December 7, 2007

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
U.S. ARMY	)	Docket No. 40-8838-MLA
	)	
(Jefferson Proving Ground Site)	)	

NRC STAFF PROPOSED FINDINGS OF FACT AND CONCLUSIONS OF LAW, AND ORDER IN THE FORM OF AN INITIAL DECISION

I. INTRODUCTION

1. This initial decision rules on all outstanding issues in this 10 C.F.R. Part 2, Subpart L proceeding concerning the contention challenging the U.S. Army ("Army") application for issuance of an amendment granting an alternate schedule for submission of a decommissioning plan for its facility at the Jefferson Proving Ground ("JPG") site in Madison, Indiana. The license amendment would provide the Army with a five year extension for the submission of its decommissioning plan. During the five year period, the Army will carry out the activities described in the Field Sampling Plan ("FSP") in order to characterize the site. Save the Valley ("STV") sponsored a contention challenging the adequacy of the Army's FSP, which was supported by 18 bases.[1]

2. After considering all of the evidence in this proceeding, we find that the record

[1] Two of these bases, L and P, have been withdrawn by STV, and the part of Basis Q pertaining to calculation of DU dissolution rates in multiple soil samples has been withdrawn. Motion for Leave to Withdraw, Amend, and Supplement Contentions of Save the Valley, Inc. (May 31, 2006). In addition, STV has presented no testimony or other evidence in support of Basis K, which involves the analysis of DU penetrators for transuranics, or Basis R, which objects to the dual role of project manager and independent technical review team leader. In the absence of evidence supporting Bases K and R, the Board considers these bases to be withdrawn.

demonstrates that, contrary to STV's contention, the Army has met its burden of showing that the FSP is adequate to support the granting of the alternate schedule amendment.

II. BACKGROUND

A. Procedural History

3. Between 1984 and 1994, the Army conducted, under a U.S. Nuclear Regulatory Commission ("NRC") materials license (SUB-1435), accuracy testing of depleted uranium ("DU") tank penetration rounds at JPG.

4. In August 1999, the Army submitted to the NRC a license amendment application for decommissioning the JPG site. In response to the notice of opportunity to request a hearing in the *Federal Register* (64 Fed. Reg. 70,294 (December 16, 1999)), STV filed a petition to intervene and request for a hearing, which was subsequently granted in LBP-00-9, 51 NRC 159 (2000) by a Presiding Officer. At the Army's request, the proceeding was suspended pending further interaction with the NRC staff ("Staff") regarding the submitted decommissioning plan.

5. In June 2001, the Army submitted a new decommissioning plan, which superseded the 1999 plan. The Staff did not accept the 2001 plan for a number of reasons, including the lack of an off-site transport model. SER at 2, Staff Exh. 13. In June 2002, the Army submitted a revised decommissioning plan, and the Staff determined that the off-site transport model would need to be validated before NRC could accept the plan. *Id.* at 2-3. In mid-2003, the Army withdrew the 2002 plan because the Army believed the site characterization activities needed to validate the off-site transport model would be too dangerous to perform due to the presence of unexploded ordnance ("UXO") at the JPG site. *Id.* at 3.

6. In September 2003, the Army submitted to the Staff a proposal for a five-year, possession only license ("POLA"), which would be renewable until such time as it became possible to perform the required site characterization safely. In October 2003, the Staff

published in the *Federal Register* a notice of opportunity to request a hearing on the POLA proposal. *See* 68 Fed. Reg. 61,471 (Oct. 28, 2003). STV's request for a hearing on the POLA proposal was granted, along with its unopposed motion to hold further proceedings in abeyance pending the completion of the Staff's technical review of the proposal. LBP-04-1, 59 NRC 27 (2004).

7. By letter dated May 25, 2005, the Army submitted to the NRC an application for an alternate schedule for submission of a decommissioning plan amendment to License No. SUB-1435, pursuant to 10 C.F.R. § 40.42(g)(2), for JPG. FSP, Cover Letter at 1, Staff Exh. 14. In support of its request, the Army enclosed, among other information, the FSP which set forth the reasons that five years are necessary for site characterization. *Id*. at 1-2. The Army intended to continue with its Possession Only License for JPG, but without the contingency of five-year renewable periods. *Id.* at 1.

8. The NRC published a notice of receipt of the application in the *Federal Register* on June 27, 2005. 70 Fed. Reg. 36,964 (June 27, 2005).

9. In July 2005, the Army filed a motion to dismiss the POLA proceeding in which it reported that it was abandoning the POLA proposal and was only seeking the alternate schedule for submittal of a decommissioning plan. Applicant's Motion for Dismissal of Proceeding (July 19, 2005) (ML052130480); *see* LBP-05-25, 62 NRC 435, 438 (2005).

10. On September 12, 2005, the Presiding Officer issued an order, which (1) *sua sponte* reinstated the conditionally dismissed prior proceeding concerning the decommissioning of the site; (2) referred the reinstatement to the Commission for its consideration; and (3) held the motion to dismiss the present proceeding concerning the Possession Only License Amendment in abeyance to await the outcome of the referral. LBP-05-25, 62 NRC at 435.

11. On October 26, 2005, the Commission affirmed the Presiding Officer's decision to reinstate the earlier proceeding, and ordered that STV's standing "shall be considered

already established." CLI-05-23, 62 NRC 546, 550 (2005).

12. On November 23, 2005, STV filed a petition to intervene and request for hearing in response to the June 27, 2005 *Federal Register* notice regarding the alternate schedule in which STV proffered six contentions. Petition to Intervene and Request for Hearing of Save the Valley, Inc. (November 23, 2005).

13. In LBP-06-06, 63 NRC 167, 183-85 (2006), the Board admitted STV's Contention B-2, alleging that the FSP was inadequate:

> As filed, the FSP is not properly designed to obtain all the verifiable data required for reliable dose modeling and accurate assessment of the effects on exposure pathways of meteorological, geological, hydrological, animal, and human features specific to the JPG site and its surrounding area.

14. On December 20, 2006 and May 1, 2007, the Board rejected STV's other contentions as inadmissible. *See* LBP-06-27, 64 NRC 438 (2006); LBP-07-07, 65 NRC 507, 515 (2007).

15. On July 13 and 20, 2007, STV filed its initial pleading and testimony. On August 17, 2007, the Staff and the Army filed their initial and rebuttal pleadings and testimony. On September 18, 2007, STV filed its rebuttal pleading and testimony. On September 24 and 25, 2007, the Army and Staff filed their sur-rebuttal pleadings and testimony, respectively. On October 2, 2007,[2] STV filed its sur-rebuttal pleading and testimony.

16. By order, the Board allowed the parties to file motions *in limine* regarding the prefiled testimony and motions to permit cross-examination by the parties. On July 23, 2007, the Staff submitted a motion in limine to strike certain portions of the testimony of STV witness

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[2] The cover page of Mr. Norris' sur-rebuttal testimony is dated September 18, 2007 which appears to be erroneous because it conflicts with the October 2, 2007 date on the certificate of service and affidavit.

Charles Norris,[3] and the Army supported the motion.[4] The Board denied the motion without awaiting a response from STV. Memorandum and Order (Summarily Denying NRC Staff's Motion in Limine to Strike Portions of Norris Testimony) (July 24, 2007). On August 23, 2007, the Army filed a motion to strike portions of its own prefiled direct testimony[5], and STV responded[6] the following day. The Board dismissed the Army's motion as improvident but accepted it as notice of withdrawal of the testimony. Memorandum and Order (Accepting the Army's Motion to Strike as Notice of Withdrawal of Testimony) (August 28, 2007).
On September 25, 2007, the Army filed a motion to strike certain portions of the prefiled rebuttal testimony of STV witness James Pastorick,[7] and STV opposed the motion.[8] On October 2, 2007, the Board denied the Army's motion to strike portions of the Pastorick rebuttal testimony, but noted that all testimony will be considered only to the extent that the Board deems it to come within the scope of the admitted contention. Order (Denying Motion to Strike Testimony) (October 2, 2007). No party filed a motion to permit it to conduct cross-examination.

17. Pursuant to 10 C.F.R. § 2.1207(a)(3), all parties submitted proposed questions for the Board to ask during the evidentiary hearing.

18. An evidentiary hearing concerning the admitted contention was held in Madison,

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[3] NRC Staff's Motion in Limine to Strike Portions of Norris Testimony (July 23, 2007).

[4] Army Response Joining in the NRC Staff's Motion in Limine (July 23, 2007).

[5] Army's Motion to Strike Portions of the Testimony of Army Witness Harold W. Anagnostopoulos (August 23, 2007).

[6] Response of Save the Valley, Inc. to Army's Motion to Strike Parts of the Testimony of Its Own Witness Anagnostopoulos (August 24, 2007).

[7] Army's Objection and Motion to Strike Pastorick Rebuttal Testimony (September 25, 2007).

[8] Response of Intervener Save the Valley, Inc., in Opposition to the Army's Motion to Strike Rebuttal Testimony of Witness Pastorick (served September 28, 2007).

Indiana on October 22, 2007, in accordance with the notice of hearing published in the *Federal Register*. During the hearing, the Board admitted into evidence the prefiled written direct, rebuttal, and sur-rebuttal testimony as exhibits, in accordance with 10 C.F.R. § 2.1207(b)(2), and other exhibits proffered by the parties. In addition to the testimony, the Board admitted 35 Army exhibits, 1 STV exhibit, and 37 Staff exhibits.

B. Witnesses

19. During the evidentiary hearing on STV's FSP contention, a total of 13 witnesses [9] appeared on behalf of the Army, STV, and Staff. All of the witnesses were found to be qualified to present testimony in their areas of expertise.

a) Army Witnesses

20. The Army presented a total of five witnesses at the evidentiary hearing. They were (1) Mr. Harold W. Anagnostopoulos, a Senior Health Physicist, who is the Army's technical consultant and expert on issues at JPG, including air sampling and sample collection and analysis;[10] (2) Mr. Michael L. Barta, a Senior Ecological Risk Assessor, who designed the deer sampling study described in the FSP and assisted with the deer collection;[11] (3) Mr. Joseph N. Skibinski, an Environmental Chemist and Human Health Risk Assessor;[12] (4) Mr. Todd D. Eaby, a Geologist, who acts as the Army's technical consultant and expert on selected issues, such as electrical imaging, surface water gauging, soil verification, surface water flow monitoring, and

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[9] Additionally, Mr. Paul D. Cloud, the Army's Radiation Safety Officer for JPG and Base Realignment and Closure Base Environmental Coordinator for JPG, provided pre-filed written testimony on behalf of the Army. Cloud Testimony, Army Exh. 6.

[10] Anagnostopoulos Testimony at 1, Army Exh. 1.

[11] Barta Testimony at 1-2, Army Exh. 2.

[12] Skibinski Testimony at 1; Army Exh. 3.

well location selection and installation;[13] and (5) Mr. Stephen N. Snyder, a Senior Hydrogeologist, who has conceptualized and guided the development of the groundwater characterization studies at JPG.[14]

21. Army witness Harold Anagnostopoulos is a Board Certified Health Physicist with 21 years of experience and 11 years of Board certification. Anagnostopoulos Testimony at 2, Army Exh. 1. Mr. Anagnostopoulos has experience in the operation and maintenance of nuclear power reactors, the decommissioning of nuclear facilities, and emergency response. *Id.* He has also served as a task manager and technical expert for the post-remediation verification of radiologically contaminated soils under a U.S. Army Corps of Engineers Formerly Used Remedial Action Program project. *Id.* Since early 2004, Mr. Anagnostopoulos has provided technical support to the Army's JPG facility and has first-hand knowledge of the site. *Id.* He presented testimony which addressed, *inter alia*, sample collection and analysis. The Board finds Mr. Anagnostopoulos to be qualified as an expert witness on the subjects of health physics and sample collection and analysis, including air sampling.

22. Army witness Michael Barta received Bachelor of Arts and Bachelor of Science degrees in Zoology from Miami University, and a Master of Science degree in Zoology with an emphasis on environmental toxicology from Ohio State University. Barta Testimony at 2, 29, Army Exh. 2. He has over 15 years of experience with ecological risk assessment ("ERA") and was the lead scientist on 26 ERAs. *Id.* at 2. Mr. Barta has evaluated impacts on both terrestrial and aquatic organisms, including food-chain exposures and bioaccumulation. *Id.* at 29, 33, 34. With respect to JPG, Mr. Barta designed and participated in the deer sampling study included in

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[13] Eaby Testimony at 1-3; Army Exh. 4.

[14] Snyder Testimony at 1-3, Army Exh. 5.

the FSP that investigated depleted uranium concentrations in deer tissue and bone. *Id.* at 35. He presented testimony which addressed, *inter alia*, the need for an ERA at JPG and biota sampling. The Board finds Mr. Barta to be qualified as an expert witness on the subjects of ecological risk assessments and biota sampling.

23. Army witness Joseph Skibinski received a Bachelor of Science degree in Chemistry from Shippensburg University and has over 17 years experience in environmental chemistry, including human health risk assessments, environmental fate and transport assessments, quality assurance evaluations, data validation, management, and analysis, field investigations, and environmental compliance assessments. Skibinski Testimony at 11, Army Exh. 3. Mr. Skibinski has calculated risks and radiation doses, developed remedial goal options, and conducted quantitative uncertainty analysis using Monte Carlo techniques in the evaluation of exposures of different receptor groups to chemicals and radionuclides in various media and food chain pathways. *Id.* at 2. In addition, Mr. Skibinski has completed an Advanced Course in Modeling Groundwater Contamination in Non-aqueous Phase Liquids. *Id.* at 3. He has provided support to the Army's JPG facility since 2004 and has been the Project Manager for SAIC's work at JPG since 2006, overseeing all aspects of site characterization, environmental radiation monitoring, and decommissioning activities. *Id.* Army witness Skibinski has personally examined a DU penetrator embedded in shallow surface soil during the electrical imaging ("EI") survey. *Id.* The Board finds Mr. Skibinski to be qualified as an expert witness on the subjects of environmental chemistry and human health risk assessment.

