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January 7, 2005

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In the Matter of
LOUISIANA ENERGY SERVICES, L.P.
(National Enrichment Facility)
Docket No. 70-3103-ML

Dear Administrative Judges:

Enclosed for filing in the above-referenced docket is the prefiled direct testimony of Louisiana Energy Services, L.P. ("LES") on NIRS/PC Contention EC-1. Hard copies have also been placed in U.S. First Class mail to the parties.

Yours sincerely,

James R. Curtiss

Enclosures
cc: See enclosed Certificate of Service

Template=SECY-055

SECY-02

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
	)	Docket No. 70-3103-ML
Louisiana Energy Services, L.P.	)	
	)	ASLBP No. 04-826-01-ML
(National Enrichment Facility)	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of the "PREFILED TESTIMONY OF GEORGE A. HARPER AND ROGER L. PEERY ON BEHALF OF LOUISIANA ENERGY SERVICES, L.P. CONCERNING NIRS/PC EC-1 ("IMPACTS UPON GROUND AND SURFACE WATER")," in the captioned proceeding have been served on the following by e-mail service, designated by **, on January 7, 2005 as shown below. Additional service has been made by deposit in the United States mail, first class, this 7th day of January 2005.

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January 7, 2005

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
	)	Docket No. 70-3103-ML
Louisiana Energy Services, L.P.	)	
	)	ASLBP No. 04-826-01-ML
(National Enrichment Facility)	)	

PREFILED TESTIMONY OF GEORGE A. HARPER AND ROGER L. PEERY ON BEHALF OF LOUISIANA ENERGY SERVICES, L.P. CONCERNING CONTENTION NIRS/PC EC-1 ("IMPACTS UPON GROUND AND SURFACE WATER")

I. WITNESS BACKGROUND

A. George A. Harper ("GAH")

Q1. Please state your name, occupation, and by whom you are employed.

A1. (GAH) My name is George A. Harper. I am employed as the Manager of Regulatory Compliance Programs at Framatome ANP ("FANP") in Marlborough, Massachusetts.

Q2. Please describe your current responsibilities.

A2. (GAH) As Manager of Regulatory Compliance Programs at FANP, I manage over 50 scientists, engineers, and technicians in the Regulatory Compliance Programs Department. This department provides an array of services, including, for example, services related to: health and safety, environmental science and engineering, health physics, radiation protection, quality assurance, and laboratory radiological analyses. In this capacity, I both perform and oversee various environmental analyses and safety evaluations in support of nuclear facility design, licensing, and operations.

Q3. Please summarize your educational and professional qualifications.

A3. (GAH) I hold B.S. and M.S. degrees in Civil Engineering from the University of Massachusetts. In addition to earning those degrees, I have completed numerous technical training courses on a variety of engineering and hydrology-related topics. Also, I am a Registered Professional Engineer in Massachusetts, New Hampshire, and Maine, as well as a member of the American Society of Civil Engineers. I have over 25 years of experience in engineering, environmental, licensing, and regulatory compliance matters, many of which have involved nuclear facilities. This experience includes analyzing environmental, hydrologic, hydraulic, seismic, geotechnical, groundwater, tornado and tornado missile, and probabilistic risk assessment issues relating to nuclear facilities. A more detailed account of my education, training, and experience, including a discussion of representative projects, is set forth the statement of my professional qualifications attached hereto.

Q4. Are you familiar with the proposed National Enrichment Facility ("NEF") and the operations that will take place there?

A4. (GAH) Yes.

Q5. What is the basis of your familiarity with the NEF?

A5. (GAH) Louisiana Energy Services, L.P. ("LES"), applicant in this matter, contracted FANP to assist it in the preparation of the NEF license application, including the NEF Environmental Report. As the manager of Regulatory Compliance Programs, I managed a team of FANP employees involved in preparing the NEF Environmental Report. I also prepared specific portions of the Environmental Report and the Safety Analysis Report, and participated in the preparation of the Integrated Safety Analysis. Finally, I managed and contributed to the preparation of required state permit applications, including LES's New Mexico Groundwater

Discharge Permit. As such, I am familiar with the portions of LES's license application, as well as other permit applications, relating to the NEF's potential impacts on water resources.

Q6. What is the purpose of your testimony?

A6. (GAH) As stated above, my testimony relates generally to the potential impacts of the NEF on ground and surface water. This issue is the subject of Contention NIRS/PC EC-1 ("Impacts on Ground and Surface Water"). The principal purpose of my testimony, therefore, is to respond to specific claims made by NIRS/PC relative to the potential impacts of the NEF on ground and surface water. In doing so, I will focus on issues relating to the management of facility effluents and site runoff, the general design and operation of the NEF site engineered basins and systems that will be installed to contain contaminated and potentially contaminated effluent and runoff, non-NRC authorizations that relate to the protection of ground water at the site, and certain aspects of NEF site hydrology and hydrogeology.

B. **Roger L. Peery ("RLP")**

Q7. Please state your name, occupation, and by whom you are employed.

A7. (RLP) My name is Roger L. Peery. I am employed as the Chief Executive Officer and a Senior Hydrogeologist at John Shomaker & Associates, Inc. in Albuquerque, New Mexico.

Q8. Please describe your current responsibilities.

A8. (RLP) As a Senior Hydrogeologist at John Shomaker & Associates, Inc., I am responsible for managing projects involving a variety of hydrogeological and water-resources evaluations. As CEO, I also am involved in the business operations of the company.

Q9. Please summarize your educational and professional qualifications.

A9. (RLP) I hold a B.S. in Geology and an M.S. in Water Resources from the University of New Mexico. In addition to those degree programs, I have completed numerous technical training courses in the areas of hydrology, hydrogeology, and groundwater remediation. Further, I am a registered Professional Geologist in Wyoming and Texas (New Mexico does not register geologists), and a member of the American Institute of Professional Geologists. I have over 15 years of work experience as a hydrogeologist. For example, I managed the investigation and remediation of sites containing groundwater contaminated by leaking underground-storage tanks; performed groundwater flow modeling, aquifer test pumping and interpretation of test data, and evaluations of ground water in storage; evaluated and developed water resources within the State of New Mexico; and sited and supervised the installation of numerous water wells and monitoring wells, including wells exceeding depths of 3,000 feet. I also have provided expert testimony on water resources issues on numerous occasions before various commissions and committees within the State of New Mexico, including the New Mexico Office of the State Engineer hearing examiners. A detailed statement of my professional qualifications is attached hereto.

Q10. Are you familiar with the proposed National Enrichment Facility ("NEF") and the operations that will take place there?

A10. (RLP) Yes.

Q11. What is the basis of your familiarity with the NEF?

A11. (RLP) I was hired by LES as an expert witness on hydrogeological and water resources issues in this proceeding. In this capacity, I have carefully reviewed relevant portions of NEF license application (including the NEF Environmental Report), the NRC Staff's draft environmental impact statement ("DEIS"), and extensive supporting materials, such as

hydrogeologic investigations of the NEF site and other sites in vicinity of NEF and relevant scientific literature. In view of this knowledge, and my training and experience in hydrogeological and water-resources issues, I am prepared to testify regarding the potential impacts of the NEF on ground and surface water.

Q12. What is the purpose of your testimony?

A12. (RLP) As stated above, my testimony relates generally to the potential impacts of the NEF on ground and surface water. This issue is the subject of Contention NIRS/PC EC-1 ("Impacts on Ground and Surface Water"). The principal purpose of my testimony, therefore, is to respond to specific claims made by NIRS/PC relative to the potential impacts of the NEF on ground and surface water. In doing so, I will focus on issues relating to NEF site geology and hydrogeology, including the underlying lithology; to describe the collection and/or interpretation of hydrogeological data relevant to the NEF site; and to discuss postulated groundwater flow conditions beneath the NEF site, including the fate of liquids collected in the facility's engineered basins and the postulated transport of liquids collected by the facility septic systems.

II. REGULATORY BACKGROUND – APPLICABLE NRC REQUIREMENTS

Q13. Please describe the NRC regulatory requirements, and any related NRC guidance, applicable to the assessment of potential impacts of a proposed facility on water resources under the National Environmental Policy Act ("NEPA").

A13. (GAH) To implement and ensure compliance with the requirements of NEPA, the NRC has issued 10 C.F.R. Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions." Pursuant to 10 C.F.R. § 51.45, an applicant for an NRC license must prepare an environmental report. That report must contain, among other things, a description of the proposed action, a statement of its purposes, a description of the environment affected, and discussion of a number of specified environmental considerations, including, among others, a discussion of the impact of the proposed action on the environment. The applicant's environmental report provides the basis for the NRC Staff's environmental impact statement concerning the proposed action.

