the degree of impact falls into the first order category (a few hours of icing or fogging each year or a few kilograms of salt drift per hectare per year), the reviewer may conclude that these impacts are not of sufficient magnitude to warrant further evaluation.
- *The impact is adverse, but can be mitigated by design and procedure modifications*. If the degree of impact falls within the second-order category (a few tens of hours per year increase in fog or ice or a few tens of kilograms of salt drift deposition per hectare per year), the reviewer may conclude that the effects are adverse and that mitigating actions should be considered. For these cases, the reviewer should consult with the Environmental Project Manager (EPM) and the reviewer for ESRP 9.4.1 for verification that the modifications are practical and will lead to an improvement in the benefit-cost balance. The reviewer should prepare a list of verified modifications and measures and controls to limit the corresponding impact. These lists should be given to the reviewer for ESRP 5.10.
- *The impact is adverse and is of such magnitude that it should be avoided, if it cannot be mitigated*. If the degree of expected impacts falls within the third order category (hundreds of hours of increase in fog and ice or hundreds of kilograms of salt drift per hectare per year), the reviewer may conclude that the impacts of operation are sufficiently adverse that consideration of alternative designs or locations to avoid the impact is warranted. When impacts of this nature are identified, the reviewer should inform the EPM and the reviewer for ESRP 9.4.1 that an analysis and evaluation of alternative designs or procedures is needed. The reviewer should participate in any such analysis and evaluation of alternatives that would avoid the impact and that could be considered practical. If no

such alternatives can be identified, the reviewer should provide this conclusion to the reviewer for ESRP 10.1.

V. IMPLEMENTATION

The method described herein will be used by the staff in evaluating conformance with the Commission's regulations, except in those cases in which the applicant proposes an acceptable alternative for complying with specified portions of the regulations.

VI. REFERENCES

10 CFR 51.45, "Environmental report."

10 CFR 51.75, "Draft environmental impact statement—construction permit."

10 CFR 51.95, "Supplement to final environmental impact statement."

10 CFR 52, Subpart A, "Early Site Permits."

Endangered Species Act, as amended, 16 USC 1531 et seq.

Fish and Wildlife Coordination Act Amendment, 16 USC 661 et seq.

U.S. Nuclear Regulatory Commission (NRC). 1976. *Preparation of Environmental Reports for Nuclear Power Stations*. Regulatory Guide 4.2, Rev. 2, Washington, D. C.

U.S. Nuclear Regulatory Commission (NRC). 1977. *Terrestrial Environmental Studies for Nuclear Power Stations*. Regulatory Guide 4.11, Rev. 1, Washington, D. C.

U.S. Nuclear Regulatory Commission (NRC). 1998. *General Site Suitability for Nuclear Power Stations*. Regulatory Guide 4.7, Rev. 2, Washington, D. C.

during the licensing of the facility or the mechanisms of NPDES permitting and associated 316(a) and (b) determinations. They either were found acceptable or mitigated. For some plants with once-through cooling systems, the large volumes of water withdrawn, heated, and discharged back to the receiving water may cause adverse effects to fish and shellfish populations during the license renewal term. Because impacts of entrainment of fish and shellfish, impingement, and thermal discharge effects could be small, moderate, or large, depending on the plant, these are Category 2 issues for plants with once-through cooling systems. These issues will need to be analyzed in the supplemental NEPA document at the time of license renewal.

4.3 COOLING TOWERS

This section introduces cooling towers and their emissions (Section 4.3.1) and then evaluates the impacts of the emissions on surface water and groundwater (Section 4.3.2), aquatic ecology (Section 4.3.3), agricultural crops (Section 4.3.4), terrestrial ecology (Section 4.3.5, which also includes bird collisions with cooling towers), and human health (Section 4.3.6). Impacts of cooling-tower noise are also addressed (Section 4.3.7). Each section that evaluates impacts (Sections 4.3.2–4.3.7) provides a conclusion that defines the significance of the impacts. These conclusions are based on reviews of cooling-tower data available for towers at specific nuclear plants as well as for other cooling towers (e.g., those at coal-fired plants).

4.3.1 Introduction

Mechanical- and natural-draft wet cooling towers transfer waste heat to the atmosphere primarily by evaporating water. Natural-draft towers are generally up to 160 m (520 ft) in height, whereas mechanical-draft towers are generally less than 30 m (100 ft) tall (Roffman and Van Vleck 1974). Because of the large cooling capacity of natural-draft towers, only one such tower is required for each reactor unit; but two or more mechanical-draft towers are required for equivalent cooling.

Most of the water lost from a cooling tower escapes to the atmosphere as water vapor in the exhaust flow. About 10 percent of the vapor recondenses after release, forming the visible part of the plume leaving the tower (Golay et al. 1986). Drift droplets of cooling water are also entrained in the air stream inside the tower and escape directly into the atmosphere. A particulate solid drift material remains after droplet evaporation. The drift contains varying amounts of salts, biocides, and microorganisms.

Natural-draft towers release drift and moisture high into the atmosphere where they are dispersed over long distances. Local impacts are more likely to occur with mechanical-draft towers because the plume is not dispersed over as great an area. The visible moisture plume from a natural-draft cooling tower may be 20 to 30 percent longer than that from comparable mechanical-draft towers (Roffman and Van Vleck 1974). Icing of vegetation and roads can occur near mechanical draft towers when fog is present and temperatures are below freezing. Much of the drift eventually deposits on the earth. The atmospheric transport of drift and the

amount of deposition to the earth has been estimated for most nuclear plants through the use of computer models. Actual measurements of drift deposition have been collected at only a few nuclear plants. These measurements indicate that, beyond about 1.5 km (1 mile) from nuclear plant cooling towers, salt deposition is not significantly above natural background levels.

