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)	)	

PREFILED TESTIMONY OF JON M. PECKENPAUGH

Under penalty of perjury, I, Jon M. Peckenpaugh, declare as follows: I attest that the factual statements herein are true and correct to the best of my knowledge, information, and belief; and the opinions expressed herein are based on my best professional judgment.

Q.1. Please state your name and employment.

A.1. Jon M. Peckenpaugh. I am the Systems Performance Analyst (hydrogeologist) for the U.S. Nuclear Regulatory Commission. I am an employee of the NRC in the Office of Federal and State Materials and Environmental Management Programs, Division of Waste Management and Environmental Protection, Environmental Protection and Performance Assessment Directorate, and Performance Assessment Branch.

Q.2. Are there any acronyms or abbreviations in your testimony that should be identified?

A.2. Yes, the following acronyms or short names have the meanings shown:

The “Staff” refers to the NRC Staff;
“STV” refers to Save the Valley, Inc, the intervenor;
“JPG” refers to Jefferson Proving Ground;
“DU” refers to depleted uranium;
“RAI” refers to a request for additional information from the NRC to the Army;
“FSP” refers to the Field Sampling Plan as amended and supplemented by the Army;
“FTA” refers to Fracture Trace Analysis;
“EI” refers to Electrical Imaging;
“STV Final Contentions” refers to the Final Contentions of Save the Valley, Inc. (May 31, 2006); and
other references as noted in my answer no. 7.

Q.3. What are your job duties and responsibilities as a Systems Performance Analyst?

A.3. My primary responsibilities include the performance assessment of hydrological systems and the review of environmental models used to estimate potential radiological doses to hypothetical receptors from waste disposal sites and sites undergoing license termination.

Q.4. Please provide an example of your work performed as part of your job duties.

A.4. I was the technical reviewer (hydrogeologist and groundwater modeler) for the Sequoyah Fuels Corporation site in Oklahoma. I evaluated the groundwater flow and transport modeling at this site by independently running the groundwater flow models. This facility was used primarily to convert uranium ore concentrates into uranium hexafluoride. The chemicals of concern were uranium, nitrate, and arsenic, which are present in the shallow and bedrock water-bearing units at levels above the U.S. Environmental Protection Agency's maximum concentration limits. I was also the technical reviewer (hydrogeologist, groundwater modeler, and dose assessor) for the Lisbon site, a mill tailings facility in Utah. I analyzed the geochemistry and hydrogeology of this site, and I evaluated the licensee's groundwater flow and transport models by independently running these models. The chemicals of concern at this site were uranium, molybdenum, selenium, and arsenic. The milling procedures at this site contributed to the mobility and transport of the chemicals of concern, particularly uranium. I also evaluated the licensee's dose assessment, which was based upon the uranium dose from the groundwater pathway, meat and milk from livestock, and garden and grain products.

I have conducted performance assessments of the groundwater and surface water at twelve complex radiological material sites and at seven commercial nuclear power reactor sites undergoing decommissioning. I have also evaluated the radiological risk at seven former

radioactive burial sites, nuclear fuel processing facilities, and a mill tailing site. I am currently the technical reviewer for two commercial nuclear power reactor sites and a nuclear fuel processing facility in decommissioning.

Q.5. Please describe your professional qualifications including education, training, work experience, and publications.

A.5. I have Bachelor and Masters Degrees in Geology and Water Resources respectively. I have over 50 semester hours of graduate work in Geology for a PhD program. I have extensive experience as a geologist, and I am a licensed Professional Geologist in Virginia and Pennsylvania. My resume, attached hereto as “Attachment A”, provides a detailed description of my general background, training, and other qualifications to express the opinions stated herein.

Q.6. Please describe your involvement and responsibilities regarding the Staff’s review of the Jefferson Proving Ground application and this case.

A.6. I am a technical reviewer of the U.S. Army’s JPG facility. I am familiar with the hydrologic and hydrogeologic technical issues pertaining to the current site characterization. After performing my analysis of Bases “A” through “I” and related issues raised by STV, I have reached conclusions as to their validity for the JPG FSP based on my professional opinion.

Q.7. Did you review or rely on any specific documents to prepare for or conduct your analysis for your testimony?

A.7. In addition to the STV Final Contentions and Contention B-2, I have reviewed the following items during the preparation of my testimony:

(1) Field Sampling Plan -- Depleted Uranium Impact Area Site Characterization Jefferson Proving Ground, Madison, Indiana --Final, Prepared for: U.S. Department of Army, May 2005 (ML051520319);

(2) Field Sampling Plan Addenda:

(A) Field Sampling Plan Addendum 2; Depleted Uranium Impact Area Site Characterization: Soil Verification Jefferson Proving Ground, Madison, Indiana – Final, Prepared for: U.S. Department of Army, July 2006 (ML061930256) ("Addendum 2");

(B) Field Sampling Plan Addendum 3; Depleted Uranium Impact Area Site Characterization: Other Monitoring Equipment Installation, Other Monitoring (Precipitation, Cave, and Stream/Spring Gauges) and Electrical Imaging Survey Jefferson Proving Ground, Madison, Indiana – Final, Prepared for: U.S. Department of Army, July 2006 (ML061930287) ("Addendum 3");

(C) Field Sampling Plan Addendum 4; Depleted Uranium Impact Area Site Characterization: Monitoring Well Installation Jefferson Proving Ground, Madison, Indiana – Final, Prepared for: U.S. Department of Army, January 2007 (ML070220165) ("Addendum 4");

(3) Safety Evaluation Report For Issuance Of Amendment No. 13 To Material License No. SUB-1435, Department Of The Army, Jefferson Proving Ground (I am also a co-author of this document) (ML053320014);

(4) Minutes of the September 8, 2005 Public Meeting (ML052650138) ("Minutes 2005");

(5) Minutes of the October 12, 2006 Public Meeting (ML062970424);

(6) Responses To Action Items Identified At The 8 September 2005 Meeting Between The U.S. Nuclear Regulatory Commission (NRC) And U.S. Army Regarding NRC License SUB-1435, Jefferson Proving Ground (ML053120288) ("Army Responses 2005");