To assist materials license applicants such as LES in the preparation of their environmental reports, the NRC Staff has issued NUREG-1748, "Environmental Review Guidance for Licensing Actions Associated with NMSS Programs – Final Report" (August 2003). That document states that the environmental report "present a detailed and thorough description of each affected resource for evaluation of potential impacts to the environment." The two affected resources relevant to this testimony and Contention NIRS/PC EC-1 are "geology and soils" and "water resources." With respect to the former, Section 6.3.3 of NUREG-1748 states that the applicant should identify the "geological, seismological, and geotechnical characteristics of the site and vicinity." This includes information regarding stratigraphy and structures, such as descriptions of geological units, major structural and tectonic

features, and any other significant geological conditions, and soil characteristics. With respect to the latter, Section 6.3.4 of NUREG-1748 states that an applicant should describe site-specific and regional data on the physical and hydrological characteristics of ground and surface water in sufficient detail to provide the basic data for the evaluation of impacts on water bodies, aquifers, and aquatic ecosystems. Section 6.4.4, in turn, provides that an applicant should evaluate impacts on water use and water quality and identify the potential impacts for both radiological and non-radiological effluents, including impacts on the physical, chemical, and biological water-quality characteristics of ground and surface water. Sections 6.3.4 and Section 6.4.4 provide very detailed lists of the specific types of information and evaluations sought by the NRC Staff in an applicant's environmental report.

Q14. In your view, has LES complied with these requirements and related guidance?

A14. (GAH) Yes.

Q15 Please state the basis for this conclusion.

A15. The NEF Environmental Report provides detailed information concerning water resources at the site and potential impacts on those resources. This information coincides closely with the specific types of data and evaluations sought by the NRC Staff in NUREG-1748. To the extent the NRC Staff requested additional information on the subject of water resources through the "RAI" process, LES provided this information and revised the NEF Environmental Report, to reflect that information, as appropriate.

In summary, Section 3.3 of the NEF Environmental Report describes the regional and local geology as well soil characteristics. Section 3.4 of the Environmental Report describes site surface and groundwater resources, including, among other things, surface hydrology, water quality, pre-existing environmental conditions, water rights and resources, potential contaminant

sources, and groundwater characteristics. Section 4.4 of the NEF Environmental Report discusses potential impacts of the facility construction and operation on water resources. This section addresses, among other things, applicable federal and state permits; receiving waters; potential impacts on groundwater quality; potential impacts on hydrological systems (though no surface water is present at the NEF site); and site-specific structures, systems, and measures to preclude contamination of water resources. Section 6.1 of the NEF Environmental Report describes in detail LES's proposed radiological monitoring program (effluent and environmental monitoring), and Section 6.2 sets forth LES's proposed physiochemical monitoring program (which provides for monitoring of non-radiological facility effluents, stormwater, environmental media (e.g., soil and vegetation), meteorological conditions) (*see* LES Exhibits 1 and 2).

Q16. In your expert opinion, does the NEF Environmental Report contain a complete and adequate assessment of the potential environmental impacts of the proposed NEF on surface and ground water?

A16. (GAH) Yes.

Q17. Please provide the basis for this conclusion.

A17. In providing the data and evaluations sought by the NRC Staff, LES has, in fact, performed a complete and adequate assessment of the potential environmental impacts of the proposed NEF on site surface and ground water. In short, the potential for adverse impacts on water resources at the NEF site is very low in view of: (1) highly favorable site hydrological and hydrogeological conditions; (2) LES's obligation to control levels of contaminants in facility effluents; (3) LES's commitment to discharge process effluents and sanitary wastewater only to engineered basins and leach fields, respectively, and to collect site runoff in retention/detention

basins; and (4) LES's commitment to implement adequate environmental monitoring and measurements programs to detect any releases to the environment.

III. SITE CHARACTERIZATION EFFORTS

Q18. Please explain how LES characterized and evaluated geological and hydrogeological conditions at the NEF site.

A18. (GAH, RLP) The geology and hydrogeology of the site vicinity are well understood as a result of prior site investigations and studies performed at sites in proximity to the proposed NEF site. In particular, the Waste Control Specialists ("WCS") site in Texas approximately 0.5 mile from the NEF site boundary, the Lea County Municipal Landfill site located immediately south of State Highway 234 near the southeast corner of the proposed NEF site, and the formerly proposed Atomic Vapor Laser Isotope Separation ("AVLIS") site adjacent to the NEF site have all been thoroughly studied in recent years in preparation for construction of other these existing/proposed facilities.

The WCS facility, which is a Resource Conservation and Recovery Act-permitted facility that disposes of hazardous material by land burial, is located east/northeast of the proposed NEF site, just across the state line in Texas. WCS has performed numerous subsurface investigations for the purpose of delineating and monitoring site subsurface hydrogeologic conditions. The proposed AVLIS facility was to be located on Section 33, on a site abutting the NEF site to the east. Information from these sites is pertinent to the NEF site given their proximity to the site.

A review of the documents and related materials associated with the WCS, Lea County Municipal Landfill, and AVLIS sites provided LES with an in-depth understanding of geological and hydrogeological conditions associated with the NEF site. *See*, e.g., *Atomic Vapor Laser Isotope Separation (AVLIS), New Mexico, Technical Appendices*, submitted by the State of New

Mexico and Waste Control Specialists, LLC; *Geology of the WCS-Flying W Ranch, Andrews County, Texas*, Prepared for Andrews Industrial Foundation, Texas Tech University Water Resources Center (Apr. 2000); Waste Control Specialists, *Section VI, Geology Report*, prepared for Waste Control Specialists, prepared by Cook-Joyce, Inc., and Intera, Inc. (Feb. 2004) ((in Attachment 6 to Exhibit 3). In addition, LES performed additional field investigations at the NEF site and site vicinity to supplement, where necessary, information about regional or site-specific conditions (*see Hydrogeologic Investigation, Section 32; Township 21 Range 38, Eunice, New Mexico,* Cook-Joyce, Inc. (Nov. 19, 2003); *Report of Preliminary Subsurface Exploration, Proposed National Enrichment Facility, Lea County, New Mexico,* MACTEC Engineering and Consulting, Inc. (Oct. 17, 2003) (in Attachment 6 to Exhibit 3). In fact, LES selected Cook-Joyce, Inc., Engineering and Consulting ("CJI") to assist in the development and conduct of the NEF site groundwater field investigation program due to CJI's extensive experience in performing similar investigations at the nearby WCS site. As we will discuss further in response to Contention NIRS/PC EC-1, our comparison of the WCS and AVLIS information to that obtained by LES at the NEF site affirm the applicability of the nearby data to the NEF site.

Q19. Please describe the additional investigations performed by LES in connection with the NEF site.

A19. (GAH, RLP) CJI performed a field investigation at the NEF site in September 2003 on behalf of LES to further evaluate hydrogeologic conditions at the NEF site. In particular, the investigation sought to ascertain the hydrogeologic conditions associated with the uppermost water-bearing zone beneath the NEF site. The investigation included the installation of nine soil borings (oriented on a three-by-three grid) to determine: (1) the depth to the Chinle

Formation "red beds," and (2) whether any saturated conditions were present in the alluvial sediments overlying the red beds. The land surface elevation was surveyed at each of the nine borehole locations to allow for computation of the top of the red bed formation (approximately 23 to 46 feet below ground surface). This information was combined with similar information from the WCS site to produce an elevation map of the top of the red bed formation. Because groundwater was not encountered in the shallow alluvium, CJI installed three monitoring wells in a siltstone/silty sandstone unit located at a depth of approximately 220 feet below ground surface, *i.e.*, the shallowest occurrence of saturated conditions beneath the NEF site. Of the three wells installed, only one well (MW-2) has produced any water. Ground water from MW-2 has been sampled at quarterly intervals for radiological and non-radiological analysis.

In addition, in September 2003, LES, through contractors Lockwood Greene and Mactec Engineering and Consulting, performed a preliminary geotechnical exploration for the proposed NEF for site construction and engineering purposes. This investigation consisted of drilling five test borings in the proposed building area to depths ranging from 40 to 100 feet below ground surface using hollow-stem auger and split-spoon sampling. The geotechnical properties of selected soil samples were determined through laboratory analysis.

IV. REGIONAL AND SITE GEOLOGY

Q20. Please describe the principal geological characteristics of the region in which the NEF site is located.

A20. (RLP) The NEF site is located near the boundary of two sections of the Southern High Great Plains Province, with the Plains section (Llano Estacado) lying to the east, and the Pecos Plains section lying to the west. The dominant geologic feature of the region is the Permian Basin. This is a massive subsurface bedrock structure consisting of a large thickness of

originally flat-lying, bedded, sedimentary rock that now has a significant downward flexure. The NEF site is located within the Central Basin Platform area of the Permian Basin. This area divides the Permian Basin into the Midland and Delaware subbasins. This area is considered to be structurally stable, *i.e.*, no major tectonic activity has occurred within the Permian Basin area since the Laramide Orogeny, which ended about 35-million years ago (*see* Figure 3.3-2 of LES Exhibit 1).