4.3.2 Surface Water Quality and Use

Sections 4.3.2 and 4.3.3 review the past and ongoing impacts on aquatic resources caused by the operation of nuclear power plants with cooling towers. Any ongoing impacts will probably continue into the license renewal term because the cooling system design and operation will not change as a result of license renewal. Judgments about the significance of these issues during the license renewal terms are based on published information, agency consultation, and information provided by the utilities (Appendix F) applicable to every nuclear power plant in the United States. The conclusions drawn in Sections 4.3.2 and 4.3.3 apply to all nuclear power plants with cooling towers.

4.3.2.1 Water Use

Two factors may cause water-use and water-availability issues to become important for some nuclear power plants that use cooling towers. First, the relatively small rates of cooling water withdrawal and discharge allowed some power plants with cooling towers to be located on small bodies of water that are susceptible to droughts or competing water uses. Second, closed-cycle cooling systems evaporate cooling water, and consumptive water losses may represent a substantial proportion of the flows in small rivers. Loss of a substantial portion of flow from a small stream as a result of evaporative losses from a cooling tower will reduce the amount of habitat for fish and aquatic invertebrates. Off-stream water uses, such as power plant consumption, must be regulated to ensure that important in-stream uses, such as habitat for aquatic organisms, boating, angling, and waste assimilation, are not compromised.

Consumptive water use can adversely impact riparian vegetation and associated animal communities by reducing the amount of water in the stream that is available for plant growth, maintenance, and reproduction. Riparian vegetation is defined as streamside vegetation that is structurally and floristically distinct from adjacent upland plant communities (Taylor 1982). Riparian vegetation has important ecological functions; and its importance as a resource has been widely recognized and reviewed (e.g., Brinson et al. 1981; Johnson et al. 1985). Briefly, riparian vegetation stabilizes stream channels and floodplains. It influences biogeochemical cycles, water temperature and quality, and the duration and magnitude of flooding. Riparian vegetation also provides diverse cover, food, water, reproductive habitat, and migration corridors for many aquatic and terrestrial animals. As a result, riparian zones often support a wide variety and high density of wildlife (deer, small mammals, songbirds, raptors, reptiles, and amphibians), especially in arid or urbanized areas. Riparian vegetation may be adversely affected by dewatering in a number of ways (Taylor 1982), including decreases in the width of the riparian corridor, changes in species and community diversity, increased susceptibility to flooding, changes in tree canopy cover, lower tree basal area, and lower seedling densities. Impacts to wildlife occur as a

direct or indirect result of degradation of riparian habitats. Such dewatering effects are most apparent in the arid and semi-arid West; in the eastern United States, dewatering effects generally involve more subtle changes in community composition because of the higher precipitation, humidity, and soil moisture and the lower water stress conditions that prevail.

Limerick Generating Station, located on the Schuylkill River at Pottstown, Pennsylvania, is an example of a plant with a closed-cycle cooling system that is subject to water availability constraints because of in-stream-flow requirements in a smaller river, controversy over water use related to interbasin transfer, competing water uses, and water-related agreements between utilities. Aquatic resource issues identified include (1) water quality and low-flow problems in the Schuylkill River; (2) water availability conflicts with downstream water users; (3) increased in-stream flow requirements, particularly with respect to continuing efforts to improve the water quality of the Schuylkill River and to reintroduce American shad into the river; and (4) concerns over saltwater movement upstream in the Delaware River as the result of upstream water use (Margaret A. Reilly, letter to G. F. Cada, ORNL, Oak Ridge, Tennessee May 24, 1990; D. T. Guise, letter to G. F. Cada, ORNL, Oak Ridge, Tennessee, July 3, 1990).

Limerick is in one of the fastest growing regions in Pennsylvania, which is experiencing heavy residential development and water demands for domestic, existing industrial, and developing industrial uses (Joseph Hoffman, letter to V. R. Tolbert, ORNL, Oak Ridge, Tennessee, August 27, 1990). Limerick is permitted to withdraw up to 13 percent of the minimum flow of the Schuylkill River and a major portion of the flow of Perkiomen Creek for cooling tower makeup. Only 5 percent of the 1.8–2.0 m^3/s (65–70 ft^3/s) withdrawn from the Schuylkill River when the flow is greater than 15 m^3/s (530 ft^3/s) is returned to the river. This loss of in-stream flow is viewed as a significant contribution to the water quality and low-flow problems in the Schuylkill River (Dennis T. Guise, letter to G. F. Cada, ORNL, Oak Ridge, Tennessee, July 3, 1990). This water-use issue may be exacerbated as efforts to reintroduce the American shad into the Schuylkill River continue. In addition to the water use from the Schuylkill River, 2 m^3/s (71 ft^3/s) of water is diverted from the Delaware River to the East Branch of Perkiomen Creek via the Point Pleasant Diversion at a rate of 2 m^3/s (71 ft^3/s); this interbasin transfer affects the achievement of the 85 m^3/s (3000 ft^3/s) minimum flow objective in the Delaware River at Trenton. The effects of the diversion are being debated through an NPDES permit appeal before the Pennsylvania Environmental Hearing Board (Dennis T. Guise, letter to G. F. Cada, ORNL, Oak Ridge, Tennessee, July 3, 1990).

The Palo Verde NGS offers another example of competing water uses that may affect continued operation of nuclear facilities that use cooling towers. Palo Verde currently uses treated effluent from the cities of Phoenix and Tolleson for cooling tower makeup water. The blowdown from the cooling towers discharges to on-site lined evaporation ponds [Arizona Public Service Company response to NUMARC survey (NUMARC 1990)]. In the absence of the power plant, part of the municipal effluent would be used for commercial purposes and the remainder discharged to the Gila River, where it would be used for groundwater recharge, irrigation, and support of riparian

habitat (Jack Bale, letter to G. F. Cada, ORNL, Oak Ridge, Tennessee, May 31, 1990). According to the Arizona Game and Fish Department (Donald Turner, Arizona Game and Fish Department letter to G. F. Cada, ORNL, Oak Ridge, Tennessee, June 29, 1990), if Palo Verde uses all of its allocation, the flow from the Gila River downstream to Gillespie Dam will be reduced, the water tables will drop significantly, and aquatic habitat and riparian vegetation will be destroyed. Sixty-nine percent of the water flowing in the Gila and Salt rivers downstream from the Ninety-First Avenue treatment plant is discharged by the treatment plant. Most if not all of the water produced by the treatment plant is committed to Palo Verde. When all three units of the plant were operating, flow in the river was significantly reduced, pools and ponds dried up, and numerous fish die-offs occurred (Donald Turner, Arizona Game and Fish Department, letter to G. F. Cada, ORNL, Oak Ridge, Tennessee, June 29, 1990).