24. Army witness Stephen Snyder received his Bachelor of Science degree in Geology from the College of William and Mary and completed continuing education in Hydrogeology at the Pennsylvania State University. Snyder Testimony at 53, Army Exh. 5. Mr. Snyder is a Licensed Professional Geologist in six states and has over 32 years of experience as a project manager, principal investigator, or project hydrogeologist on more than

200 groundwater development, site characterization, environmental remediation, and waste disposal projects. *Id.* He has experience working in fractured and karst bedrock aquifers, utilizing aerial photo and remote sensing analysis, geophysical testing, and dye trace studies, as well as in geologic mapping and aquifer pumping tests to develop groundwater supplies or characterize and design remediation for sites with fractured and karst bedrock. *Id.* Mr. Snyder has provided technical support for JPG since early 2004 and is the primary author of the FSP sections relating to DU migration pathways in groundwater and surface water. *Id.* at 3. Mr. Snyder conducted an aerial photo fracture trace analysis of 22 square miles, including and surrounding the DU Impact Area, designed the EI survey, and planned studies of DU penetrator corrosion and migration and for the placement of stream gauging stations. *Id.* The Board finds Mr. Snyder to be qualified as an expert witness on the subjects of geology, hydrology, and hydrogeology.

b) <u>STV Witnesses</u>

25. STV presented a total of three witnesses at the evidentiary hearing. They were (1) Dr. Diane Henshel, an Environmental Toxicologist,[15] (2) Mr. Charles Norris, a Geologist,[16] and (3) Mr. James Pastorick, a UXO technician.[17]

26. STV witness Dr. Henshel received a Bachelor of Science degree in Biology and a Bachelor of Arts degree in English from Brown University, and a Ph.D. in Biomedical Sciences with a specialty in Neuroscience from the Washington University School of Medicine. Henshel CV at 1, STV Exh. 2. Dr. Henshel is currently an Associate Professor of Public and

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[15] Henshel Testimony at 1-3, STV Exh. 2.

[16] Norris Testimony at 1, STV Exh. 1.

[17] Pastorick CV at 1, STV Exh. 3.

Environmental Affairs at Indiana University, where she teaches courses on environmental toxicology, risk assessment, and risk communication. *Id.* Dr. Henshel has researched the effects of pollutants on health through laboratory and field research, as well as through analysis of publicly available health and environmental data. Henshel Testimony at 1, STV Exh. 2. Dr. Henshel is an author on over 40 peer-reviewed papers and chapters and over a dozen government-published documents in the areas of toxicology, risk assessment, and risk communication. *Id.* at 2. In addition, Dr. Henshel is the sole proprietor of Henshel EnviroComm Consulting, which provides technical support for governments and communities addressing environmental contamination problems. Henshel CV at 1, STV Exh. 2. The Board finds Dr. Henshel to be qualified as an expert witness on the subjects of environmental toxicology and ecological risk assessment.

27. STV witness Mr. Norris received a Bachelor of Science degree in Geology from the University of Illinois, Urbana-Champaign, a Master of Science degree in Geology from the University of Washington, Seattle, and has completed additional graduate credits in Geology at the University of Illinois, Urbana-Champaign. Norris Testimony at 1, STV Exh. 1. Mr. Norris is a Licensed Professional Geologist in six states, who specializes in the areas of hydrology, aqueous geochemistry, and numerical modeling of hydrogeology and geochemistry. *Id.* at 1-2. Mr. Norris' experience includes working as an exploration geologist and petrophysicist for the oil industry, a research associate with the Laboratory for Supercomputing in Hydrogeology at the University of Illinois, Urbana-Champaign, and a consultant in geology and hydrogeology to industry, governmental, and private clients. *Id.* The Board finds Mr. Norris to be qualified as an expert witness on the subjects of geology and hydrogeology.

28. STV witness Mr. Pastorick received a Bachelor of Arts degree in Journalism from the University of South Carolina. Pastorick CV at 1, STV Exh. 3. Mr. Pastorick is a UXO Technician with over 18 years of active Explosive Ordnance Disposal ("EOD") and UXO

experience. *Id.* Mr. Pastorick has both military and civilian experience with EOD and UXO. *Id.* The Board finds Mr. Pastorick to be qualified as an expert witness on the subject of UXO avoidance.

c) Staff Witnesses

29. The NRC Staff presented a total of five witnesses at the evidentiary hearing. They were (1) Dr. Thomas McLaughlin, who is the Staff's Project Manager for JPG;[18] (2) Mr. Jon M. Peckenpaugh, an NRC Hydrogeologist, who reviewed the hydrologic and hydrogeologic technical issues relating to JPG;[19] (3) Dr. A. Christianne Ridge, an NRC Systems Performance Analyst, who reviewed technical issues pertaining to uranium release and transport at JPG;[20] (4) Mr. Adam L. Schwartzman, an NRC Environmental Scientist, who reviewed the technical issues relating to DU transport via air at JPG;[21] and (5) Mr. Dale Condra, the laboratory manager for the Independent Environmental Assessment and Verification ("IEAV") program of the Oak Ridge Institute for Science and Education, who oversees the daily operation of the radiochemistry group of IEAV and is familiar with the technical issues pertaining to the sample collection and analysis methods at JPG.[22]

30. NRC Staff witness Dr. McLaughlin received a Bachelor of Science degree in Chemistry from California State University, and a Ph.D. in Physical Chemistry with a specialty in spectroscopy from the University of California at San Diego. McLaughlin Testimony at 2;

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[18] McLaughlin Testimony at 1, Staff Exh. 1.

[19] Peckenpaugh Testimony at 1-3, Staff Exh. 2.

[20] Ridge Testimony at 1; Staff Exh. 3.

[21] Schwartzman Testimony at 1-3; Staff Exh. 4.

[22] Condra Testimony at 1-3, Staff Exh. 5.

McLaughlin CV at 2, Staff Exh. 1. Dr. McLaughlin has 29 years of experience in human health risk and exposure assessment, including site investigations, sample collection, laboratory processing, sample data validation and analysis, and the use of fate and transport models. McLaughlin CV, Staff Exh. 1. Dr. McLaughlin helped prepare sections of the Multi-Agency Radiation Survey and Site Investigation Manual ("MARSSIM") and its companion manual on laboratory analytical procedures ("MARLAP"). *Id.* Since joining the NRC in 2000, Dr. McLaughlin has served as a Project Manager in the Materials Decommissioning Section, Division of Waste Management and Environmental Protection and has overseen two sites that have requested alternate schedules for submittal of decommissioning plans, and is currently the Project Manager for three uranium mill tailing sites that are being decommissioned under restricted release. *Id.*; McLaughlin Testimony at 2, Staff Exh. 1. He has also assisted in revising NUREG-1757, Volume 2, Revision 1, NRC's most recent compilation of decommissioning guidance. McLaughlin Testimony at 3, Staff Exh. 1. With respect to JPG, Dr. McLaughlin has coordinated the Staff's review and response to the Army's alternate schedule request. *Id.* at 3-4. The Board finds Dr. McLaughlin to be qualified as an expert witness on the subjects of chemistry, human health risk and exposure assessment, the Army's license amendment application, NRC regulatory requirements and guidance pertaining to decommissioning, and the bases for Staff approvals of licensee requests for alternate schedules for submittal of decommissioning plans.

31. NRC Staff witness Mr. Peckenpaugh received a Bachelor of Science degree in Geology from Iowa State University, a Master of Science degree in Water Resources from Iowa State University, and has completed a number of graduate courses in Geology at the University of Nebraska. Peckenpaugh CV at 3, Staff Exh. 2. Mr. Peckenpaugh is a Licensed Professional Geologist in two states and has over 30 years of experience in hydrogeology, including working for the U.S. Geological Survey and the U.S. Environmental Protection Agency. *Id.* at 1-3.

Mr. Peckenpaugh's experience includes developing and calibrating groundwater flow and contaminant transport models, developing computer programs that calculate hydraulic conductivity and specific yield values for aquifers, collecting surface water and groundwater samples, evaluating water quality with respect to hydrogeologic conditions and pollutant sources, and performing radiological risk assessments. *Id.* As part of his official responsibilities at the NRC, Mr. Peckenpaugh has conducted performance assessments of the groundwater and surface water at 12 complex radiological materials sites and seven commercial nuclear power reactor sites undergoing decommissioning. Peckenpaugh Testimony at 2, Staff Exh. 2. He has also evaluated the radiological risk at seven sites, including former radioactive burial sites, nuclear fuel facilities, and a mill tailing site. *Id.* at 2-3. Mr. Peckenpaugh serves as a technical reviewer of the Army's JPG facility and is familiar with the hydrologic and hydrogeologic issues pertaining to the site characterization. *Id.* at 3. The Board finds Mr. Peckenpaugh to be qualified as an expert witness on the subjects of geology, hydrology, and hydrogeology.

32. NRC Staff witness Dr. Ridge has a Bachelor of Arts degree in Physics from Drew University, a Master of Science degree in Environmental Engineering from Cornell University, and a Ph.D. in Environmental Engineering from the University of California, Berkeley. Ridge Testimony at 1-2, Staff Exh. 3. Dr. Ridge has completed training on topics such as dose modeling for license termination, chemical kinetics, environmental monitoring, environmental modeling codes including RESRAD, chemical modeling codes, and simulation software. Ridge CV at 1, Staff Exh. 3. Dr. Ridge's publications include a paper regarding thermodynamic sorption models in reactive transport modeling in the context of NRC licensing. *Id.* at 2. As a Systems Performance Analyst at the NRC, Dr. Ridge reviews environmental models used to support decisions about waste disposal sites and sites undergoing license termination. Ridge Testimony at 2, Staff Exh. 3. For example, Dr. Ridge has reviewed models that estimate

the potential dose to hypothetical receptors living near disposal sites for reprocessing waste, which included the review of the selection of solubility limits and distribution coefficients (Kd values) to represent radionuclide release from waste and transport in groundwater. *Id.* The Board finds Dr. Ridge to be qualified as an expert witness on the subjects of radiation dose modeling, environmental modeling, and chemical modeling.

33. NRC Staff witness Mr. Schwartzman has a Bachelor of Science degree in Biological Sciences and a Master of Science degree in Environmental Toxicology from Clemson University. Schwartzman Testimony at 2, Staff Exh. 4. After joining the NRC, Mr. Schwartzman completed a program during which he participated in a variety of different projects related to environmental transport issues and attended classes designed to provide a general understanding of the functions, activities, and responsibilities of the NRC. *Id.* at 2-3. Mr. Schwartzman also has experience in using computer codes to evaluate transport issues regarding licensing and decommissioning of NRC-licensed sites. *Id.* at 3. As the NRC RESRAD Project Manager, Mr. Schwartzman researches and evaluates different scenarios, parameters, and assumptions used by the model to estimate doses to individuals associated with these scenarios. Schwartzman CV at 1, Staff Exh. 4. Mr. Schwartzman has reviewed the technical issues pertaining to DU transport via air at JPG. Schwartzman Testimony at 3, Staff Exh. 4. The Board finds Mr. Schwartzman to be qualified as an expert witness on the subjects of environmental transport, radiation dose modeling, and environmental modeling.

34. NRC Staff witness Mr. Condra received a Bachelor of Arts degree in Chemistry from Middle Tennessee State University. Condra Testimony at 3, Staff Exh. 5. He has worked in the field of radiochemistry for over 30 years and is currently the Counting Room Supervisor and Laboratory Manager for the Independent Environmental Assessment and Verification program of the Oak Ridge Institute for Science and Education. *Id.* at 1, 3; Condra CV. As part of his official job duties, Mr. Condra analyzes all of the radiological samples sent to his

laboratory by the NRC, reviews and interprets the radioanalytical data generated by the laboratory received by the Health Physics Survey group, and maintains a current laboratory procedure manual. Condra Testimony at 1-2, Staff Exh. 5. Since 2000, the laboratory has maintained an acceptance rate on performance evaluation samples for the analysis of isotopic uranium in various media of 99.3 percent. *Id.* at 2. The performance evaluation samples for isotopic uranium analysis have included natural uranium, depleted uranium, and enriched uranium. *Id.* Mr. Condra has published an article in *Radiation Protection Management* titled "Determination of Uranium and Thorium Concentrations in High-Z Material Samples Using Direct Counting Method of Gamma Spectroscopy." *Id.* at Condra CV. Mr. Condra is familiar with the technical issues pertaining to uranium concentrations in samples from JPG and the sample collection and analysis methods raised by STV. *Id.* at 3. The Board finds Mr. Condra to be qualified as an expert witness on the subjects of radiochemistry, sample collection and analysis for uranium, and interpretation of laboratory data regarding uranium.

III. LEGAL AND REGULATORY REQUIREMENTS

35. Under 10 C.F.R. § 40.42(g)(2), the Commission

> may approve an alternate schedule for submittal of a decommissioning plan required pursuant to paragraph (d) of this section [40.42] if the Commission determines that the alternative schedule is necessary to the effective conduct of decommissioning operations and presents no undue risk from radiation to the public health and safety and is otherwise in the public interest.

10 C.F.R. § 40.42(g)(2). Accordingly, the Commission's approval of an alternate schedule involves a three-part inquiry: the change in the time for submitting a decommissioning plan must (1) be necessary to the effective conduct of decommissioning; (2) present no undue risk from radiation to the public health and safety; and (3) be otherwise in the public interest. The alternate schedule license amendment does not affect the requirements for a decommissioning plan.

36. STV's contention challenges the adequacy of the FSP under the first part of the § 40.42(g)(2) inquiry, i.e. whether the alternative schedule is necessary to the effective conduct of decommissioning operations. *See* LBP-07-07, 65 NRC 507, 510 (2007); LBP-06-27, 64 NRC 438, 448 (2006). STV's contention does not raise a challenge under the second or third prongs of the inquiry. Where STV has questioned health risks from radiation, the risks examined were long-term risks for decommissioning rather than for the five year period of the alternate schedule. *See, e.g.,* Tr. 104-05; 112; 126. As to the third part of the § 40.42(g)(2) inquiry, STV has not argued that a five year period is inappropriate for site-characterization activities. The Board finds that a five year period is a reasonable and appropriate time period to conduct the activities set forth in the FSP.

37. The content of an eventual decommissioning plan – that is, those elements that the licensee is required to satisfy only once a decommissioning plan is submitted for approval and implementation – is beyond the scope of an alternate schedule request because the prerequisite fact at the § 40.42(g)(2) phase is that no decommissioning plan has been submitted. The necessary elements of a *submitted* decommissioning plan are outlined in § 40.42(g)(4) and are not at issue in this proceeding.

IV. FINDINGS OF FACT

A. Statement of Issue

38. The issue before the Board in this proceeding is whether the FSP is adequate. Notice of Hearing, September 20, 2007. The Army bears the overall burden of persuasion to demonstrate that the FSP is adequate to support the alternate schedule license amendment request. *See* 10 C.F.R. § 2.325. The Army must demonstrate by a preponderance of the evidence that, notwithstanding STV's Contention B-1, the FSP provides for activities that are designed to gather site-specific data which is necessary for the development of the decommissioning plan. *Pacific Gas and Electric Co.* (Diablo Canyon Nuclear Power Plant,

Units 1 and 2), ALAB-763, 19 NRC 571, 577 (1984), *review declined*, CLI-84-14, 20 NRC 285 (1984); *Philadelphia Electric Co.* (Limerick Generating Station, Units 1 and 2), ALAB-819, 22 NRC 681, 720 (1985).