(7) Wilson, John T. and others. 1999. An Evaluation of Borehole Flowmeters Used to Measure Horizontal Ground-Water Flow in Limestones of Indiana, Kentucky, and Tennessee. U.S. Geological Survey Water-Resources Investigations Report 01-4139 (ML072120378) ("USGS");

(8) Responses To The Nuclear Regulatory Commission January 18, 2006, Request For Additional Information Regarding The Proposed Field Sampling Plan For Jefferson Proving Ground (License SUB-1435) (ML060590379) ("Army Responses 2006");

(9) Decommissioning Plan For License SUB-1435, Jefferson Proving Ground, Madison, Indiana, U.S. Department of Army, July 2002 (ML021930415);

(10) Environmental Report Jefferson Proving Ground, Madison, Indiana, U.S. Department of Army, July 2002 (ML021960089);

(11) Training Range Site Characterization and Risk Screening: Regional Range Study, Jefferson Proving Ground, Madison, Indiana, August 31, 2003 (ML070170078);

(12) Well Location Selection Report - Depleted Uranium Impact Area Site Characterization: Soil Verification, Surface Water Gauge Installation, Fracture Trace Analysis, and Electrical Imaging Jefferson Proving Ground, Madison, Indiana -- Final, Prepared for: U.S. Department of Army, January 2007 (ML070220461);

(13) Jefferson Proving Ground Karst Study, Ray Sheldon, 1997 (http://www.jpgbrac.com /documents/admin_record/site%20identification%20characterization/jpg%20karst%20study..pdf) ("Karst Study");

(14) Todd Eaby, SAIC Hydrogeologist, E-Mail "JPG-Well drilling Method Modification", June 1, 2007 (ML071760399) ("Eaby June E-Mail"); and

(15) Todd Eaby, SAIC Hydrogeologist, E-Mail "JPG W[e]ll Info", July 12, 2007 (ML072120379) ("Eaby July E-Mail").

Q.8. Please describe your analysis and state your conclusion for Basis "A".

A.8. Basis "A" is stated as follows:

> The EI geophysical study which will follow the fracture analysis study, as described in section 6.1 of the FSP, is supposed to find all significant karst features and location of the water table. From these studies, 10 to 20 pairs of monitoring wells are proposed to attempt to tie into "conduits" of ground water flow. This study may help to site monitoring wells, but stream gauging studies should be an early and integral part of the search for likely conduits. The stream reaches of strong gain would be a very strong direct indicator of the discharge points of ground water "conduits." EI is an indirect technique and can miss conduits or identify features that are not conduits. The FSP alludes to doing stream gauging in its discussion of well location criteria, but the time table shown indicates stream studies will follow the ground water studies by a year.

To support Basis A, STV claims that the Electrical Imaging (EI) in the modified FSP is deficient. They also state that the Army's locations of the stream gauges are not appropriate and that the timing of the stream gauging is wrong. STV states that the groundwater system should be better understood before streams gauging is started.

STV in the above Basis states "EI geophysical study which will follow the fracture analysis study, as described in section 6.1 of the FSP, is supposed to find **all significant karst features** and location of the water table." STV Final Contentions at 9 (emphasis added). This statement by STV incorrectly summarizes the FSP, which states the following: "EI conducted

across previously identified fracture traces from fracture trace analysis will be used to refine the locations of the potential preferred ground-water flow pathways and to further characterize the subsurface features." FSP at 6-1 - 6-2. It is not possible to find all of the karst features at a site. Further, it is not necessary to identify all of the karst features to have an adequate characterization of the site.

The Army recommended that the need for low-flow stream and spring cave measurements be further evaluated following the completion of the FTA. Army Responses 2005 at 2. Even though the FTA has been completed, the Staff is awaiting the results of the stream and cave reporting data to determine the need for low-flow stream and spring cave measurements.

The existing continuous stage measurements at the seven stream and two spring cave sites are yielding low and high flows as well as other flow conditions. The stream flow conditions in these creeks have produced ponds or pools with extremely low flows during dry climatic periods. However, the streams rise rapidly within a few hours after a rainfall event. The previous statements are based upon my personal observations of these streams during September 2006 and June 2007 site visits. During my site visits, I observed the two streams in the DU area and specifically noted the high stream flow in September after a rainfall event the previous day.

Only after evaluating the relationship between stream and spring cave flows, groundwater levels in the new monitoring wells, and precipitation, can the Army assess the merits of performing low-flow measurements along these creeks and the spring caves. Therefore, it would be premature to include them in the FSP because they may not be necessary.

In Basis "A", STV raised a concern about the timing of the stream gauging. The NRC Staff shared this concern in a request for additional information. Army Responses 2006 at 3-4.

The Army has resolved this issue by agreeing to move up the time table for the stream gauging to coincide with the groundwater studies where it states, "The Army has updated and accelerated the site characterization schedule for collection of cave springs, streams, and precipitation by approximately one year, and increased the time frame and frequency of related data collection activities relative to those plans presented in the 2005 Field Sampling Plan." Army Responses 2006 at 3.

Currently, the collection of cave springs, streams, and precipitation data is at least one year ahead of the collection of groundwater levels and radiological analyses of the groundwater samples from the monitoring wells installed during the spring and fall of 2007. However, the Army has not yet analyzed the streams, spring caves, and precipitation data. The Army has indicated that it will develop rating curves for the streams and cave springs after about one year of data is available. Based upon my experiences at the U.S. Geological Survey, hydrologist and hydrologic technicians usually obtain at least one year or one climatic cycle of stream flows and stage data before developing rating curves where the stream or spring cave stages are related to flow volumes or discharges (this process is referred to as developing rating curves for these streams and spring caves).

The monitoring wells will likely be properly located using the methods proposed in the FSP to provide the necessary site specific data. STV's Basis "A" does not provide any reason why the FSP would not provide the necessary data.

Q.9. Please describe your analysis and state your conclusion for Basis "B".

A.9. Basis "B" is stated as follows:

> The discussion in section 6.2.1 is disturbing in its failure to set out the chemistry of the monitoring system at this stage and its cavalier dismissal of ground water as a direct exposure route to humans due to its supposedly "poor quality." The "poor quality" that is being cited is, in part, a function of existing data being

> sampled from wells that are definitely not in "conduits" that would presumably flush frequently and carry good water. Instead, the "poor quality" data are drawn often from tight, clayey wells and wells that may well have had multiple types of contaminating material falling into them due to poor maintenance.