Nuclear facilities on small bodies of water may experience water-use constraints related to availability. For example, during temporary drought periods, power plants with cooling towers may have to curtail operations if evaporative water losses exceed the capacity of small, multiple-use source bodies of water. Byron Station in Illinois withdraws water from the Rock River to supply natural-draft cooling towers. By agreement with the Illinois Department of Conservation, the withdrawal for makeup is limited to 3.5 m^3/s (125 ft^3/s) and net water consumption is limited to no more than 9 percent of the flow below 19 m^3/s (679 ft^3/s) [Commonwealth Edison Company response to NUMARC survey (NUMARC 1990)]. Duane Arnold Energy Center on the Cedar River in Iowa uses mechanical-draft cooling towers for condenser cooling and could also experience water availability constraints. The state of Iowa Department of Natural Resources currently has no water-use concerns with operation of Duane Arnold (Larry J. Wilson, letter to G. F. Cada, ORNL, Oak Ridge, Tennessee, May 22, 1990); however, the plant may possibly experience future constraints on the availability of water for consumptive use, because the surface water withdrawals within the state are projected to increase by 19 percent from 1985 to 2005 (Thamke 1990). Within Linn County, where Duane Arnold is located, water use is also projected to increase (Brian Tormee, telephone interview with V. R. Tolbert, ORNL, Oak Ridge, Tennessee, September 4, 1990).

Consultations with regulatory and resources agencies indicate that water use conflicts are already a concern at two closed-cycle nuclear power plants (Limerick and Palo Verde) and may be a problem in the future at Byron Station and the Duane Arnold Energy Center. Because water use conflicts may be small or moderate during the license renewal period, this is a Category 2 issue for nuclear plants with closed-cycle cooling systems. Related to this, the effects of consumptive water use on in-stream and riparian communities could also be small or moderate, depending on the plant, and is also a Category 2 issue.

4.3.2.2 Water Quality

Although cooling towers are considered to be closed-cycle cooling systems, concentration of dissolved salts in the makeup water—which results from evaporative water loss—requires the discharge of a certain percentage of the

mineral-rich stream (blowdown) and its replacement with fresh water (makeup). The quantities of blowdown are relatively small compared with the discharges from once-through systems, typically on the order of 10 percent. Water quality impacts could occur from the elevated temperatures of the blowdown or from the concentration and discharge of chemicals added to the recirculating cooling water (to prevent corrosion and biofouling, regulate pH, etc.). A unit of water may reside in the cooling circuit for 3 to 20 cycles before being lost to evaporation or released in the blowdown stream (Coutant 1981). The concentration of total dissolved solids in the cooling tower blowdown averages 500 percent of that in the makeup water, a concentration factor that can be tolerated by most freshwater biota (ORNL/NUREG/TM-226). Dilution of the low-volume blowdown by the receiving water also reduces water quality impacts of heat and contaminants discharged from closed-cycle cooling systems.

Because of strict regulation of chemical discharges from steam-electric power plants (e.g., EPA regulations per 40 CFR Part 423), water treatment systems for cooling tower blowdown have been developed. Many of these systems recapture chemical additives for recycling in the cooling system (Coutant 1981). As noted in Section 4.2, all nuclear power plants are required to obtain an NPDES permit to discharge effluents. These permits are renewed every 5 years by the regulatory agency, either EPA or, more commonly, the state's water quality permitting agency. The periodic NPDES permit renewals provide the opportunity to require modification of power plant discharges or to alter discharge monitoring in response to water quality concerns. Utility responses to the NUMARC survey (Table F.2) indicate that such changes have been made during the plants' operation to correct water quality problems.

Impacts of cooling tower discharges are considered to be of small significance if water quality criteria (e.g., NPDES permits) are not consistently violated. In considering the effects of closed-cycle cooling systems on water quality, the staff evaluated the same issues that were evaluated for open-cycle systems (Table 4.1): altered current patterns, altered salinity gradients, temperature effects on sediment transport capacity, altered thermal stratification of lakes, scouring from discharged cooling water, eutrophication, discharge of chlorine and other biocides, discharge of other chemical contaminants, and discharge of sanitary wastes. Based on review of literature and operational monitoring reports, consultations with utilities and regulatory agencies, and comments on the draft GEIS, discharge of cooling tower effluents has not been a problem at existing nuclear plants. Although occasional violations of NPDES permits have occurred at many plants (e.g., minor spills), water quality impacts have been localized and temporary. Effects are considered to be of small significance for all plants. Cumulative impacts to water quality would not be expected because the small amounts of chemicals released by these low-volume discharges are readily dissipated in the receiving waterbody. No change in operation of the cooling system is expected during the license renewal term, so no change in effects of cooling towers discharges on receiving water quality is anticipated. Effects of cooling tower discharges could be reduced by operating additional wastewater treatment systems, or by reducing the plant's generation rate. However, because the effects of cooling

tower discharges on water quality are considered to be impacts of small significance and because the changes would be costly, the staff does not consider the implementation of these potential mitigation measures to be warranted. Effects of cooling tower discharges on water quality are all Category 1 issues.