B. Description of the JPG Site

39. JPG was established in 1941 as a proving ground for the test firing of a wide variety of ordnance. FSP at 2-1, Staff Exh. 14. The facility is approximately 55,000 acres (approximately 17 miles long by four to six miles wide) and is located in Jefferson, Jennings, and Ripley Counties in southeastern Indiana. *Id.* at 2-1, 2-2 fig. 2-1. A firing line separates JPG into two areas: a 4,000-acre southern portion and a 51,000-acre northern portion. *Id.* at 2-1 (citation omitted). An east-west fence separates the area north of the firing line from the cantonment area. *Id.* The firing line demarcates the ordnance impact area to the north from the cantonment area to the south. *Id.* The area north of the firing line is heavily wooded, undeveloped, and contains the NRC-licensed DU Impact Area. *Id.* (citation omitted). The DU Impact Area is in the south-central portion of this area and is five kilometers long by 1.6 kilometers wide. *Id.*; SER at 1-2, Staff Exh. 13.

40. The Army used JPG as a proving ground from 1941 to 1994. *Id.* During this time, more than 24 million rounds of conventional explosive ammunition were fired. *Id.* Approximately 1.5 million rounds did not detonate upon impact, remaining as unexploded ordnance either on, or beneath, the ground surface. *Id.* The Army test fired DU projectiles as part of its munitions testing program. *Id.* The test firing of DU projectiles occurred between 1983 and 1994 in an area known as the DU Impact Area, which is 2,080 acres. *Id.* The DU projectiles were fired from three fixed-gun positions on the firing line at soft (cloth) targets placed at intervals of 3,280 feet (1,000 meters), starting at 3,280 feet (1,000 meters) from the gun position and continuing to 13,123 feet (4,000 meters). *Id.* Because of the type of testing conducted, the DU projectiles would impact at approximately the same location each time on

their respective lines of fire. *Id.* This firing protocol, with repeated impacts in the same area, resulted in the formation of a trench approximately 3.4 feet (1 meter) deep by 16.4 to 26.3 feet (5 to 8 meters) wide, extending for approximately 4,000 feet (1,200 meters) at the most frequently used gun position. *Id.* (citation omitted). These tests were nondestructive (i.e., no aerosolization occurred), although the rounds may have fragmented upon impact. *Id.* The primary impact location was the trench. *Id.* Approximately 220,462 pounds (100,000 kilograms) of DU projectiles were fired, and approximately 66,139 pounds (30,000 kilograms) of DU projectiles and projectile fragments were recovered on or near the surface to ensure that the total 80,000-kilogram license limit was not exceeded. *Id.*; Material License No. SUB-1435 at 1, Staff Exh. 13. Approximately 154,323 pounds (70,000 kilograms) of DU remain in the DU Impact Area. FSP at 2-1, Staff Exh. 14 (citation omitted).

41. JPG was closed in September 1995 under the Defense Authorization Amendments and Base Realignment and Closure (BRAC) Act of 1988. *Id.* at 2-4. The NRC license for the area north of the firing line was amended for possession only of DU in May 1996. *Id.* Site access to the area north of the firing line and to the DU Impact Area at JPG is controlled by the U.S. Army via the Army/Air Force/U.S. Fish and Wildlife Service Memorandum of Understanding of 2000. *Id.*

42. An environmental monitoring plan was developed for the JPG DU Impact Area before the initial DU munitions were fired in 1984, and this plan guided sample collection and analysis through 1995. *Id.* at 2-5 (citation omitted). The sampling plan and protocol were updated in 1996 and 2000. *Id.* at 2-5 to 2-6 (citations omitted). The Environmental Radiation Monitoring Program ("ERMP") Plan and Addendum defined the strategy and associated procedures for biannual sampling of environmental media within and surrounding the DU Impact Area at JPG and provided the basis for determining if onsite and offsite receptors are or will be at risk from exposure to DU. *Id.* at 2-6. The scopes of these plans were limited to the DU

Impact Area at JPG and its immediate environs and to sampling media to determine the presence or absence of DU. *Id.* The overall goals of the ERM Program at JPG are to provide an historical and current perspective of contaminant levels in various media, an indication of the magnitude and extent of any DU release or migration from past operations, and a current indication of DU contaminant release and migration. *Id.*

43. It is necessary to characterize groundwater flow and flow pathways in the DU Impact Area. Well Location Selection Report at 4-1, Staff Exh. 26. Reports and studies at JPG done prior to the FSP activities focused on groundwater within the overburden (unconsolidated soil and sediments) above the bedrock and, in a few cases, in shallow bedrock, but did not address the unique properties of groundwater flow in a karst environment present at JPG. *Id.* At JPG, the most significant groundwater flow pathways may be present within fractures and solution enhanced features or "conduits" within the carbonate bedrock and along the contact surface between the overburden and the bedrock. *Id.*

C. Depleted Uranium (“DU”) and the JPG Site

44. DU must be distinguished from uranium. McLaughlin Testimony at 10, Staff Exh. 1. Uranium is a mixture of three isotopes: U-238, U-235, and U-234. *Id.* It is a natural component of the environment and, therefore, is present in trace amounts in all media, including soil, air, water, and animals. *Id.* Uranium is processed to enhance the concentration of the isotope U-235, which is used in nuclear reactors and weapons. *Id.* After processing, the residual uranium is depleted in the isotope U-235 and referred to as depleted uranium, or DU. *Id.*

45. In the United States, gaseous diffusion is almost exclusively used to separate the uranium isotopes, and this process depletes the U-234 as well as the U-235 in DU. Anagnostopoulos, Tr. 144. Therefore, depleted uranium is lower in U-234 and U-235 than natural uranium. *Id.* The specific activity of U-234 is much higher than U-235 or U-238, so even

though there is less of it, U-234 can still be detected quite easily and at lower concentrations than the other isotopes. *Id.* at 144-45. Because there is so little U-235 in natural uranium to begin with, about 0.711 weight percent, and depleted uranium has even less, it is extremely difficult to detect by mass methods at low concentrations. *Id.* at 137; 10 C.F.R. § 40.4 (2007).

46. At JPG, the Army used 105 and 120 mm diameter DU projectiles. Cloud, Tr. 152. When manufactured as 105 and 120 mm DU rounds, each 105 mm DU projectile contains approximately 7.5 to 7.9 pounds and each 120 mm DU projectile contains approximately 8.6 to 10.1 pounds of extruded DU, alloyed with 0.754 percent by weight titanium. FSP at 2-12, Staff Exh. 14 (citation omitted). The DU penetrators are armor-piercing, fin-stabilized, discarding sabots with tracer element projectiles, which means that the DU penetrators are long, narrow cylinders (23.75 inches [603 millimeters] x 0.91 inches [23 millimeters]) encased in lightweight, clamshell-like devices that are discarded shortly after being fired while the penetrator is propelled toward the target. *Id.* (citation omitted).

47. The nature of contamination at JPG is significantly different from Los Alamos and some other proving grounds, where uranium was exploded with explosives or where the penetrators hit hard targets. Anagnostopoulos, Tr. 211. At JPG, soft-target testing was conducted, which tends not to aerosolize or finely disperse the DU, unlike exploding or hard-target testing. *Id.* For the most part, the penetrators at JPG are still intact. *Id.* at 211-12.

48. When the Army recovers DU penetrators at JPG, the penetrators are typically near surface soils and have a black oxide layer that is fairly tightly adherent with a yellow oxide layer intermixed between the two. Anagnostopoulos, Tr. 211. When the penetrator is removed, the soil adjacent to the penetrator exhibits a yellow discoloration, which is the uranium. *Id.* The yellow oxide is usually confined to a very tight layer in the area surrounding the penetrator; there is not a plume of the yellow oxide in the surrounding soils. *Id.*

49. Globally, natural uranium content of soil typically varies from 0.3 to 3.5 pCi/g.

Anagnostopoulos, Tr. 167-68. In the state of Indiana, the typical average concentration of uranium in surface water and groundwater is 0.75 pCi/L. Condra Testimony at 7, Staff Exh. 5. In the DU Impact Area at JPG, the DU concentration in the soil in the top 5.9 inches (15 centimeters) under a penetrator or penetrator fragment can be thousands of picocuries per gram. Anagnostopoulos, Tr. at 168; FSP at 2-12, Staff Exh. 14. The DU concentrations decrease with depth, and at depths greater than approximately 24 inches (61 centimeters), DU concentrations are comparable to background. FSP at 2-12, Staff Exh. 14. As the uranium from this very strong, concentrated point source begins to move, the total uranium content in the media that it is moving through will increase. Anagnostopoulos, Tr. at 178. In the Army's experience at the JPG site, when DU is present, it is fairly easy to detect. *Id.* The ratios are clear, the signal is strong, and the total uranium is elevated. *Id.*

D. Staff's Approval of the Alternate Schedule Amendment

50. According to 10 C.F.R. 40.42(g)(2), the alternate schedule can be approved if it (1) is necessary to the effective conduct of decommissioning operations, (2) presents no undue risk from radiation to the public health, and (3) is otherwise in the public interest. To the extent that STV proposes sample collection and analysis that is not necessary for the effective conduct of decommissioning operations under 10 C.F.R. Part 20, Subpart E, or to the extent that STV's proposed additions to the FSP examine risks from causes other than radiation to the public health, STV has exceeded the purpose of the FSP in its criticism and proposed modifications. McLaughlin Testimony at 4, Staff Exh. 1. In other words, the amendment was properly approved because the FSP will provide information that is necessary to the effective conduct of decommissioning operations under 10 C.F.R. Part 20, Subpart E; the five-year alternative schedule period presents no undue risk from radiation to the public health; and is otherwise in the public interest because this time will allow more specific information to be gathered concerning the condition of the site. *Id.*

51. The FSP is designed to provide site-specific information relating to the DU at JPG and, specifically, how the DU could potentially cause a radiological dose that would be detrimental to the public health. *Id.* at 5. Without this site-specific data, the Army would be unable to develop an adequate decommissioning plan for NRC approval. *Id.*

52. The Staff notes that the FSP is an iterative process, whereby the Army will collect data and refine its plan in light of information gathered and consultations with the Staff. McLaughlin Testimony at 12, Staff Exh. 1.

E. Biota and Air Sampling

a) Biota Sampling

(i) Evidence

53. In Basis N, STV asserts a need for more comprehensive research to characterize the general ecological risk due to DU at JPG than is provided for in section 6.3 of the FSP. Similarly, in Basis O, STV objects to limiting biota collection to deer unless DU is detected in at least one medium (e.g. deer, sediment, water). Final Contentions of Save the Valley, Inc. at 15 (May 31, 2006) ("Final Contentions of STV").

54. STV contends that, in order to have a meaningful fate and transport model of DU from the impact area to potential receptors, many types of biological data must be collected, including the biota species in the DU Impact Area, migratory patterns of these biota, food web relationships of the biota inside and outside of the DU Impact Area, DU bioaccumulation, biotransformation of different chemical species of weathered DU, and biological effects on biota of low level chronic exposure to DU. Henshel Testimony at 10-11, STV Exh. 2.

55. The Staff believes that STV views the purpose of the FSP too broadly in that STV is proposing sampling methods and analyses more akin to an EPA-type ecological risk assessment of the site based on the chemical properties of uranium rather than its radiological hazard. McLaughlin Testimony at 5, Staff Exh. 1. In order for adequate site characterization

which will ultimately lead to an adequate decommissioning plan, the NRC does not require an EPA-type ecological risk assessment; rather, the NRC accepts sampling methods and analyses that can be incorporated into models that use bounding and/or conservative values that will ensure the radiological dose to the public does not exceed regulatory limits. *Id.*

56. STV argues that the deer sampling results are tainted because the deer were baited, and therefore, the measured uranium concentrations are not representative of the concentrations when the deer eat only their natural diet. Henshel Testimony at 15, STV Exh. 2. In response, the Army contends that the baiting had little, if any, effect on the uranium concentrations in the deer. Barta, Tr. 164. All of the deer sampled from the DU Impact Area were collected in the fall, and in the fall the Army only used salt to bait the deer. *Id.* If the baiting did have an effect, then the deer collected from the nearby hunting zones and the background hunting zones in the winter when corn feed was used as bait would be expected to have lower concentrations of uranium than the deer that were baited with only salt. *Id.* at 165-66. However, there are no clear trends correlating one area of deer with higher levels of uranium; rather, there is a lot of overlap, which suggests that the uranium concentrations in the deer reflect only natural uranium uptake. *Id.* at 166-67.

57. STV also contends that the sampling effort was flawed because the sample size, approximately 30 deer for the FSP study, was too small. Henshel, Tr. 190. In addition, STV argues that the Army erroneously assumes that (1) the deer sampled from the Background Hunting Zone were not potentially exposed to any residual DU from the activities at JPG, and (2) that the deer in the three regions of the study were from three distinct populations of deer that do not intermix. Henshel Rebuttal at 14-16, STV Exh. 2.

58. The Army disputes that the sampling effort was flawed. Barta Testimony at 18, Army Exh. 2. The Army asserts that a sample size of 30 represents a tiered approach, which is cost-effective and reasonable from a scientific standpoint. *Id.* at 24. In a similar deer study at

the future Rocky Flats National Wildlife Refuge, which was formerly used as a nuclear weapons research, development, and production facility, the U.S. Fish and Wildlife Service collected 26 total deer to investigate tissue concentrations of radioactive isotopes. *Id.* at 24-25. These deer were collected to determine if hunting could be a future recreational use at the refuge. *Id.* at 25. Moreover, the Army asserts that it does not matter if some, none, or all of the deer collected from the DU Impact Area spent the majority of their time in the nearby hunting zones. *Id.* at 19. No hunting is allowed in the DU Impact Area, and deer were chosen from that area because those are the deer most likely to exhibit DU because their exposure would be greater than in the nearby adjacent hunting areas. *Id.* No DU was detected in any of the deer samples, so even if the deer collected from the DU Impact Area were from nearby hunting areas, this would still support the conclusion that hunters are not at risk from exposure to DU through ingestion of deer meat. *Id.* The sampling design satisfied the objectives of the study, which was to determine whether hunters were at risk. *Id.* at 19, 26.