The quality of the existing wells criticized by STV in this Basis is accounted for in the FSP. The existing wells being referred to are of varying quality. Only higher quality wells will be selected according to the FSP in section 6.2.1, and new wells will be installed as necessary. Together, these wells will provide the necessary site specific data to characterize the water-bearing units in the DU Impact Area.

Groundwater in the DU Impact Area is unlikely to become a drinking water source for humans, and the FSP will provide data adequately characterizing the groundwater as an exposure pathway to humans. This is why I support the FSP as a viable approach to developing quality monitoring wells for the DU Impact Area to support effective decommissioning.

Q.10. Please describe your analysis and state your conclusion for Basis "C".

A.10. Basis "C" is stated as follows:

> The wells to be used for staging should not be limited *by assumption* to six wells, as proposed in section 6.2.2. Six may be enough, but it also may not be. The actual number should be a function of results achieved, not assumptions made. (It is hoped that the last sentence in this section mistakenly left an "s" off the word "well.)

The Army has proposed to use 6 monitoring well data recorders. These recorders enable the Army to monitor groundwater levels as they fluctuate with weather. Over time, the recorders could be moved to other wells if any particular well is not producing reliable data. There are actually 10 to 20 monitoring well sites proposed by the Army, each with potentially three wells. FSP at 6-4 (Note, this reference mentions pairs of wells; the third potential well comes from the possible installation of a well in the unconsolidated material).

It is difficult to determine, before some monitoring well data are collected, how many monitoring wells should be installed with data recorders. After evaluating the well recorder data along with the quarterly groundwater level data for all monitoring wells for at least two quarters, the Army will be able to make a determination regarding the need for additional recorder wells and/or well data recorders. The Army then will be able to determine appropriate actions such as adding additional well data recorders, moving the well data recorders to other wells, maintaining the well data recorder network, or discontinuing the recorder well network. However, the preliminary data are necessary to determine the best location for any additional recorder wells and/or well data recorders.

The Army's proposal in the FSP for selecting recorder wells is adequate to support effective decommissioning through site characterization.

Q.11. Please describe your analysis and state your conclusion for Basis "D".

A.11. Basis "D" is stated as follows:

> The FSP specifies in section 6.2.4 that the "conduit" wells will be paired, but does not describe or explain the reason(s) for the relative positions of the two wells at each well site. Presumably, the objective is to provide a means of measuring vertical gradients at each site, but that is not explained or discussed. Nor is there an indication of whether the "paired" well will be above or below the "conduit" well or whether that relative position would change depending upon unspecified geologic or hydrogeologic conditions.

Pairing the "conduit" wells was explained in Addendum 4. Addendum 4 at 2-5. Therefore, this basis is outdated.

The Army's response to Action Item 8 from the Public Meeting held September 8, 2005, adequately addresses the NRC request for clarification of what is meant by "conduit wells". The following paraphrases the Army's response. Army Responses 2005 at 6. The primary porosity and permeability of the limestone and dolomite bedrock appears to be low. However,

secondary porosity in some areas, fractures and joints enhanced by solution (karst development), should provide much higher permeability. Therefore, the Army proposes to locate these groundwater flow conduits and monitor their groundwater levels. The well pairs were estimated by the Army for cost and scheduling purposes to have depths of 50 and 120 feet below the land surface.

The Army's proposal for conduit wells or well pairs supports effective site characterization and decommissioning.

Q.12. Please describe your analysis and state your conclusion for Basis "E".

A.12. Basis "E" is stated as follows:

> The FSP also specifies in section 6.2.4.3 that a boring that does not produce enough water for a well will be abandoned. If lack of production occurs because the system is "tight" (i.e., impermeable), that makes some sense. However, the nature of karst terrain is such that conduits may not produce water because the flow is highly transient and, unless there is a new flow event at the time of drilling and/or testing, a well may be dry even though it has been placed in an appropriate and important location. To ensure the problem is a temporary lack of water, rather than a permanent lack of permeability, it is necessary to monitor the boring for enough time to be sure it never produces before abandoning it.

To support Basis E, STV states that the FSP contains criteria that provides for abandoning a borehole if sufficient groundwater is not available at the time of the drilling. They indicate the need to hold the borehole open until significant precipitation event occurs that may provide water for the borehole.

STV's recommendation to develop a well from a dry borehole and wait for a significant precipitation event is not practical and is not justified by the slight possibility that the borehole might eventually yield enough water to sample. It is not necessary to wait for some pre-determined time before deciding when a well would not produce water.

The Army's approach for evaluating whether to abandon a borehole due to lack of water yield is based upon reviewing the drilling response and the split-spoon samples and/or core samples for the observed permeability, that is water yield, and the occurrence of fractures, bedding planes, and/or solution-enhanced zones. This approach can yield a valid decision whether to develop a well or abandon the borehole. A final decision on the abandonment of the borehole will be based upon discussion between the Army and its contractor's project hydrogeologist, project manager, and rig geologist. Addendum 4 at 2-5.

The Army's approach to well abandonment supports effective site characterization.

Q.13. Please describe your analysis and state your conclusion for Basis "F".

A.13. Basis "F" is stated as follows:

> The FSP states in section 6.2 that all new wells to be completed will be in "conduit" settings in bedrock. This placement is too limited. Certainly, most off-site transport is likely to occur through bedrock karst features. But, the projectiles and the DU reside in the till and/or the weathered bedrock/colluvium. Simply because good, shallow wells were not completed in the original set of JPG wells does not mean that properly located and completed shallow wells are unnecessary to characterize properly the hydrogeology of the site. Such wells should be included in the FSP.

To support 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.

This basis is outdated. The Army already addressed this issue.

The NRC staff requested the Army to address Action Item 2 from the Public Meeting held September 8, 2005, which read, "the army will re-evaluate its proposal to use the same screen length for new monitoring wells and whether all wells should be screened at bedrock." Minutes 2005 at 2. In its response to this Action Item, the Army agreed to revise the FSP to address screening wells in the unconsolidated materials. Army Responses 2005 at 2. The Army made the necessary modifications to the FSP in Addendum 4. Addendum 4 at 2-5.