4.3.3 Aquatic Ecology

Cooling towers have been suggested as mitigative measures to reduce known or predicted entrainment and impingement losses (see, for example, Barnthouse and Van Winkle 1988). The relatively small volumes of makeup and blowdown water needed for closed-cycle cooling systems result in concomitantly low entrainment, impingement, and discharge effects (see Section 4.2.2 for a more complete discussion of these effects regarding once-through cooling systems). Studies of intake and discharge effects of closed-cycle cooling systems have generally judged the impacts to be insignificant (NUREG/0720; NUREG/CR-2337). None of the resource agencies consulted for this GEIS (Appendix F) expressed concerns about the impacts of closed-cycle cooling towers on aquatic resources.

However, even low rates of entrainment and impingement at a closed-cycle cooling system can be a concern when an unusually important resource is affected. Such aquatic resources would include threatened or endangered species or anadromous fish that are undergoing restoration. For example, concern about potential impacts of the Washington Nuclear Project (WNP-2) on chinook salmon has been raised by the Washington Department of Fisheries (Cynthia A. Wilson, Washington Department of Fisheries, letter to G. F. Cada, ORNL, Oak Ridge, Tennessee, July 5, 1990). Although entrainment, impingement, and thermal discharges are not believed to be a problem at WNP-2, the importance of the Columbia River salmon stocks are such that the resource agency feels that monitoring should continue. Similarly, the Pennsylvania Fish Commission has expressed concern about future entrainment and impingement of American shad by the Limerick Generating Station, the Susquehanna Steam Electric Station, Three Mile Island Nuclear Station, and Peach Bottom Atomic Power Station (Dennis T. Guise, Pennsylvania Fish Commission, letter to G. F. Cada, ORNL, Oak Ridge, Tennessee, July 3, 1990). In all cases, losses of American shad at these power plants are minimal or nonexistent, but periodic monitoring has been recommended to ensure that no future problems occur as the anadromous fish restoration efforts continue.

It is unlikely that the small volumes of water withdrawn and discharged by closed-cycle cooling systems would interfere with the future restoration of aquatic biota or their habitats. Effects of operation of closed-cycle cooling systems on aquatic organisms are considered to be of small significance if changes are localized and populations in the receiving waterbody are not reduced. In considering the effects of closed-cycle cooling systems on aquatic ecology, the staff evaluated the same issues that were evaluated for open-cycle systems (Table 4.1): impingement of fish and shellfish, entrainment of fish and shellfish early life stages, entrainment of phytoplankton and zooplankton, thermal discharge effects, cold shock, effects on movement and distribution of aquatic biota, premature emergency of aquatic insects, stimulation of nuisance organisms, losses from predation, parasitism, and disease, gas supersaturation of low

dissolved oxygen in the discharge, and accumulation of contaminants in sediments or biota. Based on reviews of literature and operational monitoring reports, consultations with utilities and regulatory agencies, and comments on the draft GEIS, these potential effects have not been shown to cause reductions in the aquatic populations near any existing nuclear power plants. None of the regulatory and resource agencies expressed concerns about the cumulative effects on aquatic resources of closed cycle cooling system operations at this time, although some recommended continued monitoring in view of efforts to restore fish populations. Effects of all of these issues are considered to be of small significance for all plants. No change in operation of the cooling system is expected during the license renewal term, so no change in effects of cooling towers on aquatic biota is anticipated. Effects of entrainment, impingement, and discharges from closed-cycle cooling systems could be reduced by reducing the plant's generation rate, or by operating additional wastewater treatment systems. However, because the effects of cooling tower withdrawals and discharges on aquatic organisms are considered to be impacts of small significance and because the changes would be costly, the staff does not consider the implementation of these potential mitigation measures to be warranted. The effects of closed-cycle cooling system operation on aquatic biota are all Category 1 issues.

4.3.4 Agricultural Crops and Ornamental Vegetation

The issue addressed by this section is the extent to which the productivity of agricultural crops near nuclear plants may be reduced by exposure to salts or other effects (e.g., icing, increased humidity) resulting from cooling-tower operation. The approach to evaluating this issue was as follows: first, based on a literature review, potential impacts of salts in general (whether from cooling towers or other sources such as wind-blown salts near seashores) are described according to the rate of salt deposition to earth and the relative sensitivity of different types of crops (Section 4.3.4.1); then, the data generated by monitoring programs at a representative subset of specific nuclear plants were reviewed (Section 4.3.4.2). The subset includes 10 of the 11 nuclear power plants with mechanical-draft cooling towers. Mechanical-draft towers are the focus of this section because impacts of drift deposition and icing are more likely to occur near these towers than at natural-draft towers. Drift from natural-draft towers is released at greater heights, disperses more widely, and therefore deposits on earth at lower rates or concentrations. Data were also found and reviewed for 8 of the 17 plants with natural-draft cooling towers (Table 4.1). The coal-fired Chalk Point Plant was also included in the analysis because extensive monitoring of cooling-tower-drift effects has been conducted there and because this plant uses brackish water for cooling and represents a case with comparatively high potential for drift impacts from natural-draft towers. The only nuclear plant that has a natural-draft tower and uses brackish water for cooling is Hope Creek in New Jersey. It is included among the plants that were reviewed.

The following standard of significance is applied to the effects of cooling tower operation on agricultural crops and ornamental vegetation. The impact is of small significance if under expected operational conditions measurable productivity losses (either quantity or

quality of yield) do not occur for agricultural crops; and measurable damage (either visual or to plant function) does not occur for ornamental vegetation.