59. Further, STV argues that the deer sampling was inadequate because the Army failed to meet specified accuracy in the chemical analysis of the deer samples. Henshel Testimony at 17, STV Exh. 2. According to the FSP, all duplicate samples should have less than a 50 percent difference in value to be considered acceptable. *Id.* However, the results of the first deer sampling event, contained in the August 2006 report, show that many of the duplicate sample sets have a difference of 50 percent or greater. *Id.*

60. The Army counters that Dr. Henshel has misinterpreted Appendix A of the FSP which states, " '…the relative percent differences (RPD) between the two positive results will be calculated and used as quality control indication of the field procedures, matrix effects, and precision of the analyses conducted.' RPDs were not calculated for the field duplicate samples because there were no positive duplicate results that could be compared and calculated." Skibinski Testimony at 8, Army Exh. 3. Therefore, the Army finds Dr. Henshel's calculations

inappropriate. *Id.*

61. The Staff notes that STV did not take into account the uncertainties associated with the measurements, and the evaluation of duplicates without considering the associated uncertainties, especially on samples with concentrations at or below the detection limit of the procedure contravenes the recommendation of MARLAP in Chapter 18. Condra Testimony at 5, Staff Exh. 5; Condra Sur-rebuttal at 4, Staff Exh. 10. Even if the RPD equation was used to evaluate the results from the duplicate analyses, there are still caveats that apply, such as the analyst must be careful to ensure that the sample is thoroughly homogenized before subsampling and sample activity can be so low that small statistical variations in background cause disproportionate responses. Condra Sur-rebuttal at 3-4, Staff Exh. 10.

62. The experts of both the Army and the Staff interpret the results of the deer sampling in the same manner, i.e., that there are not elevated levels of total uranium, and the amount of total uranium in deer is consistent with expected naturally-occurring background levels of uranium. Anagnostopoulos, Tr. 157; McLaughlin Testimony at 10, Staff Exh. 1. Furthermore, the Army and the Staff argue that if the deer did uptake depleted uranium, the levels of total uranium in the deer would be elevated. Anagnostopoulos, Tr. 157; Condra Testimony at 4-5, Staff Exh. 5.

63. Among all of the deer sampled, the total uranium concentration in the tissues is roughly the same, and in many cases, it is near the detection limit of the instrumentation. *Id.* at 158. When attempting to determine if the sample is DU, the Army examined the U-234 to U-238 ratio and then propagated the errors of each of those measurements, which resulted in an estimate with a very large uncertainty. *Id.* This large error prevents one from conclusively determining whether the sample is DU or not. *Id.* STV agreed. *Id.* at 159.

64. If conservative simplifying assumptions are made in one part of a model, the dose contribution from that part of the model will be overestimated. Ridge Sur-rebuttal at 5,

Staff Exh. 8. Thus other parts of the system will be able to contribute less dose before the dose limit is met, and the corresponding parts of the model may need to be more realistic (i.e., less simplified), not less realistic. *Id*. If a bounding or conservative value is used, it is more protective of human health because it will lead to an assumed higher peak dose to a receptor. *Id* at 6.

65. With regard to the dose to humans via the ingestion of deer meat, the Army presented testimony that humans eat mainly muscle tissue and the liver rather than kidney and bone. Barta, Tr. 162. Staff witness Dr. Ridge calculated a dose following Federal Guidance Report (FGR) 11, Staff Exh. 27, that allows an amount of uranium that is ingested by humans to be translated into a radiological dose. Ridge, Tr. 286. Dr. Ridge calculated an annual dose using conservative assumptions. Dr. Ridge assumed that the concentration of uranium in the deer was the highest amount measured in muscle tissue from the FSP deer study. *Id.* Then, she assumed that the amount of deer consumed would be equal to the fiftieth percentile amount of beef that an American consumes in a year plus the fiftieth percentile of chicken that an American eats in a year, thus replacing all of the beef and chicken in a person's diet with JPG deer meat.[23] *Id.* at 287-88. She also used the higher of the two ingestion dose conversion factors provided for each uranium isotope in FGR 11. Ridge Testimony at 18, Staff Exh. 3. These assumptions result in a dose to humans of 0.27 millirem ("mrem") per year from deer consumption, as compared to the total effective dose equivalent ("TEDE") guideline for decommissioning of 25 mrem per year. *Id.* at 17-18; Ridge, Tr. at 288-89.

66. STV contends that other potential food sources for humans, such as crayfish, fish, squirrel, rabbit, and turkey, should be sampled to determine what their levels of DU are.

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[23] Based on hunting limits, it is not possible for someone to consume this much deer meat.

Henshel, Tr. 172-74. STV also objects to limiting biota sampling to deer because deer are not necessarily the best bioaccumulators. Henshel Surrebuttal at 9, STV Exh. 2. STV would like the Army to evaluate organisms that are the most likely bioaccumulators and are known to be part of the food chains for humans and other animals. *Id.* However, STV does not provide evidence supporting the premise that humans are consuming significant amounts of other biota or that other biota are likely to have significant levels of DU.

67. The Army counters that the focus of decommissioning is the protection of human health, so only biota associated with potential for human consumption should be examined. Barta Testimony at 5, Army Exh. 2. The Army and Staff agree that the deer pathway is the only major exposure pathway to humans. Barta, Tr. 175; McLaughlin Testimony at 9-10, Staff Exh. 1. For instance, although turkeys and squirrels are hunted on the JPG site, the Army and the Staff did not consider the number and amount of meat in these species to be as significant as the consumption of deer meat harvested on the JPG site. Skibinski Sur-rebuttal at 2, Army Exh. 3; McLaughlin Sur-rebuttal at 2, Staff Exh. 6. The mass of the turkey meat or squirrel meat consumed per individual hunter would be less than the mass of deer meat consumed because the muscle weights of the three species differ. Skibinski Sur-rebuttal at 2, Army Exh. 3. Also, Indiana hunting and fishing regulations and the Big Oaks National Wildlife hunting limitations restrict hunters to four deer per year, one wild turkey per year, and a daily maximum of five squirrels during available public use days. *Id.* (citation omitted). Squirrel hunting was limited to 24 days during 2007. *Id.* Further, Big Oaks National Wildlife Refuge can accommodate 420 deer hunters, but only 72 squirrel hunter slots are allocated by lottery. *Id.* Given the combination of greater muscle mass of deer than squirrel and the number of hunting days, hunters are more likely to consume larger amounts of deer tissue than squirrel tissue. *Id.* While approximately 400 to 800 deer are harvested per year at JPG, only about 50 turkey are harvested per year at JPG. Barta Testimony at 6, Army Exh. 2. Since the previous and current

biota samples show no DU present, there is no reason to require the Army to sample other biota at this time. McLaughlin Testimony at 11, Staff Exh. 1. Likewise, no DU has been detected in groundwater, surface water,[24] or sediment outside of the DU Impact Area, indicating that DU has not migrated outside of the DU Impact Area. *Id.*; Anagnostopoulos, Tr. at 293. While DU has been detected in soil, lichens, and root wash, these samples were taken from within the DU Impact Area. McLaughlin Testimony at 11, Staff Exh. 1. Thus, it is unnecessary to require additional biota sampling at this time in the FSP to protect against radiological risks to the public health. *Id.*

(ii) Board Findings

68. The Board finds that the deer sampling study is adequate to accomplish its intended purpose, determining whether hunters are at risk from consuming deer meat from JPG, and is also adequate to gauge whether additional biota need to be sampled.

69. The Board finds that the results from the deer sampling did not indicate elevated levels of total uranium. If DU were present in deer tissue, then there would have been an elevated level of total uranium in the deer tissue because the penetrators are a point source of very high concentration of all of the uranium isotopes at JPG. The levels of uranium measured in the deer at JPG are consistent with the levels of uranium found in deer that are exposed to only naturally occurring uranium.

70. The Board finds that it is unnecessary for the Army to collect additional deer samples or biota samples other than deer at this time since the previous and current biota

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[24] Army witness Anagnostopoulos noted that there was one surface water sample, SW-DU-005, in 1999 that exhibited a higher uranium concentration than surrounding and historical samples. Anagnostopoulos, Tr. at 293. Upon investigation, the Army discovered the high concentration was due to the presence of an intact penetrator near the sampling location. *Id.* This sampling location is located within the DU Impact Area. *See* Radiation Monitoring Report 2006 at 3-3 fig. 3-1, Staff Exh. 37.

samples indicate that no DU is present, and no DU has been detected in abiotic media outside of the DU Impact Area.

71. The Board finds it is acceptable for the Army to employ models that use bounding and/or conservative values that ensure the radiological dose to the public does not exceed regulatory limits.

72. The Board finds that field sampling practices used for determining ecological risk are not required by the NRC to determine radiological doses to humans. The sampling proposed in the FSP is adequate for the purpose of providing the site-specific data to model DU contamination effects resulting in radiation doses to the public.

b) Air Sampling

(i) Evidence

73. STV asserts in Basis M that the air pathway is a significant exposure pathway and the Army should conduct air sampling and analysis specifically relating to controlled burns at JPG. Final Contentions of STV at 14-15.

74. STV argues that the Los Alamos National Laboratories ("LANL") and the Aberdeen Proving Ground ("APG") studies that the Army and the Staff rely on to suggest that there is no significant risk from controlled burns at JPG do not bound the risk from the burns at JPG. Henshel, Tr. 195-96. The LANL study involved a single burn, which was a relatively small burn compared to the 10,000 acres that are burned annually at JPG. *Id.* However, the DU Impact Area, which totals approximately 2,000 acres, is divided into two areas for the purposes of the burns, and each of these areas would only be affected by the burns once every five years. *Id.* at 196. Because a larger area is burned at JPG than at LANL, STV argues that the turbulence will be greater at JPG. *Id.* at 196-97. Similarly, the burn area at APG was 5 x 25 acres per year, which is significantly smaller than the burn area at JPG. *Id.* at 197. Therefore, the turbulence at JPG is also greater than the turbulence created at APG. *Id.* At LANL, one

burn increased the level of DU in the soil by approximately 14 percent as a general disbursement at the perimeter of LANL. *Id.* at 197-98. Considering this increase at LANL occurred after only one burn, STV is concerned that the increase would be even greater at JPG over time. *Id.* at 198. STV does acknowledge, however, that the DU levels after the prescribed burns at LANL were not high enough to introduce health risks to the workers at the site. Henshel Testimony at 26, STV Exh. 2.

75. The Army challenges STV's reading of the LANL study. Mr. Anagnostopoulos did not recall any data indicating that the fires increased the level of DU in the soil at LANL. Tr. 200. Rather, he believed the study reported that the dust flux after a fire would cause the amount of suspended uranium in the air to be higher and that the dose to a receptor might be about 14 percent higher *Id.*

76. The LANL study describes the Cerro Grande fire as a wildfire that burned over approximately 3000 hectares.[25] Whicker *et al.* at 521, Staff Exh. 41.

77. In addition to the size of the burn area being greater at JPG, STV argues that the shapes of JPG and LANL are different. *Id.* at 198. JPG is long and thin, so the people who live close to the DU area are approximately one or two miles from the DU area. *Id.* In contrast, LANL is more of an oblong shape, and it seems like the distance from the boundary of the burn area to where people are living is greater than the distance at JPG. *Id.* at 198-99. Since dispersion decreases with the square of the distance, living closer to the burn area translates into higher concentrations. *Id.* at 199.

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[25] 3000 hectares equals approximately 7400 acres.

78. The LANL study states that the sampling was conducted along the western edge of the LANL property, and in each sampling plot, a line transect was established along which the dust sampling stations were positioned every 30 meters. Whicker *et al.* at 521, Staff Exh. 41.

79. In response to Dr. Henshel's claim that airborne DU dust was detected at the boundaries of LANL and that the dose to an individual at LANL could be almost half of the regulatory limit of 25 mrem, Mr. Anagnostopoulos re-examined the "Dust to Dose" paper and did not see any indications of the detection of DU dust at the boundaries of LANL. Skibinski Sur-rebuttal at 6, Army Exh. 3. In fact, the Army argues the paper indicates that air samplers that detected an increase were established with 30-meter spacing on transects in or immediately adjacent to the burned areas. *Id.* Further, Dr. Henshel's rebuttal fails to address the highly conservative assumptions used in the LANL study and the significant differences in the physical nature of the DU contaminant at JPG. *Id.* In addition, the 14 mrem per year dose rate was for a worst-case source-term estimate at LANL, and for occupational workers who occupy the burned areas for 2,000 hours per year. *Id.*; Whicker *et al.* at 528. This clearly is not a reasonable assumption for controlled burns of the DU Impact Area at JPG. Skibinski Sur-rebuttal at 6, Army Exh. 3.

80. The Army asserts that the LANL study is useful for JPG because it serves as an upper bound, a worst case estimate of what could happen at JPG. Anagnostopoulos, Tr. 200; Anagnostopoulos Testimony at 8, Army Exh. 1. The LANL study is bounding for several reasons. First, the burnt area at LANL was about five times greater than the whole DU Impact Area, and when the DU Impact Area receives a controlled burn, only a small portion of the DU Impact Area actually burns. Anagnostopoulos, Tr. at 201. In addition, the LANL study used the absolute worst case maximum concentrations for the estimates, and the environment and soil type at LANL are different than those at JPG in the direction that would increase the upper bound estimate as compared to JPG. *Id.* For example, LANL is arid and has tree thinning

which exposes additional soils to the effects of wind erosion at LANL, but JPG is heavily wooded. *Id.* at 201-02. After the fire at LANL, the dose increment increase is still fairly low and, when compared to the dose received from natural background sources, extremely low. Tr. 200-202.

81. The Staff agrees with the Army that LANL serves as an upper bound for the dose from controlled burns at JPG. LANL and APG contain a wide range of environmental conditions, such as soil type, amount of rainfall, and temperature, and demonstrate that the contribution of DU transported by air during fires is minimal. Schwartzman Rebuttal at 2, Staff Exh. 9.

82. While admitting that Staff witness Mr. Schwartzman reasonably examined the air sampling data at APG to relate it to JPG, STV contends that Mr. Schwartzman failed to recognize that APG has moister ground conditions than JPG. Henshel Rebuttal at 26-27, STV Exh. 2. However, STV then acknowledges that the comparison to APG holds during wet years, and the comparison to LANL applies during dry years. *Id.* at 27. The Staff asserts that the initial APG study as well as follow-up studies demonstrate that the risk from the mobilization of DU from fires is extremely small. Schwartzman Testimony at 5, Staff Exh. 4. In fact, one of the follow-up studies concluded that airborne radiation levels calculated from air emissions data collected during three controlled burns could not be distinguished from ambient concentrations and were considered not to pose a health risk. *Id.*

(ii) Board Findings

83. The Board finds that the area burned at LANL is approximately 7,400 acres, and the area burned at JPG is approximately 10,000 acres. However, the relevant area of JPG to compare with LANL is the portion burned at JPG, which is not greater than the size of the DU Impact Area, approximately 2,000 acres, since the entire DU Impact Area does not burn at one time.