In the addendum for well installation, the Army plans wells in the unconsolidated material, such as, the till or the weathered bedrock/colluvium. Addendum 4 at 2-4. During the spring 2007 well installation, wells in unconsolidated materials were installed at locations 9 and 10, which I observed during my June 5 - 6, 2007 site visit. The wells were also noted in an e-mail from Todd Eaby. Eaby July E-Mail at 1. The Army has committed that, "at all sites, if sufficiently permeable saturated materials are identified in the unconsolidated deposits, the installation of a well with a screened interval in the permeable zone will be considered." Addendum 4 at p.2-5. Thus, the Army has installed monitoring wells at all well locations with adequate saturated unconsolidated materials and will consider installing more as conditions allow. With Addendum 4, the FSP provides data for adequate characterization of DU contamination in shallow groundwater.

Q.14. Please describe your analysis and state your conclusion for Basis "G".

A.14. Basis "G" is stated as follows:

> The FSP states in section 6.2.4.4 that the new wells will not be tested for permeability. Granted, if a particular well is sunk into a well-developed conduit, it will not be feasible to measure permeability. But, the nature of karst features is to be hard to locate precisely, so it is likely that at least some of the wells will simply be in bedrock with some enhanced permeability, which should be measured if it can be. Moreover, the conductivity of the rock adjacent to and feeding the conduit is a major determinant of flow through the system. The same holds true for aquifer testing. If pumping the aquifer shows interconnection among two or more of these conduit pairs, that result will provide very valuable information about the system transporting DU from the site, so it should be determined and reported when it occurs.

To support Basis G, STV states that the modified FSP is deficient by failing to characterize the hydraulic properties of the soils and rocks drilled, including the conduit zones, where wells will be completed.

This basis is outdated. The Army already addressed this issue.

The FSP addresses hydraulic conductivity, which is referred to as permeability here by STV. The Army in its response to the RAI 2 has agreed to evaluate the merits of performing aquifer testing and to discuss these issues and options with the NRC after reviewing the results from the new monitoring wells and stream and spring cave flows. Army Responses 2006 at 5. Obtaining hydraulic conductivity values may not be necessary for developing bounding conservative values for DU transport at the site. The Army has also mentioned in its response to Action Item 5 that long-term pump testing will be considered as the site conceptual model is developed. Army Responses 2005 at 5. If the Army determines that hydraulic conductivity data are necessary for the proper characterization of DU transport at the site, the Army may take additional actions such as pump testing or aquifer testing. However, it is not possible to conclude at this stage whether hydraulic conductivity testing is needed without the results from the new monitoring wells and stream and spring cave flows.

The Army's approach supports effective site characterization.

Q.15. Please describe your analysis and state your conclusion for Basis "H".

A.15. Basis "H" is stated as follows:

> Contrary to section 6.2.4.3, geophysical testing and video taping of all of the well drilling should be required in intervals where it is physically possible. The understanding obtained from cuttings, particularly air-drilled cuttings, what material has been drilled through and in which a well is being completed is extremely limited. Logging and videoing the borings as they are being drilled actually records what the boring encountered and provides much valuable information for reasonably interpreting the water data that is later collected over time. If turbidity precludes video taping of a boring, teleview logging is a valuable alternative. Where boring logs cannot safely be run, logging through the casing can and should be done.

To support Basis H, STV states that the modified FSP is deficient by failing to require geophysical logging of the boreholes or characterization of the physical properties of the cores.

The Army in its response to Action Item 5 from the public meeting held September 8, 2005, discussed its reasons for not including geophysical logging procedures and video taping in this investigation. Army Responses 2005 at 5. The NRC Staff found the reasons acceptable. The planned drilling procedures which included a steel casing that was advanced during drilling prohibited the use of most geophysical logging techniques, which require an open borehole.

The Army in its addendum for well installation and in an e-mail from Todd Eaby revised the drilling procedures described in the original FSP. Addendum 4 at 2-7, 2-8; Eaby June E-Mail at 1 - 2. The current drilling procedures include logging the borehole's lithology by the contractor's field geologist and developing a complete record of the borehole materials with split-spoon samples of the unconsolidated materials and with cores of the bedrock. The revised drilling method is split-spoon advancement through the unconsolidated materials and diamond drilling (coring) techniques in the bedrock where the casing is advanced as the core is cut. The diamond drilling was substituted for air rotary drilling discussed in the FSP for safety reasons.

With the revised drilling methods from the addendum, the Army will be able to log the boreholes without using the geophysical methods and video taping suggested by STV. In addition, there will generally be a complete sample of the bedrock and unconsolidated material. The core and split-spoon samples will provide information regarding lithology, fractures, and bedding planes for use in selecting screen intervals and interpreting water data.

The Army's drilling, sampling, and logging support effective site characterization for decommissioning. Videotaping and geophysical testing is unnecessary to the conduct of effective decommissioning.

Q.16. Please describe your analysis and state your conclusion for Basis "I".

A.16. Basis "I" is stated as follows:

> Specifying the exact number and precise locations of the surface

> water sampling and gauging points at the outset of FSP implementation, as proposed in section 6.4.1, is not acceptable practice. Until the analysis of ground water data shows where to look for discharges and the discharges confirmed by inspection, such points cannot be reasonably selected. There is no scientific reason why the locations for surface water sampling and sediment sampling need to be the same locations. Each medium should be sampled at locations that are appropriate for that medium. Sediment buildup has nothing to do with the location of base flow connections between ground and surface water. Similarly, the FSP concept in section 6.4.2 of installing only five gauging stations which are all sited before the ground water system is better understood, is both too limited in the number and may well be counter productive in the locations of the stations.

To support Basis I, STV states that the modified FSP is deficient by specifying the precise locations of surface water sampling and gauging points. They are also opposed to co-locating surface water and sediment sampling sites.

STV's statement in this Basis that the Army has specified the "precise locations of the surface water sampling and gauging points at the outset of FSP implementation" is incorrect.

The Army has only discussed general locations of the 14 sampling sites for Big Creek, Middle Fork Creek, and the spring caves. FSP 6.4.1 at 6-29. The Army states that the "the final surface water sampling locations will be documented in an addendum to this FSP." FSP 6.4.1 at 6-29. Although the Army did not specify the exact location of the stream and spring cave gauging sites, there are a limited number of acceptable sites for installation of stream and spring cave gauging sites within the DU Impact Area.