4.3.4.1 Overview of Impacts

4.3.4.1.1 Ambient Salts and Cooling-Tower Drift

Agricultural crops can be affected by chemical salts and biocides in cooling tower drift and drift-induced or plume-induced ice formation. Increased fogging, cloud cover, and relative humidity resulting from cooling-tower operation have little potential to affect crops, and adverse effects have not been reported. Generally, drift from cooling towers using fresh water has low salt concentrations and, in the case of mechanical draft towers, falls mostly within the immediate vicinity of the towers (ANL/ES-53), representing little hazard to vegetation off-site. Typical amounts of salt or total dissolved solids in freshwater environments are around 1000 ppm (ANL/ES-53). In arid environments, competition for water resources can result in the use of relatively low-quality or saline water for cooling, and the potential for drift-induced damage to surrounding vegetation may be greater (McBrayer and Oakes 1982). For example, source water for cooling at Palo Verde in Arizona is withdrawn from an onsite reservoir containing treated sewage effluent of relatively high salinity. As a result, cooling tower basin water also had high salinity levels including 10,000 to 26,000 ppm total dissolved solids, 3,400 to 7,000 ppm Cl^-, and 2,700 to 8,600 ppm Na^+ (NUS-5241). High salt levels also occur at plants on the coasts or coastal bays. Brackish cooling water used by the Chalk Point coal-fired plant in Maryland contained 11,000 to 26,000 ppm total soluble salts and 6,600 to 18,000 ppm Cl^- (Mulchi and Armbruster 1983). Nuclear plants with cooling towers use fresh water, except for the Hope Creek Plant in New Jersey, which uses saline water. At the Crystal River Plant, Florida, which currently uses brackish water in once-through cooling, a helper cooling tower has been constructed to cool water in a canal that receives discharge from five fossil and one nuclear units.

Talbot (1979) has concluded that adequate estimates of natural background levels of atmospheric salt loading (naturally occurring drift) and rates of deposition thereof are not available for points remote from oceans. In field measurements at a wet cooling tower, A. Backhaus et al. (1988) estimated that up to 60 percent of the chemical contents in the sample came from atmospheric aerosols and not from the tower. Therefore, observed deposition is not all drift from cooling towers (Talbot 1979). Recent work (ORNL/TM-11121) has quantified background aerosol deposition for a dozen sites throughout the country, but deposition for most locations remains poorly known.

Salts from cooling towers are deposited on vegetation by (1) wind-driven impaction, (2) droplet and particulate fallout, and (3) rainfall (Talbot 1979; CONF-740302, 1975b). In high-salt environments such as a windy seashore, impaction is usually the most important process, delivering 10 times more salt to vegetation than does fallout. Increasing wind speeds and salt concentrations increase impaction, hence increasing vegetation injury (Talbot 1979). In most humid environments, rainwater will wash off salts deposited on vegetation (ANL/ES-53), but exposure can be significant during periods between rainfalls.

4.3.4.1.2 Effects of Salt Drift

Plants damaged by salt drift may have acute symptoms, including necrotic or discolored tissue, stunted growth, or deformities (Talbot 1979; Hoffman et al. 1987). Chronic effects are less obvious but may include some degree of chlorosis and reduced growth (Talbot 1979) or increased susceptibility to disease and insect damage (Hosker and Lindberg 1982).

Climatic conditions affect plants' ability to tolerate salt (Talbot 1979; Maas 1985). The degree of injury is related to the salt content in the leaves, but hot or dry weather conditions and water stress are critical in inducing injury (most crops can tolerate greater salt stress during relatively cool and humid weather) (Maas 1985).

Among the factors that affect the plant's foliar accumulation of salt are physical characteristics of the leaves (Maas 1985; CONF-740302, 1975d; Taylor 1980), type and concentration of salt, ambient temperature and humidity, and length of time the leaf remains wet (Maas 1985). Because salt on foliage is apparently absorbed from solution, high humidity, which retards evaporation, enhances salt uptake (CONF-740302, 1975d; McCune et al. 1977; Talbot 1979; Grattan et al. 1981). Because precipitation and dew affect salt deposition, uptake, and resultant injury, dose exposure is difficult to predict (Talbot 1979; Grattan et al. 1981; McCune et al. 1977; EPA-600/3-76-078).

Plant species and crop varieties vary significantly in their tolerance to drift deposition and to soil salinity (Talbot 1979; Maas 1985). In general, salt uptake, plant injury, and reduction in crop yield have been shown to increase with increasing levels of airborne salt or deposition and with time of exposure (CONF-740302, 1975b; Mulchi and Armbruster 1981; Maas; Grattan et al.; EPA-600/3-76-078). Some plants, however, have shown a slight increase in vegetative productivity [e.g., tobacco at < 4 kg/ha (3.6 lb/acre) per week (Mulchi and Armbruster 1983) and cotton at 8 kg/ha (7 lb/acre per week) (Hoffman et al. 1987)]. Based on experimental exposures, a yield reduction of 10 percent has been estimated for deposition levels as low as 4.7 kg/ha (4.2 lb/acre) per week to corn, a species sensitive to foliar salt injury (Mulchi and Armbruster 1981). Relationships between experimental levels of salt deposition, foliar concentrations of sodium and chloride, and corn yield show that yield may be slightly reduced even at rates as low as 2 kg/ha (1.8 lb/acre) per week (Mulchi and Armbruster 1981). Also, bush beans can have reduced yield depending on the age of plants, with older plants being most sensitive (EPA-600/3-76-078). Deposition rates near nuclear-plant towers, according to available deposition data (Section 4.3.5.1.2), appear to be generally below the rates that would affect sensitive agricultural crops.

Talbot (1979) tabulated salt deposition amounts known to induce acute toxicity symptoms in vegetation (Table 4.2). Corn was the most sensitive crop, showing injury above 1.8 kg/ha (1.6 lb/acre) per week; the least sensitive was pinto beans, showing injury above 253 kg/ha (226 lb/acre) per week. Armbruster and Mulchi (1984) showed that foliar salt deposition of 3.2 to 8.8 kg/ha (2.9 to 7.9 lb/acre) per week increased foliar chloride content and damaged foliage of corn, with the higher deposition reducing the yield of grain by as much as 11 percent. They found similar results for soybeans, with bean yields

Table 4.2 Estimates of salt-drift deposition rates estimated to cause acute injury to vegetation