84. The Board finds that the calculated increase in dose at Los Alamos from the severely burned areas, upon which STV relies, is insignificant in terms of radiation exposure.

85. The Board finds that the studies conducted at LANL and APG bound the site conditions at JPG, as even STV acknowledges that JPG is comparable to LANL during dry periods and to APG during wet periods, and the dose from the air pathway at JPG is insignificant.

F. Karst Geology

86. The FSP presented a proposed method for locating and identifying preferential groundwater flow paths. Well Location Selection Report at 4-1, Staff Exh. 26. The method was a phased approach of fracture trace analysis ("FTA"), completion of an electrical imaging ("EI") survey, site selection of well pairs, installation of well pairs, collection of stage data, comparison of groundwater stage, precipitation and surface water flow data to evaluate connectivity of the installed wells, and groundwater chemistry sampling. *Id.*

a) Fracture Trace Analysis

(i) Evidence

87. Water can be present in solid sedimentary rocks within voids. FSP at 5-1, Staff Exh. 14. Fracturing of the rock and enhancement of the fracture openings can provide interconnected pathways or groundwater conduits. *Id.* The majority of flow through aquifers occurs within the groundwater conduits. *Id.* To characterize groundwater flow in a fractured and solution-enhanced aquifer, the groundwater conduits need to be identified to select appropriate sites for monitoring wells. *Id.*

88. A fracture trace analysis is a study of data such as aerial photographs or satellite images to find fracture traces that are visible at or near the surface of the earth. Norris Testimony at 10, STV Exh. 1. Bedrock fracture locations and orientations can often be interpreted from linear or semi-linear features, which represent surface fracture traces visible in

aerial photographs. FSP at 5-1, Staff Exh. 14. The Army conducted an FTA using aerial photographs of 22 square miles including and surrounding the DU Impact Area. Snyder Testimony at 3, Army Exh. 5.

89. Mr. Norris testifies that the FTA in the FSP does not identify groundwater conduits. Norris Testimony at 11, STV Exh. 1. Mr. Norris claims that an FTA can only identify fractures that have an expression on the surface of the earth. *Id.* at 12. He further testifies that FTA cannot distinguish between simple fractures and fractures that are part of a karst network. *Id*. STV argues that FTA is most useful at sites other than JPG because JPG has a widespread layer of relatively young glacial sediments. *Id*.

90. The Staff determined that STV incorrectly summarizes the purpose of the FSP when STV claimed that all significant karst features should be found, as it is neither possible nor necessary to find all karst features. Peckenpaugh at 8, Staff Exh. 2. The FSP has built in flexibility to allow for evaluation of potential well sites based on information in addition to FTA. *Id*. at 6.

91. The Army notes that the connection between FTA and its ability to identify flow pathways, particularly in karst aquifers, is well documented in the literature. Snyder Testimony at 22, Army Exh. 5. The Army provides testimony that FTA can distinguish between simple fractures and fractures that are part of a karst network because soil-tonal and vegetation differences, topographic features, and straight line stream segments are often caused by karst activity. Snyder Testimony at 22-23, Army Exh. 5 (citation omitted). There are numerous examples in the literature of FTA being effective in areas overlain by glacial sediments. *Id*. at 23.

92. The Staff determined that the Army's method of aerial photographs combined with field evaluations is a viable method. Peckenpaugh Testimony at 17, Staff Exh. 2.

93. Mr. Norris testifies on behalf of STV that traces of fractured glacial sediments

may have no bearing on deeper bedrock features of interest and cited a study of fracturing in glacial tills at JPG. Norris Testimony at 12, STV Exh. 1 (citation omitted). Mr. Snyder testifies on behalf of the Army that the sentence cited by STV was in the context of a discussion of measured hydraulic conductivities, and the fractures in the study cited were on the scale of inches, and were not relevant to fracture traces that may occur in areas overlain by till. Snyder Testimony at 23-24, Army Exh. 5 (citation omitted).

94. Mr. Norris testifies that limiting analyzed imagery to pre-JPG photographs is unduly restrictive, and that all technology should be considered, including side-scan and ground penetrating radar. Norris Testimony at 13, STV Exh. 1.

95. The Army does not dispute the merits of using color, false color photographs, and side-looking airborne radar. Snyder Testimony at 24, Army Exh. 5. However, Army witness Snyder testified that the ground-penetrating radar would only penetrate a few feet at a site like JPG. *Id*. STV agreed that ground-penetrating radar will not identify deeper karst features that are below the stream level, but STV stated that it otherwise still differed in its belief as to what ground-penetrating radar will show. Norris, Tr. 277. The Army maintains that FTA is one of the most productive approaches and supports its statement with citations to literature. Snyder Testimony at 24-25, Army Exh. 5 (citations omitted).

96. Staff witness Peckenpaugh testified that, while alternate methods have strengths, the Army's plan will likely provide the necessary information. Peckenpaugh Testimony at 17-18, Staff Exh. 2.

97. On rebuttal, STV testified that remote sensing and ground geophysical surveys were needed to find open conduits below the stream bases, but STV declined to specify what these would be, and instead deferred to consultation "with those familiar and experienced with searches for these types of features." Norris Rebuttal at 36-37, STV Exh. 1. During the evidentiary hearing, STV witness Norris stated that he would identify well locations by using an

electrical technique on a grid and a seismic technique, which would look for different physical properties and would show cave systems. Norris Tr. at 276. The Staff maintains that the FSP is sufficient, and additional remote-sensing programs would be repetitive and unnecessary. Peckenpaugh Sur-rebuttal at 7, Staff Exh. 7.

98. STV witness Norris testified that known surface expressions of groundwater conduits and a prior study (the “Sheldon Study”) of the JPG karst features must be integrated into the analysis of aerial photographs, as must earlier USGS work on lineaments and fracture traces (the "Greeman Study"). Norris Testimony at 13-14, STV Exh.1.

99. Army witness Snyder testified that the Sheldon Study was considered, as evidenced by the Well Location Selection Report. Snyder Testimony at 25, Army Exh. 5; Well Location Selection Report at 3-2, Staff Exh. 26. The Army also notes there is not a requirement to correlate the Sheldon Study with the use of fracture traces, and supports its argument by citing literature that discussed fracture traces and lineaments while specifically referring to JPG but made no reference to correlating caves with fracture traces. Snyder Testimony at 25, Army Exh. 5. The Army stated that the Greeman Study, a USGS historical fracture trace analysis for the JPG area, indicated that fracture traces and lineaments are the best locations to develop the most productive well sites and are useful in finding groundwater flow pathways. *Id.* The Greeman Study was used, but it was not sufficient for the Army to locate wells on karst features. Snyder Testimony at 25-26, Army Exh. 5. The Army noted that the general trends documented in the 1981 Greeman Study agreed with the Army's 2007 study. *Id.* at 26.

100. STV was concerned that the field walkover that followed the FTA was not sufficient, and specifically that a one-day walk-over by a geologist, after the analyses has been completed, is inadequate. Norris Testimony at 14, STV Exh. 1. Also, the walk-over should include off-road areas. *Id.*

101. The Army replied that the analyses should be complete before the walkover

because first fracture traces are mapped from aerial photographs, and then the hydrogeologist can take the information to the field and evaluate the mapped fracture traces. Snyder Testimony at 26, Army Exh. 5. Prior to conducting the fracture trace analysis and while writing the FSP, Mr. Snyder actually conducted a two-day field reconnaissance of the JPG DU Impact Area, which allowed him to familiarize himself with the site's topography and anticipate how an FTA would be conducted. *Id.* Regarding off-road areas, the existing network of roads allows access to the complete perimeter of the DU Impact Area and crosses the DU Impact Area in appropriate intervals and along important hydrogeologic features, such as Big Creek. *Id.* at 27. Additionally, Mr. Snyder's experience is that the majority of the observations are generally made along the roadways because it is easier to see the terrain, which often is covered by dense vegetation and woods, from the road. *Id.* Also, the off-road areas at JPG present risks from UXO. *Id.* at 26-27.

102. STV witness Norris testifies that potentially important dipping fractures would not be identified by the FTA described in the FSP. Norris Testimony at 14, STV Exh. 1. The Army disagreed and pointed to literature that stated that fracture traces are one of the most productive approaches to locating wells in zones of high hydraulic conductivity. Snyder Testimony at 27, Army Exh. 5 (citation omitted). The literature does not support STV's assertion that intersections of fractures that dip would be more likely to develop major karst elements than intersections of vertical fractures. *Id*. The Army also states that any high hydraulic conductivity zones would be interconnected, thus STV's argument regarding which feature is more likely to develop major karst elements is not significant. *Id.* at 28.

103. The Staff considers STV to have overstated the importance of FTA in the location of the monitoring wells and notes that the FSP allows flexibility for evaluating potential well sites. Peckenpaugh Testimony at 18, Staff Exh. 2.

104. STV testifies that there are karst networks that have developed independently of

fractures, or whose controlling fractures are too deep to reach the present-day surface, or are dipping instead of vertical, and thus would not be identified as possible well locations. Norris Testimony at 15, STV Exh. 1. The Army considers STV's concern to be unlikely and maintains that a deep network would not be a viable pathway for DU migration because it would not be in communication with the surface. Snyder Testimony at 28, Army Exh. 5.

105. The Staff also believes that STV's assertion that there are independent karst networks did not match the existing site observations or the nature of the karst system at JPG. Peckenpaugh Testimony at 19, Staff Exh. 2. The Staff buttressed its testimony with specific information regarding Big Creek and Middle Fork Creek being the base level for the karst system and its observation that no major karst features appear to be below the bedrock. Peckenpaugh Testimony at 19, Staff Exh. 2. The Army argued that the shallow groundwater systems would be the first to become contaminated, and the FSP characterizes the shallow system. Snyder testimony at 28-29, Army Exh. 5. If the characterization indicates a concern for DU exposure, then Army will augment the FSP. *Id.* at 29.

106. STV stated that the FSP should be modified to include an expanded network of characterization wells to investigate deeper karst networks that may channel water to unmonitored groundwater discharges. Norris Rebuttal at 25, STV Exh. 1.

107. The Army stated that if streams are found to be materially losing flow, then the Army would determine where the flow is going and would identify and characterize any deeper pathway. Snyder, Tr. at 265. The Staff has seen no evidence that there are deeper karst features. Peckenpaugh, Tr. at 272. Deeper drilling has shown denser, tighter bedrock with fewer fractures and more shale units, indicating that there is lower permeability deeper into the bedrock. *Id.* at 273. Big Creek and Middle Fork Creek affect shallow karst features, but the Staff has not seen evidence of base water flow that would control a deeper network. *Id.* at 273-274.

(ii) Findings

108. The Board finds that the FTA method may be used to identify flow pathways.

109. The Board finds that FTA is effective at sites with glacial till.

110. The Board finds that gathering hydrologic data is necessary for site characterization.

111. The Board finds that the previous background studies or surveys (e.g. Sheldon, Greeman) were considered in developing the FSP, but previous characterizations at JPG did not address the karst environment.

112. The Board finds that possible deeper karst networks with no surface expressions are not relevant to the surface contamination at JPG.

113. The Board finds that the FTA survey proposed as part of the FSP is adequate to identify potential flow pathways.

b) Electrical Imaging Survey

(i) Evidence

114. FTA identifies the locations of potential preferential pathways or groundwater conduits. FSP at 6-1; Staff Exhibit 14. An electrical imaging ("EI") survey conducted across previously identified fracture traces from FTA can be used to locate groundwater flow pathways and to characterize subsurface features. *Id.* at 6-1 to 6-2. EI is a geophysical survey technique that measures electrical response within the earth to an electrical signal transmitted at the surface of the earth. Norris Testimony at 18, STV Exh. 1. The FTA and EI survey enhance or verify the locations of groundwater flow pathways and the associated sites for monitor well installation. FSP at 6-2, Staff Exh. 14. The results from the FTA and the EI study were used to identify potential groundwater conduits and were evaluated in the well location selection study. Well Location Selection Report at 1-7, Staff Exh. 26.

115. The objective of the EI survey was to provide data on potential preferred

groundwater flow pathways to support site selection of groundwater characterization well pairs. Well Location Selection Report at 5-1, Staff Exh. 26; Snyder Testimony at 3, Army Exh. 5.

116. In Basis A, STV asserts that, although the EI that follows the FTA may help to site the 10 to 20 pairs of monitoring wells, it is an indirect technique and can miss or misidentify conduits, so stream gauging studies should be an early and integral part of the search for likely conduits of groundwater flow, instead of a year after the groundwater studies. Final Contentions of STV at 9.

117. Basis A implies that significant additional information is needed to assist in positioning wells. Snyder Testimony at 4, Army Exh. 5. The Army states that its EI technique locates fractures that conduct groundwater because the fractures are full of moisture and are electrically conductive. Snyder, Tr. at 253. The technique does not detect caves filled with air, as they are non-conductive, but there is no need to detect them because they are above the water table and therefore not of interest in well location. *Id*.

118. STV believes that drilling locations should be based on an EI technique run on a grid and a seismic technique. Norris, Tr. 276. Specifically, STV argued that the orientation of the EI survey lines were oblique to the mapped fracture trace analysis lineaments, thus a loss of precision occurred. Norris Testimony at 18, STV Exh. 1. Also, "EI Line 4" was not "best" because it followed the sinuous path of a road rather than following a straight line. *Id*.

119. The Army testifies that even placing some EI survey lines perpendicular to fracture traces has not impacted the success of the well placement determinations. Snyder Testimony at 30, Army Exh. 5. The Army testifies that it was understood by the involved geophysicists and hydrologists that some segments of the EI line were along curves, and therefore had to be considered with a degree of caution. *Id.* at 30-31.

120. STV claims that the Army's implementation of EI precludes using the survey as a 3-D mapping tool. Norris Testimony at 18-19, STV Exh. 1.

121. The Army's expert testifies that the 3-D method is non-traditional, and when used, is usually focused on areas of a few acres. Snyder Testimony at 29, Army Exh. 5. Also, the purpose of the EI was to substantiate the results of the FTA, the purpose of which was to place groundwater monitoring wells, not to produce a 3-D map. *Id.* at 31.

122. The Staff considered the EI survey proposed in the FSP to be capable of providing useful data for placement of wells. Peckenpaugh Testimony at 18, Staff Exh. 2. While acknowledging the greater characterization provided by the grid desired by STV, the Staff believes the Army's survey is adequate since FTA and EI are likely to provide the necessary information. *Id.*

123. STV testified that the Army's interpretation of EI results is simplistic. Norris Testimony at 19, STV Exh. 1. STV suggests that weather, mineral content, and variations in electrical conductivity of groundwater will cause the Army's interpretation to be deficient. *Id.* at 19-20.