Co-locating the stream and spring cave gauging sites with the surface water and sediment sampling sites, as proposed by the Army, has merit. This approach provides stream and cave flow volumes at the surface water and sediment sites. Therefore, potential DU concentrations in the surface water and sediments can be compared against different flow volumes.

The Army's Addendum 3 includes information on the plans to install seven gauges and three spring cave gauges. Addendum 3 at 2-1. Only two of the proposed three spring cave gauges were installed because the third spring cave was dry.

STV is concerned about installing the stream and spring cave gauges before the groundwater system is better understood. I disagree because stream gauges have priority. The FSP was modified so that enough stream gauging information will be collected to develop rating curves for the stream and spring cave sites as I have discussed in my response to Basis "A" above. The goal for this work is to have the stream and spring cave gauges functional for providing water volume values when water samples are collected from the monitoring wells, streams, and spring caves. The above adjustments were made in the original FSP to enhance the site characterization.

Q.17. Can you form an overall conclusion as to Bases "A" through "I"?

A.17. Yes, the purpose of the FSP is to provide additional characterization of the DU Impact Area. The objectives of the site characterization are to enhance the understanding of the nature and extent of contamination and transport, define and verify the conceptual site model, and provide the basis for developing a Decommissioning Plan within 5 years. Based upon the FSP and the performance of the field work listed in the FSP, the characterization of this site should be significantly enhanced by this work. The FSP is an iterative process where the following items have been and/or will be added to the FSP:

Army's responses to the Action Items from the Public Meetings;
Army's responses to the RAI on the original FSP; and
Addenda to the FSP.

Based on my experience and education and as supported by my analysis above, I can conclude that the STV discussion in these bases includes inaccurate factual statements and outdated statements that have not reflected modifications in the FSP.

More importantly, STV has not adequately supported its position that the FSP is not properly designed. The FSP will fulfill its purpose and provide bounding and/or conservative values for adequate site characterization of DU leading to an adequate Decommissioning Plan. Furthermore, the Contention Bases discussed above are frequently both outdated with respect to the FSP as amended and insignificant with respect to providing bounding or conservative values for site characterization.

<u>Rebuttal to STV's Prefiled Testimony of Mr. Norris</u>

Q.18. Have you read the pre-filed testimony of Mr. Norris and analyzed any of the issues he discussed?

A.18. Yes, Mr. Norris raises some issues in his testimony which I analyzed including: FTA and EI; karst development; the fate and transport of DU in water and sediments; gauging of streams and spring caves; well location and selection; well installation; and monitoring well selection. Some of Mr. Norris' testimony relates to the Bases raised by STV, which I have discussed above and do not need to repeat.

Q.19. Please provide your analysis of the points raised by Mr. Norris regarding Fracture Trace Analysis and Electrical Imaging.

A.19. Mr. Norris is critical of the Army's FTA, particularly the use of only historical aerial photographs to develop the FTA. Although a variety of satellite images may be used in FTA, the use of historical aerial photographs with field evaluations is a viable method for delineating linear traces on the land surface at this site. While Mr. Norris suggests that other methods be used, the methods he proposes have limitations in their usefulness. For example, Mr. Norris' suggestion that ground penetrating radar could be used at this site is questionable. Norris Testimony at 13. Ground penetrating radar normally travels only a few feet into clay, particularly wet clay. The glacial till at JPG contains large amounts of clay, and the till is several feet thick on the land surface. Therefore, ground penetrating radar would not be a good choice for

performing the FTA. While each method has its strengths, FTA combined with EI are likely adequate to provide the necessary information, and Mr. Norris does not provide a basis to justify the use of an alternate method.

Furthermore, Mr. Norris has overstated the importance of the FTA in the location of the monitoring well selection. If the data are insufficient, the Army may have to make modifications in the selection procedures where needed**.** Mr. Norris' statement, "there are karst networks that have developed independently of fractures or whose fractures are too deep to reach the present day surface or are dipping rather than vertical" does not match existing site observations of the relatively shallow nature of the karst system within the upper bedrock. Norris Testimony at 15. However, the flexibility of the FSP allows for evaluating potential well sites based on other information in addition to the FTA.

The EI survey proposed in the FSP is capable of providing useful data for siting wells and supporting effective decommissioning. While an EI survey developed in a grid as described by Mr. Norris (Norris Testimony at 18) would provide a greater characterization of resistivity, it is unnecessary. The Army's proposal is sufficient. The grid STV desired involved performing an EI survey off road. The Army's actual EI patterns and instrumentation were limited to the existing roads because of the risk of unexploded ordnance in the areas off of the roads. However, this limitation does not affect adequate site characterization.

The Army has installed wells at six of the ten locations during May and June 2007. The location and installation of monitoring wells has been designed as a potentially phased approach where the Army may install additional monitoring wells based upon the results of on-going or previous characterization of the site. In this way, the FSP allows well locations to continue to improve throughout the FSP implementation process as the understanding of groundwater characteristics improves with additional data.

Q.20. Please provide your analysis of the points raised by Mr. Norris regarding

karst development.

A.20. I disagree with some of Mr. Norris' testimony pertaining to the development and extent of the karst features in the DU Impact Area. Mr. Norris' statement that "[t]he longer the conditions for karst development persist, the larger and more integrated the karst features become …" is not always correct. Norris Testimony at 5 - 6. For the karst system to develop over multiple depths, the groundwater must have a geochemistry that will dissolve the carbonate materials that it flows through, and the base level for the groundwater discharge must continue to change, usually dropping, so that deeper carbonate rocks are dissolved. Mr. Norris implies in his testimony that the Ordovician and Silurian carbonate bedrock at JPG may have developed multiple karst networks because it is over 400 million years old. Norris Testimony at 6. Karst systems develop under conditions which are independent of the age of the rock units.

As previously stated, Mr. Norris' assertion that "there are karst networks that have developed independently of fractures or whose fractures are too deep to reach the present day surface or are dipping rather than vertical" does not match existing site observations of the relatively shallow nature of the karst system within the upper bedrock. Norris Testimony at 15.