Species	Deposition above which injury is expected (kg/ha/week)	
Crops and ornamental plants		
Zea mays (corn)	1.82	
Glycine hispida var York (soybean)	7.28	
Gossypium hirsutum (cotton)	8.0	
Medicago sativa (alfalfa)	15.7	
Forsythia intermedia var spectabilis (forsythia)	189.6	
Phaseolus vulgaris var Pinto (pinto bean)	252.8	
Albizzia julibrissin rosea (mimosa)	379.2	
Koelreutaria paniculata (golden rain tree)	568.8	
Native species		
Cornus florida (flowering dogwood)	1.2	(in Maryland)
	47.4	(in New York)
Fraxinus americana (white ash)	1.3	(in Maryland)
	18.9	(in New York)
Tsuga canadensis (Canadian hemlock)	9.4	
Pinus strobus (white pine)	189.6	
Quercus prinus (chestnut oak)	379.2	
Robinia pseudoacacia (black locust)	379.2	
Acer rubrum (red maple)	474.0	
Hammamelis virginiana (witch hazel)	1042.8	

Source: Adapted from Talbot 1979 and Hoffman et al. 1987.
Note: To convert kg/ha to lb/acre, multiply by 0.8924.

reduced by as much as 7 percent at the highest deposition rate.

W. C. Hoffman et al. (1987) experimentally exposed cotton and cantaloupe in the arid environment near Palo Verde to foliar salt deposition rates of 8 to 415 kg/ha (7 to 370 lb/acre) per year total salt and alfalfa to depositions up to 829 kg/ha (740 lb/acre) per year. They found foliar injury in alfalfa only at the highest deposition level but no injury to cantaloupe or cotton despite increases in foliar Na^+ and Cl^-. Yields of cantaloupe and alfalfa were not reduced, but 415 kg/ha (370 lb/acre) per year reduced cotton boll production and seed cotton yield by approximately 25 percent.

The burning quality of tobacco is known to be adversely affected by elevated Cl^-. Experiments have shown that burning quality, or length of time the leaf will burn, is impaired by increasing experimental doses of salt deposition (Mulchi and Armbruster 1983). A 17 percent reduction in burning quality was estimated for a Cl^- deposition of 5 kg/ha (4.5 lb/acre) per week, based on regression relationships of deposition, leaf chloride concentration, and leaf burn (Mulchi and Armbruster 1983).

Field studies of the effects of salt drift have been conducted at the Turkey Point plant and the coal-fired Chalk Point plant. Hindawi et al. (EPA-440/5-86-001) investigated field exposures of bean and corn plants to saltwater drift from a test cooling tower and power spray module at the Turkey Point plant. Salt concentrations in tissues of bean and corn plants increased with time during three weeks of exposure and decreased exponentially with distance from the salt drift source. Some injury to leaves was visible at the site of greatest exposure.

The coal-fired Chalk Point plant has a relatively high potential impact from natural-draft cooling towers because brackish water is used for cooling. Other than the Hope Creek plant, all nuclear plants with natural-draft towers use fresh water for cooling. Deposition rates at Chalk Point were measured at 12 monitoring sites at distances of from 1.6 km to 9.6 km (1 to 6 miles) from the towers during their initial 5 years of operation (Mulchi et al. 1982). No increased deposition resulting from cooling-tower operation was detected at these distances. Deposition rates at the sites ranged from about 0.5 to 1.2 kg/ha (0.4 to 1 lb/acre) per month for NaCl, which comprises most of the solids in the brackish cooling water. Monitoring sites, which were established to study effects on agricultural crops, were not located in areas closer to the towers because no active cropland was in these areas and because the plant, located on a peninsula on the Patuxent River, is bounded by water except to the north and north-northwest. Most drift probably deposits in the river.

A study of tobacco plants 3 years after Chalk Point cooling towers began operating failed to find any increase in leaf salt content that could be attributed to drift (Mulchi and Armbruster 1983). Chloride levels in tobacco and chloride and sodium levels in corn and soybeans at 1.6 km (1 mile), the closest distance crops were grown to the Chalk Point towers, were within the range of preoperational values and were no higher than levels found up to 9.6 km (6 miles) from the towers (Mulchi et al. 1982; Mulchi and Armbruster 1983).

4.3.4.1.3 Effects on Soils

Drift deposition also has the potential to damage vegetation by soil salinization. Soil salinization does not usually occur in areas where rainfall is sufficient to leach salts from the soil profile. In arid regions, however, such as at Palo Verde, cooling tower drift has the potential to increase soil salinity and thus affect native and agricultural plants (McBrayer and Oakes 1982). Salinity of irrigated soils in arid regions may also be increased by drift, even though such soils already have a high salinity resulting from salts in irrigation water and high evaporation rates. Responses of crop plants to soil salinity appear to be poorly correlated to their tolerance to foliar-applied salts (Grattan et al. 1981; Maas 1985).

In an experiment in a more humid environment, salts were applied to soils to simulate drift deposition from the Chalk Point coal-fired plant with brackish water cooling towers. One-time applications of 14–112 kg/ha (13–100 lb/acre) NaCl affected leaf Cl^- in corn and soybeans but resulted in no visible damage or reduction in yield (Armbruster and Mulchi 1984). These soil salt treatments also increased soil pH and extractable cations (Armbruster and Mulchi 1984), but leaching by winter precipitation returned soil to pretreatment status.

In humid environments, effects of drift deposition on soils appear transitory if they can be detected at all. Field measurements of the effects of the operating cooling towers at Chalk Point showed no changes in soil chemical elements at distances of 1.6 to 9.6 km (1 to 6 miles) (Mulchi et al. 1982). In a study of five saltwater cooling towers near Galveston Bay, Texas, salt deposition up to 746 kg/ha/year was found within 100 m (328 ft) of the towers, with levels decreasing to <52 kg/ha (46 lb/acre) per year at 434 m (1424 ft) (Wiedenfeld et al. 1978). Weekly deposition ranged from 4.27 kg/ha (3.81 lb/acre) per week to 58.8 kg/ha (52.5 lb/acre) per week. In the survey, salt content of the soil at 104 m (341 ft) from the towers returned to previous levels when towers were shut down during the winter.