124. For mineral content, the Army notes that mineral content is most often what is mapped during EI. Snyder Testimony at 31, Army Exh. 5. This is because the variations come from clay and silt deposits left behind by groundwater activity, and the variations help locate where karst conduits may be characterized and monitored. *Id.* at 31-32.

125. Regarding weather and soil moisture variations, the Army's Well Location Selection Report documented that unusually high or low resistivities in the deeper portions of any cross-section were treated with caution. Well Location Selection Report at 5-5, Staff Exh. 26. The report documented that the contact resistances were found to be sensitive to soil moisture, quickly fell following a precipitation event, and rose within hours as the soils dried. *Id.* at 5-6. The report further noted noise from high temperatures. *Id.* However, the report concluded that even with the weather and temperature-related noise, the data are adequate to use for the identification of fractures and solution-enhanced zones within the bedrock. *Id.*

126. The Army testified that the purpose of the EI was not to identify intermittent flows controlled by the weather. Snyder Testimony at 31, Army Exh. 5. The data from the EI survey are adequate for their intended purposes of identification of fractures and solution enhanced zones within the bedrock. Well Location Selection Report at 5-6, Staff Exh. 26. The intermittent transmission of DU along with water from precipitation events and high groundwater conditions are being investigated. Snyder Testimony at 31, Army Exh. 5. Caves in the DU Impact Area can intercept precipitation and high groundwater, and sampling of streams and sediment from these caves will be far superior to constructing dry wells in shallow unsaturated voids in the subsurface. *Id.*

127. The specific conductance of groundwater has little ability to impact the electrical conductivity of bedrock, because groundwater was under one percent of the bedrock volume. *Id.* at 32. It is extremely unlikely that there are small pockets of groundwater with different specific conductivities that will be mistaken as evidence of weathering, and that even if there were, the pocket of groundwater would have be coincident with a mapped fracture trace to impact the investigation. *Id.*

128. STV argues that, even if the Army's interpretation of EI data was appropriate, the EI will not accomplish its purpose. Norris Testimony at 20, STV Exh. 1. Additional steps of determining which resistance anomalies function as conduits, mapping those anomalies, and determining flow direction must be done to determine the entry and exit point of groundwater, and that the lack of verification drilling at JPG precludes this. *Id.* at 21.

129. The Army responded by asserting that STV misunderstood the purpose of the FTA/EI, which was to select locations for installation of wells. Snyder Testimony at 34, Army Exh. 5. The Army points out that verification drilling will be completed during the well drilling and installation, and subsequent water level monitoring will be done. *Id.*

(ii) Findings

130. The Board finds that EI may be used to verify information identified through FTA.

131. The Board finds that groundwater conduits may be found using the FTA/EI method described in the FSP. The EI will locate the fractures that conduct groundwater because the fractures are full of moisture and are electrically conductive.

132. The Board finds that variations in electrical conductivity of groundwater will not likely impact the EI.

133. The Board finds that weather and temperature related noise did not invalidate the results of the EI.

134. The Board finds that electrical variations associated with mineral content are often what is mapped during EI and help determine where to characterize and monitor karst conduits.

135. The Board finds that the EI survey is not intended to find features only intermittently filled by precipitation or high groundwater. DU transport via those features is best monitored via sampling, not by drilling a well into the dry location.

c) Well Location Assessment and Selection

(i) Evidence

136. STV argues that well location assessment and selection will not be adequate for site characterization. Norris Testimony at 34, STV Exh. 1. STV asserts the FSP was inadequate because it does not require installation of wells in aquifers found in unconsolidated sediments above the bedrock. *Id.* Deferring installation of those wells to the discretion of the licensee is inappropriate. *Id.* at 35. Groundwater conduits need to be mapped, rather than just finding the areas where they pass under the site's roads because otherwise potential pathways of DU from the site to discharge points cannot be established. *Id.* Flow surveys of site streams would allow site characterization to identify active conduits by showing where streams are

receiving flow or losing water to groundwater conduits, and such flow surveys are not part of the FSP. *Id.* at 35-36. Discharges and recharges for groundwater conduits have not been located, and that the only use of observable conduit flow as a well selection criterion was dropped from the FSP. *Id.* at 36. STV claimed that the Sheldon Study, which mapped caves, was not fully and appropriately incorporated into the FSP. *Id.*

137. In Basis F, STV asserts that shallow wells are necessary to characterize the site because the DU projectiles reside in till and/or weathered bedrock/colluvium. Final Contentions of STV at 10. STV believes that wells must be selected after groundwater conduits are mapped, or else the data will not support site modeling. Norris Testimony at 39, STV Exh. 1.

138. The Army responded that its methods are tried and proven, whereas STV's methods are not common practices. Snyder Testimony at 39, Army Exh. 5. The Army notes that STV wants all active groundwater conduits located, whereas the Army does not believe this is necessary or possible during the requested alternate schedule period. *See id.* at 40. The Army states that the karst conduits that transfer water offsite will be interconnected, and monitoring the water levels and analyzing responses to precipitation will establish the degree of interconnection. *Id.* Also, the Sheldon Study was used in the planning and implementation of the site characterization. *Id.* at 41.

139. The Army characterized Basis F as requiring the installation of shallow wells. Snyder Testimony at 12, Army Exh. 5. The Army intends to consider shallow wells based on the observed site conditions. *Id.* at 12-13. The FSP Addendum 4 and the January 2007 Well Selection Report present plans to install at least one well in unconsolidated material based on actual site conditions. *Id.* The biggest pathways will be visible from aerial photos and detected by the EI. Snyder, Tr. at 267. The locations chosen for well placement result in wells that sample the entire periphery of the DU portion of the site. *Id.*

140. The Staff notes that the phased characterization of the site includes the

installation of monitoring wells, and that if necessary, more wells can be added. Peckenpaugh at 22, Staff Exh. 2. In support of Basis F, STV states the modified FSP does not require wells to be installed when aquifers are found in the unconsolidated sediments above the bedrock. Peckenpaugh at 11, Staff Exh. 2. STV's basis is outdated, and does not support its contention. *Id.* A Staff witness has observed the installation of wells in unconsolidated material. *Id.* at 12. The FSP with Addendum 4 provides adequate data for shallow groundwater characterization. *Id.*

(ii) Findings

141. The Board finds it is unnecessary to find all groundwater conduits because conduits that transfer water offsite are interconnected.

142. The Board finds that shallow groundwater wells in unconsolidated above-bedrock sediment are both planned and installed.

143. The Board finds that the FSP is adequate with respect to well location assessment and selection. The phased approach includes the installation of more wells if necessary.

d) Stream and Cave Gauging and Stream Staging

(i) Evidence

144. Stream gauging is the measurement of the rate at which water flows past a point in the stream. Norris Testimony at 23, STV Exh. 1. Cave gauging is measuring the rate at which water flows past a point in the cave or from the mouth of a cave. *Id.* Stream staging is the measurement of the height of the surface of a stream. *Id.* Stream or cave gauging uses the water height (stage) as part of the computational process to determine flow rates. *Id.*

145. STV testified that the FSP is deficient in its stream and cave gauging because it is predicated on the previous inadequate understanding of the site that was developed without consideration of karst development in bedrock. *Id.* at 26. Further, the objectives are irrelevant

with respect to the information that is needed for exposure modeling. *Id*. Additionally, the installation schedule and placement of gauging and staging locations will not provide meaningful input. *Id.* STV stated that locations of stream gauging, such as those coincident with bridges and culverts under roads, are proposed without consideration of the meaningfulness of any data collected. *Id.* at 64.

146. STV testified that additional stream gauging activities were needed in the form of seepage runs. Norris Rebuttal at 32-33, STV Exh. 1. STV's expressed concern was that the existing FSP program was not capable of identifying where a stream was gaining or losing to groundwater. *Id.*

147. Army witness Snyder testified that STV has premised its arguments on speculation, and that the alleged deficiency in the surface water gauging and staging is based on a highly-speculative scenario regarding surface water dropping into conduits then resurfacing at a distance. Snyder Testimony at 36, Army Exh. 5. That scenario has not been shown to occur in any of the studies of the JPG area. *Id.* Should any gains or losses of water from Big Creek be occurring, they would be detected by the gauges located at the up-gradient and down-gradient boundaries of the DU Impact Area and the gauge in between. *Id.* These and other installed gauges on the northern tributary to Big Creek and Middle Fork Creek would detect any inter-basin or intra-basin losses or gains, which would prompt further investigation. *Id.* The Army has not yet determined if there are any losing streams, but will do so as part of its characterization. Snyder Tr. at 263. If the Army finds DU in streams near where they are losing flow, then the Army will develop a study to determine where the flow goes. *Id.* at 264-265.

148. The Army acknowledged that seepage runs would provide potentially useful data, but the data were not necessary or useful for locating wells. Skibinski Sur-Rebuttal at 9, Army Exh. 3. The use of continuous stream and cave gauges, as proposed in the FSP and addenda, is superior to the seepage run survey suggested by STV. Snyder Testimony at 37,

Army Exh. 5. The Army's method will allow the Army to understand and quantify the percentage of precipitation falling on the DU Impact Area that runs across the surface, the percentage that drops into caves, and the percentage that reaches the groundwater table and travels to streams through the aquifer. *Id.* at 37-38.

149. STV states that stream surveys and gauging should have been part of the process of installing the initial wells in order to optimize the location of the wells. Norris, Tr. at 234. STV admits that the Army will use the information from the wells and stream gauging to decide where next to sample. *Id.* at 235.

150. The Staff observed that these locations are consistent with the common practice for locating stream gauges by the U.S. Geological Survey. Peckenpaugh Testimony at 21. The locations provide some protection from ice and tree trunk jams for the gauges, and also are better for monthly service and measurement when UXO is considered. *Id.*

151. The Staff also does not think such data are needed. Peckenpaugh Sur-Rebuttal at 4, Staff Exh. 7. It is not necessary to perform one or more seepage runs prior to the installation of additional characterization wells. *Id.* The four additional well locations will be placed according to fracture trace analyses and electrical imaging, which is how the six previous well locations were selected. *Id.* These two methods are used to delineate potential conduits and preferred groundwater pathways in the bedrock and provide adequate data for selecting well site locations. *Id.*

(ii) Findings

152. The Board finds the placement of the gauges by culverts and roads is common practice, and will provide useful data. Seepage runs are not required for well placement.

e) Well Installation

(i) Evidence

153. STV testified about six general issues for well installation and assessment: 1) an inconsistency between the original FSP and Addendum 4 regarding the need for centralizers during well installation, 2) failing to set depth targets for drilling, 3) failing to require logging of boreholes or characterization of the cores, 4) failing to characterize hydraulic properties of soils and rocks, 5) failing to establish boring abandonment criteria, and 6) taking only well water level measurements in an initial round of data collection. Norris Testimony 39-48, STV Exh. 1.

154. Army witness Eaby testified that the first concern was an obvious typographical error. Eaby Testimony at 26-27, Army Exh. 4. Flexibility was needed for target depths to account for field conditions. *Id.* at 27-28. The Army argued that bore hole logging was not needed, noted that the revised drilling procedures provide rock cores and other important data, and concluded that STV's additional tests were not necessary for site characterization. *Id* at 28-30. The Army considers STV's collection of hydraulic data to be a waste of time, effort, and money, and believes that the phased approach of the FSP is sufficient. *Id.* at 30-31. For abandonment criteria, the Army believes direct observation by a rig geologist is most appropriate. *Id.* at 32. For the sixth alleged deficiency, the Army states that the evaluation is more than just a single round of water level data. *Id*. at 34. As shown in the Well Location Selection Report, additional evaluation includes information from the rig geologist about drilling conditions, evaluation of groundwater stage data and precipitation to determine how the well is connected to the preferential flow pathway in the aquifer, and comparison of cations/anions in the conduit wells to non-conduit wells. *Id.* (citations omitted).

155. The Staff finds that the Army had valid reasons for its installation methods, and that the deficiencies alleged by STV were insignificant. Peckenpaugh Testimony at 23,

Staff Exh. 2. No alternate drilling program was necessary. Peckenpaugh Sur-Rebuttal at 5, Staff Exh. 7.

156. In Basis C, STV asserts that six monitoring wells may or may not be enough, but the actual number of wells should not be limited to initial assumptions, but instead be based on results achieved. Final Contentions of STV at 9-10.

157. The Staff concludes that the FSP is adequate for selecting recorder wells given that it is difficult to determine appropriate well recorder locations before data are collected. Peckenpaugh Testimony at 9, Staff Exh. 2. The Army also notes that the number of wells will be reviewed as groundwater staging data are collected. Eaby Testimony at 16, Army Exh. 4.

158. In Basis D, STV asserts that reasons for the relative positions of each well at each well pair site are not explained, and that there is no indication of whether the paired well be above or below the conduit well, or of the relative position would change depending on unspecified site conditions. Final Contentions of STV at 10.

159. The Army reads Basis D as implying that additional details of the installation of paired conduit wells is needed. Snyder Testimony at 8, Army Exh. 5. Some of the information STV wanted is present in other sections of the FSP. *Id.* Also, FSP Addendum 4, submitted after STV drafted Basis D, includes details of well locations and proposed depths. *Id.* at 9. The flexibility to modify and design the wells based on actual site conditions is crucial to the successful installation of monitoring wells due to the highly variable nature of fractured and karst features. *Id.*

160. The Staff believes that Basis D is outdated because pairing the “conduit” wells was explained in Addendum 4. Peckenpaugh Testimony at 9, Staff Exh. 2 (citations omitted).

161. In Basis E, STV asserts that it is necessary to monitor a non-producing well for enough time or a flow event to be sure that it never produces water before abandoning it

because the nature of karst terrain is that flow is highly transient. Final Contentions of STV at 10.

162. The Army states that the intent of conduit well installation is to provide a monitoring well network to characterize the groundwater and groundwater flow in and around the DU Impact Area. Snyder Testimony at 10, Amy Exh. 5. Transient flow from rain or flood events will drain via groundwater or flow through the shallow karst network. *Id.* at 10-11. A dry well would not be part of the flow pathways, and it is unnecessary to monitor such a well for site characterization. *Id.* at 10. Furthermore, STV's suggestion to monitor above-water-table dry wells is impractical. *Id.* at 11. The Army notes that the well pairs are at depths of 50 and 120 feet, and these depths are below the water table, and therefore not subject to temporary dryness. *Id.* at 10.

163. The Staff believes that STV's recommendation to develop a well from a dry borehole and wait for a significant precipitation event is not practical nor justified. Peckenpaugh Testimony at 10, Staff Exh. 2. The approach in the FSP, which involves reviewing the drilling response, split-spoon or core samples, the occurrence of fractures, and other factors, can yield a valid decision regarding whether to develop a well or abandon the borehole. *Id.* at 11. The final decision will be based upon discussion between the Army and its contractor's project hydrogeologist, project manager, and rig geologist. *Id.* (citing FSP Addendum 4 at 2-5, Staff Exh. 18).