Big Creek and Middle Fork Creek are the base levels for the karst system which have developed in the upper carbonate bedrock within the DU Impact Area. The karst system (that is, the caves and springs) at this site has discharge points and in some cases for a limited time period, inflow points above the current Big Creek and Middle Fork Creek stream beds. A review of the cave study at this site indicates that there are no lower cave segments below the upper carbonate bedrock. Karst Study at 43 - 44. This karst system lies approximately 5 to 10 feet above the creek beds. There do not appear to be any major karst features below the upper carbonate bedrock. This does not preclude fractures in the bedrock that the creek beds lie upon, which would allow stream flow or groundwater to flow between each other. Therefore, I believe that many of Mr. Norris' statements pertaining to the karst system at the DU Impact Area

are not representative of actual site conditions. See "Attachment B" which is a diagram depicting a schematic cross section through Big Creek Valley within the DU Impact Area. This diagram provides a general representation of the relationship of the primary karst system, the caves, and Big Creek.

Based on these conditions and my personal observation, Mr. Norris' arguments concerning the karst system do not demonstrate a deficiency in the FSP.

Q.21. Please provide your analysis of the points raised by Mr. Norris regarding the fate and transport of DU in water and sediments.

A.21. Mr. Norris made several comments throughout his testimony regarding the fate and transport of DU in water and sediments at the DU Impact Area that I believe are misleading. I discuss the significant comments in my following testimony.

In his Answer 19, Mr. Norris provides a substantial list of information that he claims are required to meet the needs of meaningful fate and transport. I disagree. His list includes unnecessary information. For example, he asserts that temporal variability must be measured along each groundwater path. Norris Testimony at 19. That is unnecessary. Instead, the fate and transport model of the DU can be bounding and/or conservative for the conditions at the site to produce an adequate site characterization that will then allow development of an adequate dose model and decommissioning plan.

Many of Mr. Norris' comments or recommendations amount to wanting site-specific data. But these are not required to develop an adequate fate and transport model of the DU at this site. There are several parameters in the dose assessment model where site-specific values can be used, but as a dose modeler, I know 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.

Contrary to Mr. Norris' testimony in Answer 17 regarding the three mechanisms of DU

transport, entrained sediment transport does not occur in unsaturated flow because of the low water velocities. Entrained sediment transport occurs in some surface water flow and groundwater flow usually within karst systems where the flow velocities exceed a critical value. Also, entrained sediment transport will not occur in groundwater porous media flows because the flow velocities are too low.

Overall Mr. Norris' testimony pertaining to the fate and transport of DU in water and sediments does not reveal any deficiencies in the Army's FSP.

Q.22. Please provide your analysis of the points raised by Mr. Norris regarding gauging of streams and spring caves.

A.22. Some of Mr. Norris's testimony in his section on the gauging of streams and spring caves is confusing and incorrect.

First, Mr. Norris's Figure 1 is a confusing schematic representing a hypothetical site. His figure shows two streams, while in fact, there is only one stream system being impacted by the karst system in the DU Impact Area. Norris Testimony at 30. Furthermore, the streams are not labeled, and it is unclear if the middle feature is a well, a karst feature, or something else. It is also unclear if the figure is in plain view or is a cross section.

Second, Mr. Norris feels that locating the stream gauging stations at bridges and culverts under roads is inappropriate. I feel these are correct locations. This is common practice in locating stream gauges by the U.S. Geological Survey. These locations provide some additional protection for the gauges from ice and tree trunk jams that occur in the winter and for the Army's contractors from unexploded ordnance during their monthly service of the equipment and measurement of stream discharge.

Q.23. Please provide your analysis of the points raised by Mr. Norris regarding well location and selection.

A.23. The Army's well location and selection procedures, which have been based upon locating wells utilizing results of the FTA and EI programs will be improved for future well location and selection procedures using information from the existing wells.

Mr. Norris may have over-emphasized the importance of conduit wells that monitor the groundwater in the karst features. Instead, the emphasis should be placed on monitoring non-conduit wells, that is, wells screened in non-karst features. These wells provide information on the potential movement of DU in the groundwater within the unconsolidated, upper carbonate bedrock, and lower carbonate bedrock water-bearing units. If DU has not reached these units, then the impact of potential DU transport in the karst features and the streams will be decreased. Also, the potential DU transport in the karst features can be monitored by sampling the DU in groundwater carried by the springs in the caves and fractures along the creek valleys.

Mr. Norris stated that the Army selected ten monitoring well locations for drilling instead of twenty locations (the upper level mentioned in the FSP) for budgeting purposes. Norris Testimony at 32. This statement demonstrates his apparent lack of understanding that the FSP was designed to allow for phased characterization of this site, that is, install monitoring wells, evaluate the results, and decide whether additional wells should be installed. Thus, it would not be prudent to use 20 well locations during the first phase of drilling. The Army has not indicated that only 10 well locations will be used. The FSP has been designed to allow flexibility in planning well locations. Therefore, selection of monitoring well locations, even those scheduled for installation later this fall may be modified based upon the examination of the existing and new data.

Q.24. Please provide your analysis of the points raised by Mr. Norris regarding well installation.

A.24. Mr. Norris discusses what he considers are deficiencies in the Army's well installation procedures specifically including permeability. Norris Testimony at 44 – 52. However, I believe these deficiencies are either insignificant or the Army has valid reasons why they chose alternative methods for their well installation than those suggested by Mr. Norris.

Mr. Norris feels that advancing the casing when the bedrock borehole is drilled should not be done because useful geophysical logs can not be performed through the metal casing. However, the Army decided to advance the casing as they drill through the bedrock because of potential lost of circulation fluids if they drill through a conduit. The Army's revised drilling and sampling procedures allows for collecting continuous samples of the borehole materials with split-spoon samples of the upper unconsolidated materials and with cores of the bedrock. Addendum 4 at 2-7, 2-8, Eaby June E-Mail 1 - 2. The continuous samples permit visual examination of the samples and the option to perform other physical tests on these samples.

Additional information of the permeability of wells screened in the carbonate bedrock is available from investigations performed at JPG south of the firing line, which is about 2 miles south of the southern boundary of the DU Impact Area. For example, the U.S. Geological Survey has performed flowmeter tests on three uncased boreholes about 2 to 3 miles to the south of the DU Impact Area. USGS at 26 - 30. The stratigraphy in this area is similar to that observed in the DU Impact Area. The flowmeter tests for these three boreholes indicate that the upper carbonate bedrock is much more permeable than the lower carbonate bedrock. Results from these boreholes are transferable to the bedrock in the DU Impact Area.