4.3.4.2 Plant-Specific Operational Data

Annual reports of environmental monitoring for vegetation damage at nuclear plants were reviewed. Vegetation monitoring included detailed measurements of vegetation structure and composition on permanent plots, aerial infrared photography with subsequent field surveys for vegetation injury, or general surveillance. Vegetation damage ranging from foliar chlorosis to defoliation can be identified on false-color infrared aerial photographs (NUREG/CR-1231). Vegetation monitoring for drift effects has been conducted at 18 nuclear plants. Most of the nuclear plants are not located close to agricultural areas, but six of the plants monitored crops, pasture, orchards, or ornamental vegetation. None reported visible damage to ornamental vegetation or reduction in crop yield (Table 4.3).

A detailed study at Palo Verde in Arizona showed that, after 6 years of operation, no change in agricultural soils attributable to cooling tower emissions occurred. Although significant increases or decreases occurred in some soil parameters at some monitoring locations, these changes appear unrelated to cooling-tower operation and were believed to have been caused by irrigation management, cropping, and fertilizer application. At the conclusion of the 6-year study, no significant effects on

Table 4.3 Results of nuclear facility monitoring for cooling-tower drift effects on terrestrial vegetation

Plant	Vegetation effects	Type of monitoring
	Natural draft	
Arkansas	No visible damage; no foliar chemical changes after one year	Aerial photography; foliar chemistry; orchard, native trees
Beaver Valley	No visible damage	Aerial photography; soil pH and conductivity; native vegetation
Byron	No visible damage	Aerial photography; crops; woody, ornamental, and native vegetation
Callaway	No visible damage	Aerial photography; permanent vegetation plots; native trees
Davis-Besse	No visible damage	Aerial photography; soil chemistry; native vegetation
Hope Creek	No visible damage after one year; no foliar chemical changes after one year	Ground survey; foliar chemistry; soil chemistry; native vegetation
Three Mile Island	No visible damage	Visual inspection; crops and native vegetation
Trojan	No visible damage	Aerial photography; pasture, ornamental and native vegetation
	Mechanical draft	
Catawba	Possible ice damage to loblolly pine < 61 m (200 ft) from towers	Aerial photography; ground survey; native trees
Duane Arnold	No visible damage	Visual inspection; native vegetation
Edwin I. Hatch	No visible damage	Aerial photography; permanent vegetation plots; native vegetation

Table 4.3 (continued)

Plant	Vegetation effects	Type of monitoring
Joseph Farley	No visible damage	Aerial photography; native vegetation
Palisades	Severe ice damage < 61 m (200 ft) from towers; some icing beyond 250 m (820 ft); sulfate injury < 150 m (492 ft) from towers; change in vegetation caused by damage to trees	Aerial photography; permanent vegetation plots; native vegetation
Palo Verde	No visible damage; foliar salt concentrations increased on site	Aerial photography; foliar chemistry; soil chemistry; crops and native vegetation
Prairie Island	Frequent ice damage to oaks adjacent to towers; change in canopy structure caused by ice damage; reduced viability in acorns from oaks near towers	Aerial photography; ground survey; acorn viability survey; native vegetation
River Bend	No visible damage	Aerial photography; permanent vegetation plots; native vegetation
Fort Saint Vrain	No visible damage	Aerial photography; crops; native vegetation
Washington	No foliar chemical changes	Foliar chemistry; soil chemistry; native vegetation

crops or native vegetation had been noted, and the study was discontinued (Halliburton NUS 1992).

At the Palisades plant in Michigan, concern was expressed by owners of nearby fruit orchards about possible effects of elevated humidity on the incidence of disease, particularly apple scab, in their orchards. The concern was that increased humidity could result in the need for increased applications of disease-control sprayings and thus increase orchard operating costs. NRC staff recommended a survey program to assess impacts of cooling-tower moisture on yield, quality, and frequency of disease-control sprayings (NRC 1978). Weather conditions encouraging apple scab are temperatures of 17 to 24°C (63 to 75°F) and

>85 percent relative humidity for 9 h or more. A study was conducted to determine these weather conditions near Palisades cooling towers and in more distant areas (Ryznar et al. 1980). Long-term weather records from weather stations outside the influence of the Palisades cooling towers were analyzed. In addition, a network of meteorological stations was established in the vicinity of the Palisades plant. No increase in weather occurrences favoring apple scab was observed that could be related to Palisades operation.

4.3.4.3 Conclusion

Monitoring results from the sample of nuclear plants and from the coal-fired Chalk Point plant, in conjunction with the literature review and information provided by the natural resource agencies and agricultural agencies in all states with nuclear power plants, have revealed no instances where cooling tower operation has resulted in measurable productivity losses in agricultural crops or measurable damage to ornamental vegetation. Because ongoing operational conditions of cooling towers would remain unchanged, it is expected that there would continue to be no measurable impacts on crops or ornamental vegetation as a result of license renewal. The impact of cooling towers on agricultural crops and ornamental vegetation will therefore be of small significance. Because there is no measurable impact, there is no need to consider mitigation. Cumulative impacts on crops and ornamental vegetation are not a consideration because deposition from cooling tower drift is a localized phenomenon and because of the distance between nuclear power plant sites and other facilities that may have large cooling towers. This is a Category 1 issue.

4.3.5 Terrestrial Ecology

This section addresses the impact of cooling tower drift on natural plant communities (Section 4.3.5.1) and the impact of bird mortality resulting from collisions with natural-draft cooling towers (Section 4.3.5.2).

4.3.5.1 Effects of Cooling-Tower Drift

This section addresses the extent to which natural plant communities near nuclear plants are affected by exposure to salts, icing, or other effects (e.g., fogging and increased humidity) caused by operation of cooling towers. The approach to evaluating this issue is the same as that used for evaluating the impact on agricultural crops in Section 4.3.4.