With respect to stratigraphy, the top of the Permian deposits are approximately 434 meters (1,425 feet) below ground surface at the proposed site. They are overlain by sedimentary rocks of the Triassic-aged Dockum Group. The upper formation of the Dockum Group is the Chinle Formation, a tight claystone and siltstone layer. The Chinle Formation, also referred to as the "red beds," is overlain by the Tertiary-age Ogallala, Gatuna, or Antlers Formations, all of which are alluvial deposits (*i.e.*, unconsolidated terrestrial sediments composed of sorted or unsorted sand, gravel, and clay that have been deposited by water). The Ogallala Formation, however, is not found at the proposed NEF site. In some areas near the NEF site, but not on the NEF site, a caliche layer (*i.e.*, a crust or layer of hard subsoil encrusted with calcium-carbonate) can be found extending to the surface. Quaternary-age dune sands frequently overlie the Tertiary alluvial deposits.

Q21. Please describe the principal geological features of the NEF site.

A21. (RLP) The major geologic features underlying the site generally parallel those of the region. Surface exposures consist mainly of Quaternary-aged eolian and piedmont sediments typical of those found along the far eastern margin of the Pecos River Valley. These include the reddish-brown, fine to loamy-fine dune sands of the Brownsfield-Springer Association (also known as the Blackwater Draw Formation). Underlying these sediments are the Gatuna and

Antlers Formations (Pleistocene/mid-Pliocene-aged). These are Pecos River Valley alluvial deposits comprising sand and silty sand with sand and gravel at the base. In some areas near the site, these deposits are interbedded with caliche near the surface or are underlain by a layer of caliche. The alluvial deposits are underlain by the Chinle Formation, which consists of Triassic-aged claystone, siltstone, sandstone, and silty clay (*i.e.*, the "red beds"). The Chinle Formation, in turn, is underlain by the Santa Rosa Formation, which includes sandy red beds, conglomerates, and shales. The Santa Rosa Formation overlies the Permian deposits (*i.e.*, muddy sandstone and shale red beds) of the Dewey Lake Formation. (*see* Table 3.3-1 and Figure 3.3-5 of LES Exhibit 1).

V. SITE HYDROLOGY AND HYDROGEOLOGY

Q22. Please describe the principal hydrogeological features of the NEF site.

A22. (GAH, RLP) Potential groundwater resources beneath the NEF site are limited. Furthermore, the site is not located within the recharge area of any sole source or major aquifer. The shallow alluvial soils beneath the site (*i.e.*, within 1 to 55 feet below ground surface), which consist primarily of relatively fine grained, silts, sands and silty sands, with some pockets of sand and gravel, are dry due to low rainfall rates and a high evapotranspiration rate. Accordingly, natural recharge to groundwater is not inferred to be taking place beneath the site.

As stated previously, the shallow alluvium is underlain by the Chinle Formation red beds, *i.e.*, Triassic-aged claystone, siltstone, sandstone, and silty clay. The Chinle red beds are over 1,000-feet thick and, as discussed further herein, have a very low permeability. The shallowest saturated zone beneath the NEF site occurs within the Chinle red beds at a depth of about 214 to 222 ft below the ground surface. The permeability of this approximately 15-foot thick siltstone to silty sandstone unit is fairly low, as evidenced by the slow rate at which monitor wells

completed in this unit – at both the NEF and WCS sites – have produced water. As stated above, in September 2003, LES installed three monitor wells with screened intervals in this unit. Only one of these monitor wells, MW-2, located near the northeast corner of the site, has produced any water. Similarly, monitoring wells screened in this same unit to the east of the site on the WCS property also have shown slow recovery after drilling and sampling operations, with some wells not equilibrating between sampling events (on the order of one or more months). In addition, based on chemical analyses of water samples taken to date from MW-2, it appears that the water quality in this unit is poor. Total dissolved solids ("TDS") values have ranged from 2,880 to 6,650 mg/L. The New Mexico Standards for Domestic Water Supply provide a TDS limit of 1,000 mg/L. EPA Secondary Maximum Contaminant Levels provide a TDS limit of 500 mg/L. TDS values from MW-2 are above both the New Mexico and EPA limits.

A recent investigation performed for the WCS site indicates that there also is a 100-foot thick water-bearing layer approximately 600 ft below ground surface. The first well-defined "aquifer" beneath the site, however, occurs in the Triassic-aged Santa Rosa Formation, approximately 1,115 feet below the NEF site. LES has not conducted local investigations of these water-bearing units due to their great depths and the thickness and low permeability of the overlying Chinle Formation red beds.

Q23. You stated earlier that the potential for adverse impacts on water resources at the NEF site is very low due, in part, to highly favorable site hydrological and hydrogeological conditions. Please explain the basis for this statement.

A23. (GAH, RLP) As set forth in Section 3.4 of the NEF Environmental Report, there are no surface water bodies or drainage features at the NEF site. In fact, LES requested and received a site inspection from the U.S. Army Corps of Engineers ("USCOE") to solicit the

USCOE's independent assessment of the existence of surface water bodies or drainage features at the site. I (GAH) accompanied the USCOE inspector. By letter dated March 17, 2004, the USCOE notified LES that there are no jurisdictional waters at the NEF site. (*see* Attachment 4 of LES Exhibit 3).

With respect to ground water, the few saturated, water-bearing units present beneath the NEF site occur at distinct depths – approximately 220, 600, and 1,115 feet below ground surface. As a result, these saturated strata are separated from one another by hundreds of feet of low-permeability sediments (*i.e.*, the Chinle Formation red beds). Indeed, WCS investigators have concluded that the very large hydraulic head differences associated with these units indicates a lack of hydraulic communication in the Triassic Dockum Group in the site area. (*see* LES Exhibit 3). In short, the thick, low-permeable red beds act as a natural barrier to the downward migration of groundwater, and hence, preclude natural recharge of the water-bearing units by waters originating on the surface of the NEF site, as well as hydraulic connection among those units.

Additionally, because the NEF site is located within a semi-arid climate, annual precipitation rates are lower than annual evaporation/evapotranspiration rates. In other words, water available for infiltration into the subsurface is limited in amount and is most likely to be lost through the evapotranspiration process, *i.e.*, there is generally a net deficit of water. As set forth in NEF Environmental Report, one recent study using field investigation techniques (e.g., geochemical and soil-physics techniques) and computer modeling has shown that no precipitation recharge occurs in thick, desert vadose (unsaturated) zones with desert vegetation. Under such conditions, which exist at the NEF site, precipitation that does infiltrate into the subsurface is efficiently transpired by the native vegetation (*see* LES Exhibits 1, 5). Specifically,

natural thermal gradients that exist within the deeper portions of such vadose zones induces water vapor to diffuse upward toward the base of the root zone. This water vapor, in effect, creates a negative pressure potential at the base of the root zone that acts like a sink, from which water is taken up by the plants and transpired.

The dry nature of the soils observed by LES in the various boreholes installed at the NEF site support the conclusion that hydrological conditions at the site are dominated by this process. Of the nine borings installed by LES in September 2003, only one of the borings produced drill cuttings that were *slightly moist* at 6 to 14 feet below ground surface. The other cuttings were very dry. Moreover, no water was observed in these borings after they were left open for at least a day. Likewise, of the five geotechnical borings completed by LES, only one boring, B-2, exhibited slight moisture from a depth of 35 to 41.4 feet below ground surface; the cuttings generated by these borings, on the whole, also were very dry. I (RLP) will discuss the observed lack of saturated conditions in these borings in greater detail in connection with specific NIRS/PC claims.

Q24. You have stated that the Chinle Formation red beds, which exceed 1,000 feet in thickness below the NEF site, are low-permeability sediments. Please provide the basis for this conclusion.

A24. (GAH, RLP) As set forth in Table 3.3-2 of the NEF Environmental Report (*see* LES Exhibit 1), measured vertical permeabilities at the WCS site ranged from 1.00×10^{-9} cm/sec (clays) to 1.93×10^{-6} cm/sec (siltstones and sandstones), and measured horizontal permeabilities ranged from 1.63×10^{-9} cm/sec (clays) to 6.53×10^{-7} cm/sec (average value for siltstones and sandstones). Based on these data, LES estimated the hydraulic conductivity of the red bed clay to be on the order of 2×10^{-8} cm/sec. To provide some context, the permeability of the red bed

clay is comparable to that associated with engineered landfill liner materials. Notably, a slug test performed by LES in MW-2 at the NEF site yielded a hydraulic conductivity value of 3.7×10^{-6} cm/sec for the siltstone/silty sandstone water-bearing unit located approximately 220 feet below ground surface. This low value, 3.7×10^{-6} cm/sec, is consistent with the laboratory-measured siltstone/sandstone permeability values cited above.