Q.25. Please provide your analysis of the points raised by Mr. Norris regarding selecting monitoring wells for the characterization study of this site.

A.25. Mr. Norris is concerned about the Army's statement that it will use only

groundwater levels from one sampling event of the new monitoring wells, the Range Study monitoring wells, and the ERM monitoring wells to decide which wells will be monitored during the characterization of this site. Norris Testimony at 47. Mr. Norris mischaracterizes the FSP Addendum 4 where it describes which wells will be monitored. Addendum 4 at 4-3. Items other than one water-level sampling event will be used in selecting which monitoring wells will be used. For example, the logs of the wells, screened intervals, well locations, and other items will likely be used. If the groundwater levels are significantly impacted by climatic conditions, additional water levels will be needed before the monitoring wells can be selected. The FSP will be able to handle the selection of which monitoring wells should be used to characterize groundwater in the DU Impact Area.

Q.26. Can you provide an overall conclusion to Mr. Norris' Testimony?

A.26. Yes, while many of the issues raised by Mr. Norris were included within the Bases used by STV to support its Contention B-1 and were therefore discussed in my testimony above, none of the new issued raised by Mr. Norris in his testimony provide a justification why the FSP is not adequate. Much of Mr. Norris' testimony questions how the sampling will occur at JPG without waiting to see how the preliminary data will affect future decisions such as monitoring well siting. As such, Mr. Norris' testimony does not demonstrate that the FSP is not adequate to support the approval of the alternate schedule.

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)	)	

PREFILED TESTIMONY OF JON PECKENPAUGH

I, Jon Peckenpaugh, do declare under penalty of perjury that my statements in the foregoing testimony and my attached statement of professional qualifications are true and correct to the best of my knowledge and belief.

/Original Signed By/
____
Jon Peckenpaugh

Executed at Rockville, MD
This 17th day of August, 2007.

Attachment A

Jon M. Peckenpaugh
Systems Performance Analyst
Office of Federal and State Materials and
Environmental Management Programs
U.S. Nuclear Regulatory Commission

Work Experience

Systems Performance Analyst, U.S. Nuclear Regulatory Commission, Rockville, MD, 2001 – Present

- Performed technical reviews of ground water and surface water issues at twelve complex nuclear fuel processing facilities and seven commercial nuclear reactors undergoing decommissioning.
- Performed radiological risk assessments at seven sites (including former radioactive burial sites, nuclear fuel processing facilities, and a mill tailing site).
- Evaluated ground-water flow and transport models at four hydrogeologic complex sites.
- Evaluated ground water and surface water compliance monitoring at decommissioning sites.
- Performed project management and contract management duties on multiple sites.
- Presented ACNW, NRC Counterparts, and public meeting presentations.
- Compiled and edited responses to the External Peer Review of NRC's Total System Performance Assessment Code 3.2 (Final and draft CNWRA publications).

Environmental Scientist, U.S. Nuclear Regulatory Commission, Rockville, MD, 1999 – 2001

- Performed project management and contract management duties.
- Performed technical reviews of nuclear material, ground water, and surface water issues at multiple sites.
- Developed technical bases and methodology for estimating the potential impacts from soil reuse of soil originating from NRC-licensed facilities.

Environmental Scientist, U.S. Environmental Protection Agency, Washington, DC, 1997 – 1999

- Performed reviews and evaluations of pesticide literature and registrant data for registration of new pesticides, re-registration of pesticides, and special uses of registered pesticides.
- Developed and ran vadose, ground water, and surface water models to evaluate the fate and transport of pesticides in the soils, groundwater, surface water, and air.

- Evaluated and/or designed monitoring programs for pesticide residues in the ground water and surface water.
- Technical contract manager for ground water and surface water pesticide residues database.

Project Manager/Hydrogeologist, EA Engineering, Science, and Technology, Inc., Sparks, MD, 1993 – 1997

- Provided technical (hydrogeological) reviews and project management support on several remedial investigations/feasibility studies and remedial design studies (prepared 15 reports/publications).
- Performed hydrogeological investigations and developed ground-water flow and contaminant transport models (developed 12 ground-water flow or transport models).
- Compiled and analyzed hydrogeologic, hydrologic, and water use data.
- Developed project proposals and ground-water marketing strategy.

Hydrologist, U.S. Geological Survey, Water Resources Division, Lincoln, NE, 1978 – 1993

- Developed and calibrated three multi-county, river basin-based ground-water flow models that simulated water levels and streamflows.
- Compiled and developed hydrogeologic, water use, climatic, soil, and land-use data.
- Collected surface water and ground-water samples and evaluated their water quality with respect to hydrogeologic conditions and pollutant sources.
- Planned, supervised, performed and analyzed mass water level measurements and aquifer tests.
- Utilized GIS in the development and display of hydrogeologic, water use, and other data.
- Evaluated surface and ground-water resources for three Indian reservations. Used GIS to evaluate and display the water resources.
- Wrote six interpretive hydrogeologic reports and one report that was a documentation of a finite-element ground-water flow model and the water-use support programs for that model.
- Developed computer programs that used geologic lithologies from test holes and well logs to calculate hydraulic conductivity and specific yield values for the aquifer.
- Developed potential evapotranspiration, water flow through root and vadose zones, and ground-water pumpage data that were used to generate water-use parameters.
- Generated ground-water recharge parameters for two regional water use studies.
- Evaluated the water quality of Nebraska streams in the Kansas River basin NAWQA study.

Water Resources Planner, Nebraska Natural Resources Commission, Lincoln, NE, 1973 – 1978

- Developed and calibrated two ground-water flow models that simulated water levels and streamflows.
- Compiled and developed hydrogeologic and water-use data.
- Prepared and reviewed reports concerning the water resources projects that impacted the State Water Plan.

Research

- Numerical modeling: developing and running ground-water flow and transport models.
- Soil-water procedures: developing and running programs that compute potential evapotranspiration (PET), runoff, recharge, and consumptive irrigation requirements based upon soil, climatic, and land-use parameters.
- Management modeling: developing and running linear and nonlinear ground-water optimization models.