4.3.5.1.1 Overview of Impacts

The potential impacts of cooling tower operation on native vegetation are similar to those for agricultural crops, including salt-induced leaf damage, growth and seed yield reduction, and ice-induced damage (see Section 4.3.4). In addition, native vegetation may suffer changes in community structure (Talbot 1979) in response to ice damage or differences in species tolerances to drift. Increased fogging and relative humidity near cooling towers have little potential to affect native vegetation, and no such impacts have been reported.

The following standard of significance is applied to the effects of cooling tower operation on natural plant communities. The impact is of small significance if no measurable degradation (not including short-term, minor, and localized impacts) of natural plant communities results from cooling tower operation.

NRC Letter No.: ER-NRC

NRC Letter Date: February 24, 2009

NRC Review of Environmental Report

NRC RAI #: 5.3.3.2-1

Text of NRC RAI:

Provide additional information needed to assess the potential effects of salt deposition from the cooling tower operation on terrestrial, wetland and wildlife resources.

ER Section 5.3.3.2 describes the results of modeling for particle drift from the cooling tower. However, no isopleth maps of salt drift are provided, and discussion regarding the potential effects to biota from salt accumulation over time is limited. NRC staff requests the following items to assess the potential for impacts from cooling tower operation on terrestrial habitats:

- Isopleth maps of seasonal high projected salt drift and deposition (in kilogram per hectare per month [kg/ha/mo]) for the project site and vicinity.
- A discussion of potential impacts to flora and fauna from salt deposition or accumulation over the license period.
- Any studies on the impacts of salt accumulation on wetlands, plants, and wildlife (if such studies are available).
- The final report prepared for the salt deposition study at CREC.

PGN RAI ID #: L-0410

PGN Response to NRC RAI:

Isopleths depicting the maximum predicted monthly average deposition rate (in grams/m^2/month [g/m^2/mo]) are provided in Attachment 5.3.3.2-1A (Figures 1 through 5). The isopleths depict the maximum predicted monthly average deposition rates, relative to the locations of the cooling towers and the LNP site boundary, for each of the 5 years that were modeled (2001 through 2005), as described in ER Subsections 5.3.3.1 and 5.3.3.2. Deposition rates shown in the figures are based on 1.0 cycles of concentration in the cooling tower circulating water. Since normal operation of the cooling towers will be 1.5 cycles of concentration, isopleths of deposition during normal operation can easily be determined by multiplying the contour values by 1.5. The deposition rates in each figure are in units of g/m^2/mo. To convert to kilogram/hectare/month (kg/ha/mo), the isopleth values should be multiplied by 10.

As discussed in ER Subsection 5.3.3.2.1, results of a deposition analysis predicted a maximum predicted off-site deposition rate of 6.81 kilogram per hectare per month (kg/ha/mo) of total solids at the nearest property boundary (Figure 2, 2002 data year), below the NUREG-1555 threshold limit of 10 kg/ha/mo. This threshold limit is the value above which an adverse impact to vegetation may occur. The maximum predicted on-site deposition (during normal plant operation) is 10.75 kg/ha/mo, slightly above the NRC-assigned threshold. The maximum on-site deposition was predicted for the 2004 data year (Figure 4).

With regard to the salt deposition study that was performed at CREC, the study was performed at the request of FDEP as a condition of the facility's site certification, as well as its NPDES and PSD permits. The study was conducted from 1981 through 1995 to evaluate the physical impacts of salt deposition from that facility's natural and mechanical draft cooling towers on vegetation surrounding the CREC. The results of the study demonstrated that there were no significant impacts to vegetation in the area surrounding the plant resulting from cooling tower operation. In 1994 Florida Power Corp. (FPC, now PEF) requested approval to terminate the study. In March 1996, the FDEP concluded, based on the results of the study, that there were no significant impacts to vegetation due to salt drift from the plant and authorized FPC to discontinue the study. Attachment 5.3.3.2-1B contains a copy of FPC's April 25, 1994 letter to FDEP requesting approval to terminate the study, FDEP's March 20, 1996 response granting the request, and the final annual report that was submitted to FDEP for the 1992 – 1993 study year.

Long-term effects of salt drift on terrestrial habitats are not well documented, with only a limited number of studies reported in the public domain. Precipitation, humidity, species composition and photoperiod are known to influence salt tolerance, and extrapolating experimental salt deposition effects on vegetation to natural conditions is somewhat speculative due to the complexities of a natural habitat response.

As previously discussed, results of the 14-year CREC field study evaluating the effects of cooling tower drift on communities in the vicinity of the CREC show no significant impacts to the vegetative communities of maritime hammock, salt marsh, and pine flatwoods. Results of the CREC salt deposition study may be applicable to the LNP pine plantations, which shares common vegetative assemblages with the CREC.

Adverse impacts of salt drift on vegetation generally decrease with increasing distance from the cooling tower. Most areas in the immediate vicinity of the LNP cooling towers will be impacted as part of plant development. Many of the vegetative communities on the LNP site but beyond the immediate plant area are proposed for enhancement or restoration as part of the wetland mitigation program and will be monitored in accordance with the Conditions of Certification and Section 404 Permitting Guidelines.

Literature evaluating the long-term effects of salt accumulation on wetlands, plants, and wildlife is limited. Available studies that address the effects of salt drift and/or salt tolerance on terrestrial biota are the Salt Deposition Study at CREC, which is attached to this response as Attachment 5.3.3.2-1B, and "Review of Potential Biological Impacts of Cooling Tower Salt Drift" and "Effect of Photoperiod, Temperature, and Relative Humidity on Chloride Uptake of Plants Exposed to Salt Spray," both of which are available in the Progress Energy-provided Reading Room.

Associated LNP COL Application Revisions:

None

Attachments/Enclosures:

- 040 Attachment 5.3.3.2-1A.pdf
- 041 Attachment 5.3.3.2-1B Part 1 of 2.pdf
- 042 Attachment 5.3.3.2-1B Part 2 of 2.pdf