164. The Staff believes the FSP already adequately describes tasks necessary for determining whether to develop a well or abandon a borehole, such as reviewing core samples. Peckenpaugh Testimony at 10-11, Staff Exh. 2. The FSP approach adequately informs a decision to abandon a non-productive borehole. *Id.*

165. In Basis G, STV states that testing of new wells for permeability should be measured, that new wells should be tested for permeability, and that aquifer testing should be done. Final Contentions of STV at 11.

166. The Army states that the FSP stated that no aquifer testing was scheduled at that time, but the FSP uses a phased approach, and aquifer testing and collection of additional information will be considered later. Eaby Testimony at 17, Army Exh. 4. Proposing aquifer testing without knowledge of the basic aquifer parameters and well construction details is inappropriate. *Id.* at 18.

167. The Staff argues that Basis G is outdated, and the FSP contains appropriate steps to address hydraulic conductivity or permeability. Peckenpaugh Testimony at 12-13, Staff Exh. 2. It is not possible to conclude at this stage that hydraulic conductivity tests are needed because such a decision must be informed by the results from new monitoring wells and stream and spring cave flows. *Id.* at 13. Obtaining actual hydraulic conductivity values may not even be necessary because bounding or conservative values may be used. *Id.*

168. In Basis H, STV asserts that geophysical testing and video taping and other tests of all well drilling should be done where possible. Final Contentions of STV at 11.

169. Army witness Eaby testified that the geophysical and video logging cannot be conducted because the drilling methods and site conditions preclude it. Eaby Testimony at 19-20, Army Exh. 4. The logging methods suggested by STV are of limited value and do not provide additional aquifer information beyond what is already provided by the rig geologist's observations. *Id.* The Army's experience with the alternate methods proposed by STV is that they would not work due to potential equipment damage. *Id.*

170. The Army notes that the drilling method selected will provide rock cores from the boring that can be directly observed. *Id.* at 20. The ability to observe the cores eliminates the need for, or usefulness of, many of the borehole geophysical methods. *Id.*

171. In consideration of what is actually being done at the site, the Staff concludes that videotaping is unnecessary. Peckenpaugh Testimony at 14, Staff Exh. 2. Actual techniques being used include sampling and well logging. *Id.*

(ii) Findings

172. The Board finds that the well installation process uses a phased approach that accounts for field conditions. Flexibility in the FSP is crucial during well installation due to the variable nature of fractured and karst features. Appropriate techniques are being used to observe drilling and cores. When to develop a well or abandon a boring is addressed in the FSP.

f) UXO

(i) Evidence

173. STV asserts that unexploded ordinance ("UXO") could be safely addressed. *See generally* Pastorick Rebuttal, STV Exh. 3. For example, STV disagrees with the Army considering UXO concerns when assessing the use of ground penetrating radar. *Id.* at 9. The Army could follow a guidance document to evaluate if remote sensors could be used. *Id.*

174. STV's UXO expert had no opinion on the adequacy of the FSP in terms of the proper placement of stream gauging stations. Pastorick Sur-rebuttal at 1-2, STV Exh. 3. The application of Army Corps of Engineers' procedure EP 75-1-2 requires that the merits of the various sampling methods and locations be evaluated and decided without consideration of UXO hazards. Pastorick Rebuttal at 12, STV Exh. 3. Therefore, UXO is not a reason to select road locations over off-road grid locations for EI. *Id.* If maximized EI data are not needed to support future decision making, then exposure to additional risk from UXO is not necessary and should be avoided. *Id*. at 12-13. The UXO expert had no opinion about the adequacy of the FSP in terms of its ability to characterize the site. *See id.* at 14.

175. The Army does not believe that safety concerns regarding UXO are impeding, altering, or minimizing the FSP because any necessary data can be obtained from areas cleared of UXO. Snyder, Tr. at 280. The Army's characterization efforts have not been hindered by concerns over UXO. *Id*. at 249.

176. The Staff notes that the Army's actual EI patterns and instrumentation were limited to the existing roads because of the risk of UXO in the off-road areas, but believes that this limitation does not affect adequate site characterization. Peckenpaugh Testimony at 18, Staff Exh. 2.

(ii) Findings

177. The Board finds that the FSP is adequate to allow the implementation of the FSP without detrimental effects on the characterization of the JPG site from the presence of UXO.

G. Soil, Water, and Sediment Sampling and Sample Analysis and Methodologies

a) Soil, Water, and Sediment Sampling

(i) Evidence

178. STV asserts in Basis B that the chemistry of the monitoring system is not set out, groundwater is dismissed as an exposure pathway, and existing wells are producing poor quality data. Final Contentions of Save the Valley, Inc. May 31, 2006, at 9. The first part refers to the water chemistry of the surface water and the groundwater at the JPG site. STV clarifies in its Initial Statement of Position that the extent to which the water is oxygenated and/or influenced by a carbonate/bicarbonate can affect the transport of DU in the water. STV Initial Statement of Position at 13 (July 13, 2007).

179. STV contends that the chemical characterization of groundwater and surface water are necessary to characterize all of the parameters that influence the mobility of uranium in the environment. *Id.* That characterization is expected to show the level to which the water is oxygenated and dominated by carbonate/bicarbonate anions. *Id*.

180. The Army will examine the surface water and groundwater chemistry through the FSP. While the detailed sampling addendum has not been submitted to the NRC staff by the Army, the FSP states that the Army will examine the pH, conductivity, and other parameters of surface water and groundwater. FSP at 6-21 to 6-22, 6-30, Staff Exh. 14. Further, Mr. Snyder testified on behalf of the Army that although the importance of water chemistry to the transport of DU has yet to be determined, factors such as pH and redox will be evaluated along the transport pathways and at various times. Snyder Testimony at 19, Army Exh. 5.

181. Contrary to Basis B, that groundwater is being dismissed as a potential pathway for DU transport, groundwater will be extensively examined according to the FSP. FSP at 6-4 to 6-24, Staff Exh. 14. Section 6.2 of the FSP sets forth detailed plans to install monitoring wells at various depths and in several locations in order to characterize groundwater. *Id.* The Staff notes that the FSP provides for the potential transport of DU through groundwater and provides for the collection of data to characterize groundwater as a pathway. Peckenpaugh Testimony at 8, Staff Exh. 2.

182. STV argues that, in order to characterize the site, it is absolutely necessary to collect hydrologic data. Norris Tr. 236-237.

183. Characterization of surface and groundwater is an essential component of the dose modeling used to estimate doses to demonstrate compliance with the license termination requirements in 10 CFR Part 20, Subpart E. NUREG-1757, Vol. 2, Rev. 1, F-1, Staff Exh. 21.

184. The Army has commenced the installation of wells to monitor and sample groundwater at various depths. Peckenpaugh Testimony at 11-12, Staff Exh. 2. The well logs will provide information regarding the possible transport of DU through groundwater. *Id.* at 14.

185. The existing wells referenced by STV in its Basis B are old wells which were placed prior to the FSP. While they are of varying quality, the highest quality wells may continue to be used to provide information for the characterization of the site, and new wells will

be installed as necessary by the Army to conduct its groundwater sampling under the FSP. *Id.* at 8.

186. STV asserts in Basis I that the exact number and location of the surface water sampling and gauging locations should not be specified at the beginning of the FSP implementation. Rather, the locations should be determined using groundwater data. Also, surface water and sediment sampling locations do not need to be the same. Final Contentions of STV at 11.

187. The exact number and location of surface water sampling locations are not specified in the FSP. Only general locations of the 14 sampling sites for Big Creek, Middle Fork Creek, and the spring caves are discussed in the FSP. FSP at 6-29, Staff Exh. 14. The final surface water sampling locations will be documented in an addendum to the FSP. *Id*. Although the Army did not specify the exact locations of the stream and spring cave gauging sites, there are a limited number of acceptable sites for installation of stream and spring cave gauges within the DU Impact Area. Peckenpaugh Testimony at 15, Staff Exh. 2.

188. Co-locating sediment and water samples in coordination with stream and spring cave gauges can be beneficial by providing water flow measurements at the surface water and sediment sample locations. *Id.* Co-location will allow potential DU concentrations to be compared to different flow volumes. *Id*. Further, the concern raised by STV that samples should be taken during different flow conditions is addressed by Army witness Snyder. Sampling will be conducted to detect entrained sediment and suspended transport of DU. Snyder Testimony at 19-20, Army Exh. 5. Since entrainment is a function of velocity, when the velocity is reduced, more sediment will be deposited along the path from the source. *Id*. Samples taken for these sediments will be analyzed for DU, and potential suspended DU will be measured by sampling unfiltered samples of water from streams and cave streams down-gradient and up-gradient from the DU Impact Area. *Id*.

189. Relating to soil, water, and sediment sampling, STV asserts in Basis N that samples should be taken during different seasons, specifically during high-flow and low-flow conditions. Final Contentions of STV at 15. However, STV recognizes that the addendum with sampling plan details will be submitted at a later date. Norris Testimony at 70, STV Exh. 1.

190. STV asserts that for each medium, the sampling needs to occur at the times, at the places, under the conditions, and in sufficient quantities to produce data meaningful to the eventual task of modeling the site for fate and transport of DU out of the Impact Area and the computation of realistic dose exposures at places and times of interest. Norris Testimony at 71, STV Exh. 1.

191. STV seeks site-specific information that it describes as required to meet the needs of meaningful fate and transport. Norris Testimony at 8-9, STV Exh. 1. Some of the information listed by Mr. Norris such as temporal variability is unnecessary to the extent that the fate and transport model can use bounding and/or conservative parameters for the conditions at the JPG site to produce an adequate site characterization. Peckenpaugh Testimony at 20, Staff Exh. 2.

192. If conservative simplifying assumptions are made in one part of a model, the dose contribution from that part of the model will be overestimated. Ridge Sur-rebuttal at 5, Staff Exh. 8. Thus, other parts of the system will be able to contribute less dose before the dose limit is met, and the corresponding parts of the model may need to be more realistic (i.e., less simplified), not less realistic. *Id*. If a bounding or conservative value is used, it is more protective of human health because it will lead to an assumed higher peak dose to a receptor. *Id.* at 6.

193. The Army will continue to meet with the NRC staff at least annually and will work with the NRC staff on the details of the FSP Addendum and the development of the decommissioning plan. Skibinski Sur-rebuttal at 3, Army Exh. 3.

(ii) Findings

194. The Board finds that soil, water, and sediment sampling will be described in a future addendum to the FSP as it evolves to define the methods used for obtaining site-specific data for decommissioning purposes.

195. The Board finds that the preliminary work conducted by the Army in placing groundwater wells indicates that the wells will be installed according to the FSP to provide the necessary characterization of possible DU transport in groundwater.

196. The Board finds that fate and transport modeling of DU can be bounding and/or conservative for the conditions at the JPG site to produce an adequate site characterization that will then allow development of an adequate dose model and decommissioning plan.

197. The Board finds that it is more protective of public health to use conservative parameters where there is uncertainty relating to the parameter and where the results of the dose assessment are sensitive to these parameters.

b) Sample Analysis and Methodologies

(i) Evidence

198. STV asserts in Basis Q that DU dissolution rates should be calculated in different site-specific wetness and temperature regimes. Final Contentions of STV at 17.

199. The examination of dissolution rates of the DU penetrators set forth in the FSP will establish a corrosion/dissolution rate for the penetrators subject to the environmental conditions specific to JPG. FSP at 4-3 Table 4-1, Staff Exh. 14. The Army will conduct two activities for corrosion testing. Ridge Testimony at 13-14, Staff Exh. 3. The first activity is to collect penetrators from the site that have been subject to the temperatures and wetness conditions specific to the site. *Id*. The second activity is to test new penetrators by subjecting them to controlled environmental conditions which would allow the Army to set various temperature and wetness conditions. *Id*.

200. The Army will examine penetrators to determine the mechanism for the transport of DU off of the penetrators. Anagnostopoulos, Tr. at 217.

201. STV asserts in Basis J that the Kd modeling is inaccurate, unreliable, and allows opportunities for abuse. Final Contentions of STV at 12.

202. The validity of the Kd as a mechanistic description of sorption does depend on several assumptions, while the functionality of the Kd parameter to conservatively represent or bound uranium transport does not necessarily depend on those assumptions. Ridge Testimony at 6-8, Staff Exh. 3. The two assumptions do not describe realistic conditions where sorption is non-linear and equilibrium partitioning may not be reached rapidly. *Id.*

203. Kd modeling can compensate for the model assumptions with bounding and/or conservative approaches that would result in a higher modeled potential dose at off-site locations because of a conservative value representing faster movement of the species in the groundwater. Ridge Testimony at 7, Staff Exh. 3.

204. If the local equilibrium assumption is not valid, it would affect the timing of the initial arrival of a contaminant more significantly than the time at which the peak concentration is reached, and a Kd model will over-predict the actual peak concentration. The potential invalidity of the local equilibrium assumption is not expected to have a non-conservative effect on a decommissioning decision. Ridge Sur-rebuttal at 2-3, Staff Exh. 8.

205. Alternative models such as a component additivity model as proposed by STV have limitations that affect their accuracy. Ridge Testimony at 11, Staff Exh. 3.

206. Kd modeling may have limitations associated with a situation where an alkaline plume coincides with a radionuclide plume, in which it would be difficult to describe radionuclide transport with Kd, but that type of complex chemistry is not occurring at the JPG site. Ridge Sur-rebuttal at 3, Staff Exh. 8.

207. Kd modeling is an acceptable method to the NRC and can provide reliable modeling. Ridge Testimony at 12, Staff Exh. 3.

208. STV raised in its testimony additional issues to support its contention that were not specifically set forth in its Bases. STV testimony asserts that more sensitive sampling techniques need to be used by the Army. STV argues that documenting the absence or presence of even small quantities or low concentrations of DU is critical to fate and transport modeling because that knowledge is one of the few observations against which the model can be calibrated. STV Initial Statement of Position at 13.

209. If DU were present in the soil, sediment, water, or deer tissue samples, alpha spectroscopy would likely be able to detect it. Anagnostopoulos, Tr. at 290, 302; Condra Sur-rebuttal at 6, Staff Exh. 10.

210. The Army has taken water, sediment, soil, and deer tissue samples at the site through its ERMP and scoping and characterization surveys. FSP at 2-6 to 2-7, Staff Exh. 14.

211. The samples taken pursuant to the ERMP and the scoping and characterization surveys have been analyzed for uranium content. *Id*.