Education

University of Nebraska, Major: Geology (54 semester hours of graduate courses)

Iowa State University, Major: Water Resources, M.S., 1973

Iowa State University, Major: Geology, Minor: Mathematics and Chemistry, B.S., With Distinction, 1970

Professional Qualifications

Professional Geologist, State of Virginia, 2801 001001

Professional Geologist, State of Pennsylvania, PG-002838-G

Professional Membership

American Geophysical Union (Hydrology Section)

International Association of Hydrogeologists

National Groundwater Association

Publications

A listing of a few of my reports/publications includes the following:

Dugan, J.T., and Peckenpaugh, J.M. 1985. Effects of climate, vegetation, and soils on consumptive water use and ground-water recharge to the Central Midwest Regional Aquifer System, mid-continent United States. Water-Resources Investigations Report 85-4236. U.S. Geological Survey, Lincoln, NE

Cady, R., and Peckenpaugh, J. 1985. *Documentation of RAQSIM--A regional aquifer simulation model and its use in the Twin Platte-Middle Republican study area, Nebraska.* Water-Resources Investigations Report 85-4168. U.S. Geological Survey.

Peckenpaugh, J.M. 1991. *Geographical Information Systems and Groundwater Modeling.* Presented at the Midwest Ground-Water Conference, Lincoln, NE. October 22-24.

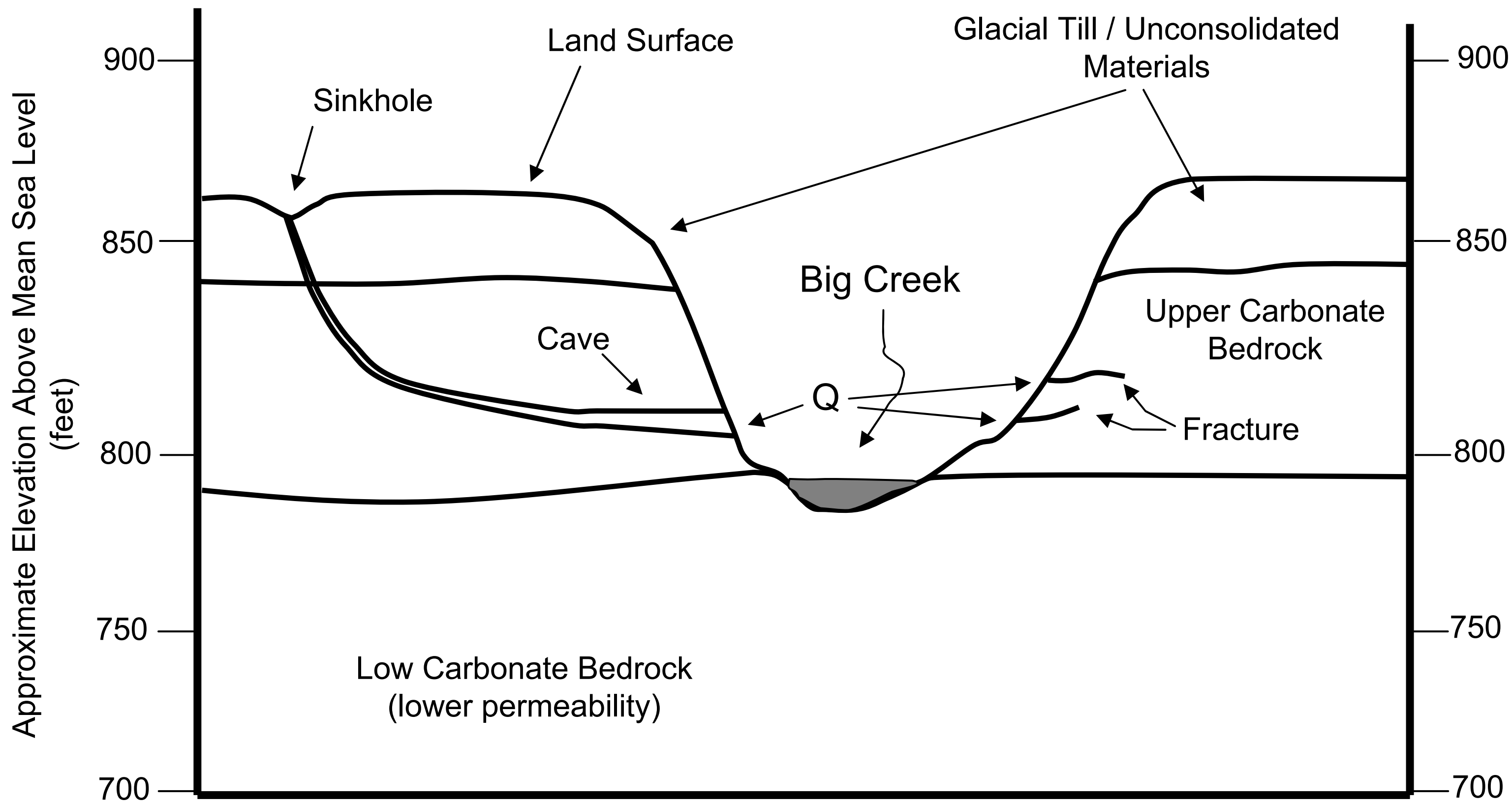
Five authors. 1992. *Hydrogeology of parts of the Twin Platte and Middle Republican Natural Resources Districts, Nebraska.* Conservation and Survey Division of University of Nebraska Water Supply Paper No. 70.

Peckenpaugh, J.M., Kern, R.A., Dugan, J.T., and Kilpatrick, J.M. 1995. Simulated Response of the High Plains Aquifer to Ground-Water Withdrawals in the Upper Republican Natural Resources District, Nebraska. Water-Resources Investigations Report 95-4014. U.S. Geological Survey, Lincoln, NE.

Several authors. 2000. *Human Interaction with Reused Soil: A Literature Search*, NRC draft NUREG-1725.

Co-editor. 2003. *Response To The External Peer Review Of The Total System Performance Assessment Version 3.2 Code.* CNWRA 2001-02 Rev 1.

Attachment B



*Q represents a discharge point from a spring cave or spring at a fracture.

Figure 1. Schematic Cross Section Through Big Creek Valley Within DU Impact Area Near Cave BC-12.