Laboratory results for 5 horizontal permeability tests of the Dockum Group (Chinle Formation) sediments at depths ranging from 68 to 90 ft ranged from 7.18×10^{-7} to 1.63×10^{-9} cm/sec at the WCS site. Results of 54 laboratory vertical permeability tests of the Dockum Group sediments at depths ranging from 34 to 208 ft ranged from 1.53×10^{-5} to $<1.00 \times 10^{-9}$ cm/sec at the WCS site, with an average of 6.2×10^{-7} cm/sec, and a median value of 5.7×10^{-9} cm/sec.

With respect to the water-bearing unit at approximately 220 to 225 feet below ground surface, WCS site data similarly indicate that the hydraulic conductivity of this unit is very low. Specifically, five laboratory permeability tests of samples from this unit yielded a geometric mean of 2.15×10^{-8} cm/sec, and two field slug tests yielded hydraulic conductivities of 6.0×10^{-8} cm/sec and 6.16×10^{-8} cm/sec, respectively. In conclusion, both NEF and WCS field data indicate that the shallowest saturated unit underlying both sites (at a depth of approximately 220 feet) is a low-permeability unit (*see* Cook-Joyce Inc., 2004a, *Section VI, Geology Report*, February 2004, prepared for Waste Control Specialists LLC, Andrews Texas, as contained in Attachment 6 to LES Exhibit 3).

Additionally, a significant amount of subsurface data are available from the nearby Lea County Landfill site, which is within the same geologic setting as the LES site. A total of 11 borings were drilled on the site to depths ranging from about 50 to 600 feet. Ten samples were

collected in the Dockum Group sediments at depths ranging from 60 to 485 and the vertical laboratory permeability ranged from 2.73 x 10^{-9} cm/sec to 7.25 x 10^{-8} cm/sec (*see* Attachment 6 to LES Exhibit 3).

The robust hydrogeologic characterizations performed at and near the LES site indicate that the Chinle Formation sediments have low permeability. Sediment samples collected for laboratory permeability in consolidated sediments, such as the Chinle Formation, would tend to be biased towards higher permeability values, rather than lower, due to the fact that the sampling device would generally have to be pounded into the sediments, potentially increasing the permeability of the sediments as a result of breaking or fracturing. Conversely, samples collected for laboratory permeability values in unconsolidated sediments, which are not present at the NEF site at the depths of interest, would tend to bias the samples towards lower permeability values as a result of the sediments being compacted as the sampling device is driven through them.

VI. NEF SITE MANAGEMENT OF PROCESS EFFLUENTS, SANITARY WASTEWATER, AND SITE STORMWATER RUNOFF AND RELATED ENVIRONMENTAL MONITORING

Q25. You mentioned LES's commitment to discharge process effluents and sanitary wastewater only to engineered basins and septic leach fields, respectively, and to collect site runoff in retention/detention basins. Please explain.

A25. (GAH) As set forth in the NEF Environmental Report, facility liquid effluents will discharged to the Treated Effluent Evaporative Basin; site stormwater runoff will be collected in the Uranium Byproduct Cylinder ("UBC") Storage Pad Stormwater Retention Basin and Site Stormwater Detention Basin; and sanitary wastewater will be discharged to the septic tanks and leach fields. NEF site liquid effluent rates will be relatively low, with the effluent flow

rate from all facility sources estimated to be about 28,900 cubic meters (7.6 million gallons) annually. This includes approximately 2,540 cubic meters (670,000 gallons) annually of liquid effluent from the NEF Liquid Effluent Collection and Treatment System, with cooling tower and heating boiler blowdown waters and sanitary sewage accounting for the remaining volume of effluent discharges.

Q26. Please describe the design and specific function of each of the engineered basins and the septic system.

A26. (GAH) The TEEB will be utilized to collect and contain liquid effluent from the Liquid Effluent Collection and Treatment System, as well as shower, hand wash, and laundry effluents. The TEEB will include two membrane liners (synthetic material with soil covering the uppermost liner) and a leak detection system between the two liners, with no outfall to preclude any infiltration into the ground. The ultimate fate of liquid effluents discharged to the basin will be through evaporation of water and impoundment of the residual dry solids byproduct of evaporation.

The UBC Storage Pad Stormwater Retention Basin will serve to collect and contain (1) cooling tower blowdown discharges, (2) heating boiler blowdown discharges, and (3) stormwater runoff from the UBC Storage Pad. Disposal of this water discharged to this basin also will be through evaporation of water and impoundment of the residual dry solids after evaporation. The basin will feature a membrane lining (synthetic material with soil cover), with no outfall, to preclude any infiltration into the ground.

The Site Stormwater Detention Basin will be used to collect runoff from developed parts of the site other than the UBC Storage Pad, such as runoff from the parking areas and building roofs. This basin will be unlined, and will have an outfall to control overflow and drainage.

Although there is some limited potential for its infiltration into the ground, water discharged to this basin will be disposed of principally through evaporation and evapotranspiration. No liquid discharges from facility operational systems will be discharged into this stormwater basin.

Finally, sanitary wastes will be discharged to six onsite septic systems, each with one or more leachfields. The six systems will be capable of handling approximately 40,125 liters (10,600 gallons) per day, though the system is expected to receive only half that amount given the actual number of employees. Similarly, while total annual design discharge will be approximately 14.6 million liters (3.87 million gallons) per year, actual flows will be approximately 50 percent of the design flows.

Q27. Do you believe that any of the facility discharges or runoff sources described above have the potential to adversely impact water resources at the NEF site?

A27. (GAH) No.

Q28. Please state the basis for your conclusion that discharges to the TEEB will not adversely impact water resources at the NEF site.

A28. (GAH) Contamination of groundwater as a result of discharges to the TEEB is unlikely for a number of reasons. First and foremost, only liquids (*i.e.*, process effluents and shower/hand wash/laundry effluents) meeting site administrative limits based on prescribed regulatory requirements would be discharged into the TEEB. To ensure that this is the case, post-treatment liquid effluent will be sampled and subjected to isotopic analysis *prior* to discharge to the TEEB, so as to confirm that release concentrations are below the concentration limits established in Table 3 of Appendix B to 10 C.F.R. Part 20. Any effluents unsuitable for release to the basin could be recycled through the liquid effluent treatment system or processed into a solid and sent to an offsite disposal facility. As a result of the liquid effluent treatment

process, it is expected that only 390 microcuries per year of uranium will be discharged to the TEEB. To put this in perspective, the TEEB will receive approximately 670,000 gallons of effluent discharge per year, but only about 1.3 pounds of uranium per year. Indeed, LES has determined that, if the total amount of uranium to be discharged to the TEEB over 30 years uranium were assumed to infiltrate into the soil to a depth of 20 feet below ground surface (well above any of the groundwater horizons described earlier), and over an area equal to that of the TEEB, that uranium would be equivalent to the uranium naturally occurring in the NEF site soil (*see* LES Exhibit 10).

As stated above, the TEEB will feature a double membrane liner, an active liquid-sensor leak detection system between the liners and will be segregated into two cells. The use of two cells will thus allow LES to isolate any leaks, assuming such leaks actually were to occur. The liner system will meet and surpass applicable New Mexico Environment Department guidelines (*see* Attachment 1 to LES Exhibit 3, LES Exhibit 4).

Moreover, the treated effluent would be disposed of via evaporation of all the water and impoundment of the remaining solids. On this point, it warrants mention that LES performed a water balance analysis of the basin. This analysis, which included consideration of effluent and precipitation inflows and evaporation outflows, indicates that the TEEB would be *dry* for 1 to 8 months of the year, depending on the rate of precipitation. (*see* Attachment 1 to LES Exhibit 3, LES Exhibit 9). Furthermore, in the event that heavy rainfalls were to occur, the TEEB is designed to retain treated effluent under conservatively-estimated precipitation conditions, *i.e.*, it includes a safety factor of 200% times the maximum storm water from a single rainfall event.

Finally, as part of its Radiological Environmental Monitoring Program, LES will install monitoring wells at five locations, two of which will be located downgradient of the TEEB.

These wells, which will be sampled quarterly for radiological and non-radiological analysis, will monitor ground water in the shallowest saturated unit approximately 220 feet below ground surface.

In sum, the foregoing measures provide for defense in depth by allowing LES to manage facility effluents and to monitor for any postulated releases to the ground.

Q29. Please state the basis for your conclusion that discharges/runoff directed to the UBC Storage Pad Stormwater Retention Basin will not adversely impact water resources at the NEF site.