212. The primary method of analysis for uranium in the samples taken from the JPG site was alpha spectroscopy. Condra Sur-rebuttal at 6, Staff Exh. 10. Alpha spectroscopy has a detection limit that varies depending on the medium being tested. In soil and water, the detection limit is 0.2 to 1.5 pCi/g.[26] Anagnostopoulos, Tr. at 156.

213. STV contends that the ability of the analysis protocol to detect and quantify low concentrations of DU depends upon the sample mass that is analyzed and the length of time the activity is counted. STV Initial Statement of Position at 14. STV contends that sampling

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[26] For water, the appropriate units are pCi/L.

protocols in the FSP Appendix A are not capable of providing the resolution needed to determine low levels of DU contamination. *Id.*

214. Alpha spectroscopy provides the quantitative assessment of U-238 and U-234 activity in a sample. Condra, Tr. at 296, 299.

215. The FSP specifies reporting limits for isotopic analysis of uranium as 0.02 pCi/g for biota, 2 pCi/g for sediment, and 1 pCi/L for surface water and groundwater samples. FSP at A.3-3 Table A.3-1, Staff Exh. 14.

216. Enriched uranium is not a consideration for the JPG site. Henshel Tr. at 139.

217. The NRC uses the guidance it helped develop, provided in MARLAP, a multi-agency laboratory manual for acceptable analytical methods. MARLAP at 1-1 to 1-2, Staff Exh. 20.

218. Accepted analytical methods require that the statistical uncertainties be considered when analyzing data. Condra Sur-rebuttal at 8, Staff Exh. 10.

219. Samples taken from within the DU Impact Area, where the penetrators are located, resulted in total uranium concentrations ranging from 1.5 pCi/g to 12,000 pCi/g with the average concentration for all 60 samples at 757 pCi/g with a standard deviation of over 2,000 pCi/g. Anagnostopoulos, Tr. 210-211. The sampling technique and alpha spectroscopy analysis methods were able to detect the high levels of total uranium in the sample. *Id.* at 178.

220. The soil, water, and sediment samples taken outside of the DU Impact Area show total uranium concentrations at the detection limit of the alpha spectroscopy method or total uranium concentrations at background levels. *Id*. at 155, 293.

221. Uranium is ubiquitous in nature and can be found in varying concentrations in the environment generally ranging from 0.3 pCi/g to 3.5 pCi/g. *Id.* at 157-158,167-168. The levels of total uranium found in the samples from outside of the DU Impact Area are within these background levels. Condra Testimony at 7, Staff Exh. 5.

222. STV asserts that DU has been detected in samples taken at the JPG site. STV provides the argument that DU has moved into the deer found at the JPG site. STV Supplement to the Initial Statement of Position at 3. Dr. Henshel testifies on behalf of STV that DU is increasing in deer over time, and that the results of the Deer Tissue Sampling Study indicate that penetrator-derived uranium has probably moved into the deer population, contrary to the conclusions of the study. Henshel Testimony at 13, 16, STV Exh. 2. Mr. Norris testifies on behalf of STV that Big Creek contains DU in rising proportion to total uranium based on ERMP data from Spring 2005 to Spring 2006. Norris Rebuttal at 41, STV Exh. 1.

223. There is no indication of routine or widespread DU contamination outside of the DU Impact Area. Anagnostopoulos Testimony at 14, Army Exh. 1.

224. STV uses water samples from Big Creek to present its argument that DU is currently present in surface water outside of the DU Impact Area. Condra Sur-rebuttal at 7, Staff Exh. 10. None of the water samples have a ratio above one after considering the uncertainties associated with the analysis, and they therefore do not provide a foundation to conclude that DU is present in the samples from Big Creek. *Id*.

225. Among all of the deer samples, the total uranium concentration in the tissues is approximately the same, and in many instances, the concentration is near the detection limit. Anagnostopoulos, Tr. at 158. In examining the U-238 to U-234 ratio and propagating the errors of each measurement, the error is high and a conclusion cannot be made whether DU is present in the tissues or not. *Id*.

226. If deer had DU uptake, sample analysis would be expected to reveal elevated activity levels compared to the background levels of total uranium at the site. Barta, Tr. at 167.

227. The range of average total uranium concentrations in deer muscle tissue at the JPG site is 0.008 to 0.013 pCi/g. Condra Testimony at 4, Staff Exh. 5. The ratios of U-238 to U-234 are almost all less than 1 with the highest ratio at 1.5, but the total uranium in that sample

was at background levels. *Id*. None of the tissue samples from deer supports the conclusion that DU has been detected in deer. Condra Sur-rebuttal at 3-4, Staff Exh. 10.

228. Sample results should report the percentage of DU out of the total amount of uranium found in the sample. STV asserts that the presence, absence, or fraction of DU in samples is a critical issue. STV Initial Statement of Position at 13. The most basic level of concern is whether the analysis can determine whether DU is in a sample, and if so, at what concentration. Norris Testimony at 72, STV Exh. 1.

229. Any given sample has only one ratio of U-238 to U-234 measured through analytical methods. Condra, Tr. at 296; Condra Testimony at 8, Staff Exh. 5; Condra Sur-rebuttal at 6, Staff Exh. 10. The ratio of U-238 to U-234 in natural uranium is about 1:1, and the ratio of U-238 to U-234 in DU is about 8:1. Anagnostopoulos, Tr. at 154.

230. The method suggested by STV to determine the percentage of DU in a sample is not an analytical measurement, rather, it is a calculation that relies on assumptions that challenge the calculation's validity. Condra Sur-rebuttal at 6, Staff Exh. 10. The calculation assumes what the isotopic ratios are and assumes that there is no DU interaction within the sample matrix. *Id*.

231. Through Mr. Norris' testimony, STV contends that fractionation may alter isotopic ratios for mobile and residual DU from the isotopic ratios in the metallic uranium projectiles. Norris Testimony at 79, STV Exh. 1.

232. Fractionation occurs when recoil from the release of an alpha particle causes an atom to separate from other uranium atoms. Anagnostopoulos Testimony at 24-25, Army Exh. 1. U-234 has a higher specific activity, so it is more frequently separated. *Id*. This higher specific activity may make U-234 more mobile in relation to other uranium and can alter the observed ratio of the isotopes in samples. *Id*.

233. The effects of fractionation cannot be described simply at the JPG site because although U-234 fractionation would be expected to decrease the ratio of U-238 to U-234, thus making a sample appear more natural if the ratio is below one, DU is depleted in U-234. *Id*. The percentage of U-234 available to fractionate is greatly reduced in DU, the magnitude of U-234 fractionation is highly variable, and the effects are typically seen in water rather than soil or tissue. *Id*.

234. The fractionation issue raised by STV relies on a study examining the effect of fractionation of U-238 to U-235 that used a solution enhanced in U-235 in the experiment because the precision of measuring the natural ratio of U-238 to U-235 is too low. The fractionation effect observed in the experiment is much smaller than the natural variation of the ratio of the isotopes. McLaughlin Testimony at 13-14, Staff Exh. 1.

235. Through Mr. Norris' testimony, STV asserts that sample size affects count rates and the precision of DU identification, which is dependant on the count rates. Norris Testimony at 74, STV Exh. 1. Specifically, Mr. Norris' testimony contends that DU was demonstrated to be in Big Creek, but that the Army dismissed the data because of the statistical uncertainty caused by the small mass of the sample analyzed. Norris Testimony at 75, STV Exh. 1. Mr. Norris identifies the planned sample size of the surface water and groundwater samples to be a critical deficiency in the FSP that will hide the existence and concentrations of DU migrating from the DU Impact Area. Norris Testimony at 76, STV Exh. 1.

236. In analyzing a sample for measurements of radioactivity, both the sample mass or volume and the concentration of radioactive material affect the results. Anagnostopoulos Testimony at 17, Army Exh. 1. A change in the proposed analytical method may have introduced confusion into this issue because the sample collection volume changed with the method. *Id.* at 17-18. The sample volume changed from the one gallon volume referenced by Mr. Norris to one liter. *Id.*; Norris Testimony at 75, STV Exh. 1. Further, the entire sample

volume or mass is not typically used during the actual analysis. Anagnostopoulos Testimony at 17-18, Army Exh. 1. Rather, an aliquot is used and dilutions may be made. *Id*.

237. Because radioactive decay is a random process, for radioactive counting statistics, the uncertainty in any estimate of the observed activity of a sample is equal to the square root of the total observed counts during the observation period. *Id* at 19. Increasing the aliquot volume only marginally reduces the propagated uncertainty. *Id*. Likewise, increasing the count time provides only the same marginal benefit. If the total observed counts is low, the square root of the total observed counts is fairly high in relation to the observed value. If the total observed counts is high, the square root of that number is higher, but much less so in relation to the observed counts. *Id*.

(ii) Findings

238. The Board finds that the FSP contains a plan to allow the Army to examine dissolution rates of penetrators under differing temperatures and wetness conditions.

239. The Board finds that the use of Kd modeling is capable of using parameters that are realistic, bounding and/or conservative to adequately model DU transport at the JPG site.

240. The Board finds that the FSP provides for the Army to conduct soil, water, and sediment sampling to examine the levels of depleted uranium outside of the DU Impact Area of the JPG site, and that the FSP will provide for additional sampling in a future addendum.

241. The Board finds that alpha spectroscopy is capable of detecting uranium in soil, water, sediment, and tissue samples to very low levels, and can be properly used to detect uranium and depleted uranium at the JPG site.

242. The Board finds that no water, soil, sediment, or deer samples currently support a conclusion that DU has been found outside of the DU Impact Area.

243. The Board finds that the ratio of U-238 to U-234 for any given sample can only provide a quantitative determination as to whether the sample is considered to contain natural

uranium or depleted uranium. No analytical method provides the means to determine what percentage, if any, is natural uranium or depleted uranium.

244. The Board finds that fractionation is not a significant concern in the analysis of samples.

245. The Board finds that the analytical methods for sample size and count times are adequately considered by the FSP, and that the FSP dictates use of accepted laboratory practices for the analysis of radiological samples.

V. CONCLUSIONS OF LAW

246. The Licensing Board has considered all of the evidence presented by the parties on the FSP contention and the hearing record, consisting of the filings of the parties in this proceeding, the orders issued by this Board, the exhibits received in evidence, and the corrected transcript of the proceeding. Based on a review of the entire record in this proceeding, consideration of the proposed findings of fact and conclusions of law submitted by the parties, and based upon the findings of fact set forth above, which are supported by reliable, probative, and substantial evidence in the record, the Board has decided all matters in controversy concerning this contention in favor of the Army and reaches the following conclusions.

247. Pursuant to 10 C.F.R. § 40.42(g)(2), the Army is required to demonstrate that, in order to receive an alternate schedule for submittal of a decommissioning plan, the alternative schedule is necessary to the effective conduct of decommissioning operations. The Board finds that the Army sufficiently rebutted STV's arguments and demonstrated that the FSP is adequate to support the alternate schedule license amendment.

248. The Board finds that STV has not raised a challenge to the necessity of deer sampling for the effective conduct of decommissioning. Further, the Board finds that the biota

sampling program is adequate to support the license amendment granting an alternate schedule for decommissioning.

249. The Board finds that the Army has demonstrated by a preponderance of the evidence that there is no significant health risk from DU via the air after controlled burns at JPG, and therefore, air sampling is not required during the alternate schedule period.

250. The Board finds that the use of FTA/EI will assist the Army in the placement of wells at locations to provide information useful to the characterization of the JPG site. The FTA/EI will assist in locating wells in important karst features for groundwater characterization, and additional techniques for well placement are not necessary.

251. Well location and installation pursuant to the FSP will be accomplished in a phased approach. This approach allows the Army to respond appropriately to conditions encountered at the site in a more efficient manner than installing all of the wells at the same time. The Army has met its burden of proof and demonstrated that a prescriptive, inflexible plan is not more efficient than the plan presented in the FSP.

252. The Board finds that the Army has demonstrated that the presence of UXO has not compromised the site characterization activities at the JPG site.

253. The Board finds that previous characterizations of the hydrology at JPG did not address the karst environment. The surface water, groundwater, soil, sediment, and biota sampling at the JPG site will be conducted pursuant to an addendum to the FSP to be submitted by the Army. The FSP contains sufficient detail to outline the expected sampling program, and the Army will work with the NRC staff to ensure that sampling procedures and analyses will be scientifically acceptable. The Army has demonstrated by a preponderance of the evidence that adequate sampling of water, soil, sediment, and biota is planned to provide the site characterization necessary for decommissioning.

254. The Board finds that Kd modeling as proposed by the Army is capable of providing DU transport modeling necessary for decommissioning, using realistic, bounding, or conservative values. The Army has met its burden of proof in demonstrating the data collected for use in the Kd model will provide information necessary for decommissioning.

255. The Board finds that the analytical methods used for the analysis of radionuclides in samples have the sensitivity required to provide site-specific data necessary for decommissioning purposes. The alpha spectroscopy method is capable of finding DU in extremely small amounts necessary for modeling. The Board finds that no analytical method is available to directly measure the percentage of DU in a sample. The Army has shown by a preponderance of the evidence that alpha spectroscopy is adequate to provide data necessary for decommissioning.

256. The Army's FSP is adequate to support its request for the alternate schedule license amendment in that the FSP provides for the collection of site-specific information that must be gathered before the Staff can approve a decommissioning plan for JPG. Therefore, delaying the submittal of the decommissioning plan is necessary to the effective conduct of decommissioning operations because the site cannot be decommissioned until the Army collects these site-specific data. Thus, the contention is resolved in favor of the Army.

257. All issues, motions, arguments, or proposed findings presented by the parties, but not addressed herein, have been found to be without merit or unnecessary for this decision.

VI. ORDER

258. For the foregoing reasons, it is hereby ordered that STV's contention is resolved in favor of the Applicant, the Army. This initial decision shall constitute the final decision of the Commission forty (40) days from the date of its issuance, unless, within fifteen (15) days of its service, a petition for review is filed in accordance with 10 C.F.R. § 2.341(b)(1).

259. It is so ORDERED.

Respectfully Submitted,

/RA/

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Counsel for the NRC Staff

December 7, 2007

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	Docket No. 40-8838-MLA
U.S. ARMY	)	
	)	
(Jefferson Proving Ground Site)	)	
	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of "NRC STAFF PROPOSED FINDINGS OF FACT AND CONCLUSIONS OF LAW, AND ORDER IN THE FORM OF AN INITIAL DECISION" in the above captioned proceeding have been served on the following by NRC internal mail with copies deposited in the Nuclear Regulatory Commission's internal mail system as indicated by a single asterisk or by U.S. Mail, first class, as indicated by a double asterisk, this 7th day of December 2007.

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