A29. (GAH) First, it is highly unlikely that water discharges to this basin will include contamination in any appreciable amounts. The cooling tower and heating boiler blowdown discharges to the basin will not have constituents or characteristics that would adversely impact water resources at the site. With respect to UBC Storage Pad runoff, LES will implement numerous measures to preclude uranium contamination of such runoff. For example, LES will use only certified cylinders to ensure cylinder integrity, and will implement a cylinder maintenance and inspection program, based, in large part, on Urenco's extensive experience in managing such cylinders in Europe. UBCs containing depleted uranium hexafluoride ("DUF_6") will be surveyed for external contamination *before* being placed on the UBC Storage Pad and also will be monitored during their storage on the pad. If any external contamination were to be detected, it would be removed prior to cylinder placement on the pad. Notwithstanding these planned measures, LES performed an assessment of potential runoff contamination levels, in which it assumed a conservative level of radioactive contamination on cylinder surfaces and 100% washoff to the UBC Storage Pad Stormwater Retention Basin from a single rainfall event. The results of this assessment demonstrate that the radioactivity level in such a discharge would

be well within NRC regulatory limits for release. As with the TEEB, disposal of waters collected in this basin will be via evaporation of the liquid and impoundment of the residual dry solids after evaporation. Indeed, a conservative water balance of this basin indicates that the basin would be *dry* for 11 to 12 months of the year, depending on precipitation rates (see LES Exhibit 9). In addition, the basin will be designed with a synthetic membrane liner, and without an outlet, to preclude any infiltration of water into the ground. This basin also will be designed to contain runoff under conservatively-estimated precipitation conditions, *i.e.*, to retain a volume of water slightly more than twice that for the 24-hour duration, 100-year frequency storm, plus an allowance for cooling tower blowdown (77,700 m^3 or 63 acre-ft) for the area served.

Finally, water and sediment samples will be collected quarterly from the UBC Storage Pad Stormwater Retention Basin to ensure that uranic material is not being deposited in the basin. Physiochemical analysis also will be performed on samples taken. Monitor wells located downgradient of the basin also will be sampled quarterly for radiological analysis.

In sum, as with the TEEB, the foregoing measures provide for defense in depth by allowing LES to manage inputs to the UBC Storage Pad Stormwater Retention Basin facility effluents and site stormwater runoff and to monitor for any postulated releases to ground water.

Q30. Please state the basis for your conclusion that runoff collected in the Site Stormwater Detention Basin will not adversely impact water resources at the NEF site.

A30. (GAH) This basin would receive runoff principally from building roofs and paved surfaces on the NEF site. Such runoff is not expected to contain contaminants in levels that would exceed applicable regulatory limits. Specifically, any chemical constituents potentially discharged to the subsurface via the Site Stormwater Detention Basin would be below concentrations that have been established by State and Federal regulatory agencies as protective

of the public health and the natural environment. LES will comply with applicable regulatory limits during the facility construction and operation phases, and confirm compliance through monitoring and collection/analysis of environmental data (*i.e.*, samples will be collected from the Site Stormwater Detention Basin to demonstrate that runoff would not contain any contaminants above regulatory limits).

Additionally, although there is some limited potential for runoff collected in this unlined basin to infiltrate into the underlying soil, it is expected that much of this water would be lost through evapotranspiration. Indeed, the water balance for this basin shows that it would be dry except during rainfall events, *i.e.*, disposal of water discharged to this basin will be principally via evaporation. In the event of a particularly heavy rainfall, the basin will be sized to contain runoff for a volume of water equal to the 24-hour, 100-year return period storm.. In any event, any infiltrating water is expected to have limited downgradient transport due to the storage capacity of the soils underlying the basin and the upward flux to the root zone characteristic of the shallow vadose zone at the NEF site. This issue is discussed in greater detail herein in connection with the NRC Staff's "plume analysis."

Q31. Please state the basis for your conclusion that sanitary wastewaters discharged to the site septic systems and leach fields will not adversely impact water resources at the NEF site.

A31. (GAH) Sanitary discharges and associated leachates will be typical of that associated with sanitary waste, *i.e.*, no plant process effluents will be introduced into the septic tanks. These discharges will meet required levels for all contaminants stipulated in any permit required for the systems, including applicable NRC regulatory limits set forth in 10 C.F.R. Part 20 and LES's New Mexico Groundwater Discharge Permit. To ensure that there is no uranic contamination within the septic tanks, each tank will be periodically sampled – prior to any

pumping out of the tanks contents – and analyzed for isotopic uranium. Any radioactive contamination from individuals, assuming it were to exist, would be in very low concentrations and likely be absorbed onto sludge in tanks. As with the Site Stormwater Detention Basin, any infiltrating water is expected to have limited downgradient transport due to the storage capacity of the soils underlying the basin and the upward flux to the root zone characteristic of the shallow vadose zone at the NEF site.

VII. LES RESPONSE TO SPECIFIC CLAIMS MADE IN CONTENTION NIRS/PC EC-2

A. Response to Contention as Originally Admitted by the Licensing Board (Original Bases)

Q32. Are you familiar with Contention NIRS/PC EC-1 ("Impacts Upon Ground and Surface Water")?

A32. (GAH, RLP) Yes. As originally admitted by the Licensing Board on July 19, 2004, Contention NIRS/PC EC-1 challenged the adequacy of the NEF Environmental Report, alleging that:

> [T]he ER does not contain a complete or adequate assessment of the potential environmental impacts of the proposed project on ground and surface water, contrary to the requirements of 10 C.F.R. § 51.45.

The original basis proffered by NIRS/PC in support of this contention, "Basis A," is set forth in their April 6, 2004 intervention petition. *See* "Petition to Intervene by Nuclear Information and Resource Service and Public Citizen," dated April 6, 2004, at 19-23. Basis A of the original contention raises 12 issues (labeled paragraphs a. through l.), purportedly relating to "the fate of waste waters and runoff that enter the subsurface at the NEF." The Licensing Board, however, admitted an amended version of this Contention NIRS/PC EC-1 on November 22, 2004 that

contains five additional bases that seek to contest the adequacy of the NRC Staff's Draft Environmental Impact Statement ("DEIS").

Q33. In Basis A of the original contention, NIRS/PC assert that LES has not adequately addressed how much water would infiltrate into the alluvium from: the TEEB, the UBC Storage Pad Stormwater Retention Basin, the Site Stormwater Detention Basin, and the septic leach field. *See* NIRS/PC Petition at 20, ¶ a. Do you agree with this assertion? If not, please state the basis for your conclusion.

A33. (GAH) No. As discussed above, with the exception of some limited potential for infiltration of water from the Site Stormwater Detention Basin and the septic leach fields, disposal of discharges and/or runoff to the various site basins and septic system will be principally by evaporation and evapotranspiration. The water balance analyses performed by LES and referred to above support this conclusion. The liners associated with the TEEB and UBC Storage Pad Stormwater Retention Basin will greatly minimize, if not entirely preclude, the potential for subsurface infiltration of water collected in these basins. Given the low precipitation and high evapotranspiration rates in the site vicinity, the low-permeability of the near-surface soils (primarily silts and silty sands), and the tendency of these soils to hold non-evapotranspired moisture in storage, infiltration of water from the Stormwater Detention Basin and septic leach fields is expected to be negligible.

Q34. In Basis A of the original contention, NIRS/PC assert that LES has not adequately identified where would water flowing along the alluvial/Chinle contact would be discharged? *See* NIRS/PC Petition at 20, ¶ b. Do you agree with this assertion? If not, please state the basis for your conclusion.

A34. (RLP) No. The likelihood that water from the Site Stormwater Detention Basin and septic leach fields would reach and flow along the alluvial/Chinle contact is low. As stated in response to the prior question, infiltration of water from the Stormwater Detention Basin and septic leach fields is expected to be negligible given site hydrological conditions. LES in not aware of any points in the site vicinity at which water purportedly flowing along the "alluvial/Chinle contact" is discharged. Moreover, NIRS/PC appear to assume that the contact between the alluvium and Chinle red beds beneath the site is uniform with respect to depth below ground surface. Boring logs for both the NEF and WCS sites, however, indicate that the depth to this contact can vary considerably. Where the depth to the contact is particularly shallow, water movement is likely to be dominated by evapotranspiration and unsaturated flow conditions, *i.e.*, flow conditions of the type found in a saturated zone or aquifer would be unlikely. Indeed, the numerous borings completed by LES at the NEF site clearly indicate that "saturated zone" conditions do not exist at the depths of interest.

In the DEIS, the NRC Staff analyzed the potential migration of hypothetical plumes that it posited to form along the alluvium/Chinle contact as a result of infiltration of water from the Site Stormwater Detention Basin and the septic leach fields (*see* DEIS at 4-13 to 4-13). The Staff concluded that the water would have limited downgradient transport due to storage capacity of the soils and the upward flux to the root zone. The Staff's analyses suggest that the portions of the plumes not evapotranspired and traveling downgradient could, in theory, result in a minor seep at Custer Mountain, or in the excavation a few miles southeast of the Monument Draw where the Chinle Formation is exposed. It warrants emphasis that these analyses are highly conservative, insofar as the Staff appears to have assumed that 100% of all annual stormwater runoff/discharge and discharges from the septic systems eventually reach the hypothetical

plumes. In any event, as the Staff correctly concluded in the DEIS, any potential impacts on water resources would be de minimis.

Q35. In Basis A of the original contention, NIRS/PC assert that LES has not determined how long it would take water from the NEF site to reach the discharge area. *See* NIRS/PC Petition at 21, ¶ c. Do you agree with this assertion? If not, please state the basis for your conclusion.

A35. (RLP) No. As stated above, LES does not believe that infiltration of water from the Site Stormwater Detention Basin and septic leach fields will result in any significant discharges – if any discharges at all – of water, via flow along the alluvial/Chinle contact. Even if one accepts that NRC Staff's highly conservative estimate of pore velocity of 252 m/yr (0.16 mile/yr) for a hypothetical plume, the time required for discharge at the postulated locations identified by the Staff (approximately 25 miles and 3 miles from the NEF site) would be on the order of 156 and 19 years, respectively.

Q36. In Basis A of the original contention, NIRS/PC claim that LES has not determined whether there are "fractures or other fast pathways that would allow water to flow rapidly from the alluvium to the Chinle, or from the Chinle to the Santa Rosa." On this point, NIRS/PC further assert that "the detection of a pesticide in MW-2 may indicate a connection to the surface, such as a fast flow path from the alluvium to the Chinle." *See* NIRS/PC Petition at 21, ¶ d. Do you agree with these assertions? If not, please state the basis for your conclusion.

A36. (GAH, RLP) In view of the various investigations performed and data available for the NEF and WCS sites, there do not appear to be any subsurface fractures or other fast pathways that would allow water to flow rapidly from the alluvium to the Chinle, or from the Chinle to the Santa Rosa. It is clear that the Chinle red beds underlying the site are low-

permeability materials. If these subsurface units were highly fractured, then we would expect to see much higher hydraulic conductivities than those previously determined in connection with the NEF and WCS sites. The confined nature of the water-bearing unit at approximately 220 feet below ground surface also indicates that there are no highly fractured zones that serve as fast flow paths. Even if fractures exist, they are not necessarily continuous or interconnected to a degree which would be conducive to enhanced fluid flow. It is unlikely that fractures/fracture zones would extend the entire depth of the alluvium or the Chinle clays. Further, such fractures may be "self-healing" in nature due to the presence of clay within the fractures, which swells as it becomes hydrated.

The one-time detection of a pesticide (4,4'-DDD) in MW-2 is not indicative of "a connection to the surface, such as a fast flow path from the alluvium to the Chinle." As set forth in the NEF Environmental Report, LES believes that the detection of a pesticide was likely due to contamination of field or laboratory equipment. This reflects a judgment by LES that the groundwater zone at issue (*i.e.*, the 220-foot zone) is well isolated from potential sources of surface contamination. The sample at issue was taken shortly after installation of MW-2. Additional sampling of MW-2 (three quarterly sampling events) supports this conclusion, insofar as no pesticides or other contaminants have been detected in subsequent samples taken from MW-2 (*see* analytical results contained in Attachment 6 to LES Exhibit 3, LES Exhibit 13).

Q37. In Basis A of the original contention, NIRS/PC claim that LES "should have determined the ages of water in the Chinle and Santa Rosa," and reason that "relatively young water would indicate that water reaches these units along fast flow paths." *See* NIRS/PC Petition at 21, ¶ e. Do you agree with this assertion? If not, please state the basis for your conclusion.

A37. (RLP) No. For the reasons set forth above, there do not appear to be any subsurface fractures or other fast pathways that would allow water to flow rapidly from the alluvium to the Chinle, or from the Chinle to the Santa Rosa. Available permeability and hydraulic conductivity data – and the sheer depths to water-bearing units in the Chinle and Santa Rosa Formations alone – indicate that "young" water is not reaching these units via "fast flow paths." Furthermore, published data obtained from geochemical analyses of groundwater samples taken from the Dockum Group in the region indicate that recharge to the Santa Rosa essentially ended more than 15,000 years ago. *See* A. Dutton and W. Simpkins, "Hydrogeochemistry and Water Resources of the Triassic Lower Dockum Group in the Texas Panhandle and Eastern New Mexico," Report of Investigations No. 161, Bureau of Economic Geology, University of Texas at Austin (1986) (*see* LES Exhibit 6).

Q38. In Basis A of the original contention, NIRS/PC allege that LES has not "adequately address[ed] whether groundwater exists in the alluvium at the proposed NEF site. *See* NIRS/PC Petition at 21, ¶ f. Do you agree with this assertion? If not, please state the basis for your conclusion.

A38. (GAH, RLP) LES has adequately addressed this issue based on its review of prior site investigations at the WCS site and its own hydrogeologic field investigations. From these data, it is clear that saturated horizons or pockets of groundwater are unlikely to exist in the alluvium beneath the site. LES has installed 14 borings (9 groundwater exploration and 5 geotechnical borings). Logs for all of these borings have been made available. As reflected in those logs, the cuttings associated with these borings were almost invariably very dry. The only moisture present was "slightly moist" in CJI boring B-9 at a depth between 6 and 14 feet below ground and "moist" in MACTEC boring B-2 at a depth between 35 and 41.4 feet below ground.

To better understand these observations, recent discussions were held between CJI and LES. According to the individual who logged boring B-9, the "slightly moist" descriptor was applied because the cuttings were not saturated, but coagulated a bit when held, indicating very little moisture was present. They indicated that this descriptor is not indicative of saturated groundwater conditions. This moisture is likely infiltrated precipitation that had yet to evapotranspire (since CJI locates drilling locations in low spots rather than high spots, *i.e.*, at top of a dune, rainfall may preferentially collect and infiltrate into the ground and then become available for evapotranspiiration). Recent discussions also were held between LES and MACTEC, with the individual who logged boring B-2. The "moist" descriptor was applied to indicate that some residual water content was present, and was not meant to be indicative of saturated groundwater conditions. If a significant quantity of water had been present in the cuttings at issue, then the boring log description of those cuttings likely would have indicated they were "very moist" or "wet" or "saturated." Significantly, with respect to the nine borings installed in September 2003, the investigators allowed at least 24 hours for water to enter the borings. No water was observed in the boreholes. The observed lack of any significant moisture content in the alluvial sediments beneath the site is consistent with site hydrological conditions discussed previously, *i.e.*, low precipitation rates and high evapotranspiration rates.

Q39. In regard to this same issue, NIRS/PC also maintain that the known existence of groundwater in the alluvium at three places *near* the NEF site further reflects LES's alleged failure to adequately address whether groundwater exists in the alluvium at the proposed NEF site. Do you agree with this assertion? If not, please state the basis for your conclusion.

A39. (RLP) No. The zones of saturation observed in the alluvium at three places to the north and east of the NEF site (*i.e.*, Wallach Quarry, Baker Spring, and the WCS site) are limited

and intermittent. These zones are due to very localized infiltration mechanisms, such as infiltration from "buffalo wallow" depressions that pond surface water and man-made features. These localized conditions, however, do not exist at the NEF site. Moreover, none of these shallow saturated unit occurrences is laterally continuous nor extends to the NEF site.

The unique conditions giving rise to the occurrence at offsite locations identified above are described in detail in Section 3.4.1.1 of the NEF Environmental Report. At Wallach Quarry, minor quantities of perched groundwater occur at the base of the sand and gravel unit in the quarry, atop the low-permeability Chinle red bed clay, which serves as a confining unit that arrests downward percolation of localized recharge.

Baker Spring, located just northeast of the NEF site, represents a second instance of saturation above the Chinle clay. Through a pedestrian survey, personal interviews, and a search of historical aerial photograph, LES investigated the origin of the area identified as Baker Spring on USGS topographic maps. Baker Spring is a manmade feature that resulted from the historical excavation of gravel and caprock materials that are present above the red bed clay. As a result of the excavation, Baker Spring is topographically lower than the surrounding area. Following rainfall events, ponding on the excavation floor occurs. Because the excavation floor consists of very low permeability clay, small quantities of water are able to pond above the red beds. Shading from the high wall and trees that have flourished in the excavated area retard the natural evaporation rates and water stands in the pond for sometime. It is also suspected that during periods of ponding, surface water infiltrates horizontally into the sands at the base of the excavated wall and is retained as bank storage. As the surface water level declines, the bank storage is discharged back to the excavation floor.

The third example of localized shallow groundwater occurrence near the NEF site is to the east on the WCS property, where several abandoned windmills are located. The windmills were once used to supply water for stock tanks by tapping small saturated lenses above the Chinle Formation red beds. The amount of groundwater in these zones is limited. The source of recharge for these localized perched zones is likely to be "buffalo wallows" (playas), *i.e.*, substantial surface depressions located near the windmills that collect surface water runoff. However, WCS has drilled monitoring wells in these areas to characterize the nature and extent of the saturated conditions. Some of these wells are dry, reflecting the localized nature of any perched water conditions that might exist. When water is present, it is slow to recover following sampling events. These findings reflect the low permeability and discontinuous nature of these localized occurrences of saturated conditions.

In sum, the conditions giving rise to localized occurrences of saturation in the alluvium *near* the NEF site are not present at the NEF site. The surface soils at the NEF site, as well as at the WCS and Lea County landfill sites, are finer-grained (*i.e.*, they consist mainly of fine sand and silt) than the sand and gravel at the Wallach site. While LES observed minimal amounts of gravel in certain zones, gravel does not appear to be consistently present beneath the site. Further, there are no excavations of the type observed at Baker Spring at the NEF site. Excavations into, and naturally occurring surface depressions ("buffalo wallows") in, the alluvium can act as "bowls" where water can more readily accumulate on top of the red-beds, which may allow localized perched zones to develop. Finally, relative to the WCS site, there are no "buffalo wallows" or related groundwater conditions at the NEF site. In any event, the localized occurrences of alluvial groundwater observed near the NEF site do not constitute

aquifers, nor do they appear to be hydrologically connected to any deeper water-bearing units (e.g., the thin saturated zone present at approximately 220 feet below ground surface).

Q40. In connection with LES's purported failure to "adequately address whether groundwater exists in the alluvium at the NEF site," NIRS/PC also aver that LES should also have addressed "the sources (recharge points) of groundwater in the Chinle and Santa Rosa" Formations. Do you agree with this assertion? If not, please state the basis for your conclusion.

A40. (RLP) No. As explained above, LES has not observed any saturated conditions in the alluvium at the NEF site and has no reason to believe that such conditions – even were they to exist beneath the site – would contribute to the natural recharge of water-beating units located at depths of 220 feet and greater below ground surface. The thick, low-permeable red beds clearly act as a natural barrier to the downward migration of groundwater, and thus preclude any natural recharge of the water-bearing units located at depth. In fact, water in the Santa Rosa aquifer is quite old, and published data indicate that recharge to the aquifer occurred during the Pleistocene, more than 15,000 years ago. Erosion of the Pecos and Canadian River valleys during the Pleistocene created groundwater basin divides along the western and northern limits of the Southern High Plains, thereby preventing modern recharge in the Dockum Group outcrops from reaching confined parts of the Dockum Group aquifer. *See* Dutton and W. Simpkins, "Hydrogeochemistry and Water Resources of the Triassic Lower Dockum Group in the Texas Panhandle and Eastern New Mexico," Report of Investigations No. 161, Bureau of Economic Geology, University of Texas at Austin (1986) (*see* LES Exhibit 6).

Earlier hydrogeologic work in the area by Nicholson and Clebsch (1961) indicated that the Santa Rosa received recharge as a result of precipitation on sand dunes overlying outcrop

areas. The more recent work on recharge to the Dockum Group sediments by Dutton and Simpkins has shown this not to be the case.

Q41. Also in connection with LES's alleged failure to adequately address whether groundwater exists in the alluvium at the NEF site, NIRS/PC suggest that LES has not adequately considered how to distinguish between groundwater contamination potentially caused by the NEF and contamination potentially caused by other nearby facilities (e.g., the Wallach quarry, WCS site, and the Lea County Municipal Landfill). Do you agree with this assertion? If not, please state the basis for your conclusion.

A41. (GAH, RLP) No. LES will install a background monitoring well, located in the north sector of the NEF site, up-gradient of the NEF, down-gradient of Wallach Quarry, and cross-gradient from the WCS facility. Monitoring at this location will occur both in the vicinity of the alluvium/Chinle contact (even though no water was present in this zone when LES conducted its NEF site investigations, nor is any expected to be present) and in the 220-foot groundwater zone. This well will be used to distinguish between postulated releases from the NEF, Wallach Quarry, and WCS sites. The Lea County landfill is located downgradient of the NEF site.

As a general matter, in ascertaining the source of any potential contaminants, LES would consider the types of contaminants involved and the location of their potential sources relative to the direction of any discernible site groundwater flow. For example, releases from the Wallach Quarry and the Sundance Services "produced water" lagoons north of the NEF site would be readily differentiated from potential releases from the NEF site.

Q42. You refer to the other facilities near the NEF site as being up-gradient, cross-gradient, and down-gradient of the NEF site. Please explain.

A42. (GAH, RLP) As set forth in the NEF Environmental Report, LES has installed three monitor wells in the 220 to 230-foot siltstone/silty sandstone unit beneath the site. To date, only MW-2 has produced any water. Monitoring wells also have been installed in this unit at the WCS site (referred to by WCS as the 230-foot zone). Groundwater levels in MW-2 are consistent with those observed in the WCS monitoring wells. Based on the groundwater levels in MW-2 and the data from the adjacent WCS site wells, LES has determined the groundwater gradient in the siltstone/silty sandstone unit to range from about 0.011 to 0.017 foot/foot, with a slope or flow direction generally to the south. Thus, locations north of the NEF would be considered up-gradient, locations south of the NEF would be considered downgradient, and locations to the west and east would be considered cross-gradient.

Q43. In Basis A of the original contention, NIRS/PC, citing the original version of the NEF license application, state that "there is a mystery as to the depth of the Santa Rosa Aquifer at the NEF site." *See* NIRS/PC Petition at 22, ¶ g. Do you agree with this assertion? If not, please state the basis for your conclusion.

A43. (GAH) No. LES has revised the NEF Environmental Report to provide clarification on this issue. Specifically, Table 3.3-1 of Revision 2 (July 2004) of the NEF Environmental Report, indicates that the depth to the Santa Rosa Formation ranges from approximately 1,115 to 1,425 feet in the vicinity of the NEF site.

Q44. On a related note, in Basis A of their original contention, NIRS/PC suggest that LES's groundwater monitoring plans are inadequate in view of "at least four potential sources of groundwater contamination at the site (three evaporation basins and the septic leach field)." In support of this assertion, they claim that: (1) LES does not intend to investigate the Santa Rosa Aquifer; (2) LES plans to install only two monitoring wells, presumably in the alluvium; and (3)

LES should install at least one background monitoring well up-gradient of the NEF site. *See* NIRS/PC Petition at 22, ¶ h. Do you agree with this assertion? If not, please state the basis for your conclusion.

A44. (GAH) No. As set forth above, facility effluents and site runoff are not expected to contain contaminants in levels that exceed any applicable regulatory limits. Moreover, the site basins and septic system will provide for appropriate containment and disposal of facility effluents and site runoff (largely by evaporation). NIRS/PC are correct in asserting that LES does not intend to investigate the Santa Rosa Aquifer. Given the substantial depth to this aquifer (*i.e.*, over 1,000 feet below ground surface) and the thickness and low permeability of the overlying Chinle Formation – which serves to inhibit potential groundwater migration to the Santa Rosa Aquifer – there is no need to investigate this aquifer. Indeed, even assuming that water were to travel from the surface of the Chinle Formation clay to the top of the Santa Rosa, the travel time would be on the order of thousands of years in view of the hydraulic properties of the Chinle materials.

The statements of NIRS/PC regarding LES's proposed monitoring are incorrect and do not reflect current information. Specifically, LES plans to install monitoring wells at five locations at the site. These wells *will* include one background monitoring well located on the northern boundary of the site, between the NEF site and the Wallach quarry; two monitoring wells located on the southern edge of the UBC Storage Pad; one monitoring well located on the south side of the UBC Storage Pad Stormwater Retention Basin; and one monitoring well located on the southeastern corner of the Site Stormwater Detention Basin. These monitoring wells will be used to monitor the siltstone/silty sandstone unit at approximately 220 feet below ground surface, *i.e.*, the shallowest occurrence of saturated conditions beneath the NEF site. As stated

previously, the up-gradient background monitoring well also will be screened to monitor any water that might occur in vicinity of the alluvium/Chinle contact, though no water was present in this zone when LES conducted its NEF site investigations. These wells will be sampled quarterly in accordance with LES's New Mexico Groundwater Discharge Permit.

Q45. In Basis A of their original contention, NIRS/PC state that, according to Table 6.2-1 of the NEF Environmental Report, "the detection limit for most metals in groundwater will be 5 ppm." They assert that this is "much higher" than the health-based standards that the Environmental Protection Agency ("EPA") has established for many metals, and that the detection limits for each metal should be no higher than the health-based standard. *See* NIRS/PC Petition at 22-23, ¶ i. Please state your conclusion relative to this claim.

A45. (GAH) Since the time NIRS/PC submitted its original contention, LES has revised Table 6.2-1 of the NEF Environmental Report to reflect that the lower limits of detection ("LLD") for all analyses listed in that table will meet applicable EPA LLDs. Therefore, the concern stated by NIRS/PC has been fully addressed.

Q46. In Basis A of their original contention, NIRS/PC assert that "the full composition of the UF_6 feedstock has not been specified," and that "LES should identify the other hazardous materials that may be contained in the feedstock." *See* NIRS/PC Petition at 23, ¶ j. Please state your conclusion relative to this claim.

A46. (GAH) LES will use only natural uranium hexafluoride ("UF_6"), containing approximately 0.71 w/o uranium-235 (^{235}U), as feed material. The NEF Safety Analysis Report, at Table 1.2-1, indicates that LES will require UF_6 suppliers to provide Commercial Natural UF_6 in accordance with ASTM C 787-96, "Standard Specification for Uranium Hexafluoride for Enrichment." ASTM C 787-96 specifies the composition of the UF_6 feed material. LES has

further indicated that it will require cylinder suppliers to preclude use of cylinders that, in the past, have contained reprocessed UF_6, unless such cylinders have been decontaminated. *See* SAR Table 1.2-1, note (1). Accordingly, LES does not expect the feedstock to contain "other hazardous materials."

Q47. In Basis A of their original contention, NIRS/PC assert that the permeabilities presented in Table 3.3-2 of the NEF Environmental Report "may be derived from laboratory measurements," and that such measurements "often underestimate the bulk permeability of a rock body because they do not account for fractures and other features that may act as fast flow paths." *See* NIRS/PC Petition at 23, ¶ k. Do you agree with this assertion? If not, please state the basis for your conclusion.

A47. (RLP) No. The permeabilities presented in Table 3.3-2 of the NEF Environmental Report are, in fact, derived from laboratory measurements performed on field samples from near the NEF site. However, contrary to the assertion of NIRS/PC, laboratory-measured permeabilities are likely to be higher than actual *in situ* values due to deformation/fracturing caused by the sampling process. In any event, the permeability data presented in ER Table 3.3-2 represent ranges of measured permeabilities for reddish brown silty clays, sandstones and siltstones near the NEF site. The values for the clay indicate that it is highly impervious. While the siltstones/sandstones may be slightly more permeable than the clays, they still have relatively low permeabilities. Comparison of boring logs from the 14 NEF borings with boring logs from the nearby WCS site demonstrate similar stratigraphy at the locations. The CJI report also supports this conclusion by its heavy reliance on WCS data to supplement the NEF data. CJI performed both studies and must have concluded that the stratigraphy information at WCS is transferable to the NEF site with adjustments as provided by

the NEF borings. As discussed above, extensive permeability data from WCS site confirm the appropriateness of the characterization of NEF site permeability values as indicative of highly impervious material. The low permeability and low hydraulic conductivity values obtained from the NEF, Lea County Landfill, and WCS site investigations do not suggest the presence of "fast flow paths" in the NEF site vicinity.

Q48. In Basis A of their original contention, NIRS/PC LES claim that LES's statement on page 4.12-9 of the NEF Environmental Report that water in the Santa Rosa Aquifer is "considered not potable" lacks basis, and state that "the Santa Rosa Aquifer is used as a source of domestic and livestock water in Lea County." *See* NIRS/PC Petition at 23, ¶ 1. Please state your conclusions regarding this assertion.

A48. (GAH, RLP) As an initial matter, this issue is not relevant to the adequacy of LES's evaluation of the proposed NEF on water resources, *i.e.*, the subject of Contention NIRS/PC EC-1. The statement on page 4.12-9 of the NEF Environmental Report was made in the context of that portion of LES's conservative radiological pathway dose assessment involving potential exposure of humans to liquid effluents. It was not made in the context of LES's assessment of potential water resources impacts. Moreover, by virtue of its great depth below ground surface (over 1,000 feet) and confinement by thick beds of low-permeable Chinle red bed clay, the Santa Rosa will not be impacted by NEF operations. Finally, data from a well installed in the Santa Rosa aquifer at the WCS site indicates that the total dissolved solids (TDS) concentration of water produced from the Santa Rosa aquifer in this area exceeds New Mexico Drinking Water Bureau standards. The WCS analysis of the Santa Rosa aquifer water resulted in a TDS value of 1,350 mg/L (*see* LES Exhibit 11). The New Mexico Standards for Domestic Water Supply provide a TDS limit of 1,000 mg/L. EPA Secondary Maximum Contaminant

Levels provide a TDS limit of 500 mg/L. The TDS value from the Santa Rosa aquifer is above both the New Mexico and EPA limits. LES acknowledges that the Santa Rosa aquifer may be used as a source of water for livestock in the region surrounding the site. However, as described above, the NEF will not impact the Santa Rosa aquifer. Therefore, use of the Santa Rosa aquifer as a source of water for livestock in the region surrounding the NEF has no bearing on this issue.

B. Response to Contention as Amended by the Licensing Board (Additional Bases)

Q49. You stated earlier that Licensing Board amended Contention NIRS/PC EC-1 on November 22, 2004 to include five additional bases that contest the adequacy of the NRC Staff's DEIS. Are you familiar with each of these five additional bases?

A49. (GAH, RLP) Yes.

Q50. In Basis A of the amended contention, NIRS/PC note that the DEIS contains estimates of the dimensions, flow rates, and discharge areas associated with "perched" bodies of groundwater that might form at the alluvium/Chinle interface due to the potential seepage of water from the Site Stormwater Detention Basin and the septic leach fields. NIRS/PC assert, however, that the "NRC provides no explanation of such calculations, and it is not possible to determine whether they are reasonable." Do you agree with this assertion?

A50. (RLP) No.

Q51. Please state the basis for you conclusion.

A51. (RLP) The NRC Staff has since provided its calculations to NIRS/PC. *See* NRC Staff's Response to Interrogatories and Document Request by Petitioners Nuclear Information and Resource Service and Public Citizen to Commission Staff, dated November 10, 2004, at 7-11 (LES Exhibit 12). The NRC Staff's explanation of the assumptions underlying these calculations leaves no doubt that the Staff's estimates are extremely conservative in nature. First

and foremost, the Staff has assumed that 100% of all annual stormwater runoff (*i.e.*, all precipitation) and discharge to the septic systems would be available to form plumes along the alluvium/Chinle contact. With respect to stormwater, the Staff noted that "[t]he plume rate is estimated as the precipitation, at a rate of 46.1 cm/yr, falling on the basin's drainage area of 39 hectares; runoff infiltration, evaporation of runoff water and basin water, and evapotranspiration have been conservatively neglected." With respect to the septic system, the Staff stated that "[t]he plume flow rate is taken as the actual system discharge, 7.3 million liters/yr; evapotranspiration has been conservatively neglected." These assumptions are highly conservative, insofar as significant quantities of precipitation runoff will be lost through the aforementioned processes, before such runoff has an opportunity to reach the Site Stormwater Detention Basin. Likewise, leachates from the septic systems will be subject to evapotranspiration.

Indeed, the annual evaporation rate in the site vicinity, 204 cm (80 inches) per year, exceeds the precipitation rate. According to a water balance analysis performed by LES, basin outflow due to evaporation and infiltration will exceed all inflows on a monthly basis. Of the amount that would infiltrate into the ground, most would be expected to eventually return to the atmosphere via evapotranspiration by vegetation growing in the vicinity of the basin, *i.e.*, it would not contribute to the formation of a plume. The Staff specifically acknowledged this fact in the DEIS, stating that "[t]he water would be expected to have limited downgradient transport due to the storage capacity of the soils and upward flux to the root zone." *See* DEIS at 4-13.

In sum, the Staff's estimates assume that water movement through the vadose zone is occurring at rates equivalent to those of saturated sediments, and that all water discharged to the basin and leach fields migrates from the site. However, these assumptions purposely ignore the

fact that there is a monthly net soil moisture deficit in the site vicinity, where evapotranspiration losses exceed precipitation. Thus, it its very conservative to assume that perched water bodies will form along the alluvium/Chinle contact as result of seepage from the Site Stormwater Detention Basin or septic leach fields. It is even more conservative to assume that all water potentially discharged to the Stormwater Detention Basin and leach fields will move "downgradient" as a plume and ultimately discharge at the land surface.

Q52. With respect to the Staff's "plume" estimates, NIRS/PC witness George Rice asserts that "[a]lthough the hydraulic conductivity used by NRC may result in a reasonable estimate of average groundwater flow rates, it underestimates the rate at which groundwater is likely to flow through the more permeable materials underlying the site (e.g., gravels)." *See* November 24, 2004 Expert Report of George Rice. In support of this assertion, Mr. Rice states that (1) gravels exist beneath the site at various depths, (2) the hydraulic conductivity of gravels ranges from 0.1 cm/sec to 100 cm/sec, and (3) the porosity of gravel ranges from 0.25 to 0.40. Do you agree with Mr. Rice's assertion that the NRC Staff has underestimated the rate at which groundwater is likely to flow through the more permeable materials underlying the site?

A52. (RLP) No. I would also like to point out that the staff analysis is overly conservative.

Q53. Please state the basis for your conclusion.

A53. (RLP) As stated previously, given site hydrological conditions, it is highly conservative to posit that any water that infiltrates from the Site Stormwater Detention Basin or leach fields will result in the formation of perched water bodies or plumes. Notwithstanding, the Staff's assumed conservative hydraulic conductivity value, as the Staff itself recognized in stating that: "The chosen k_h = 0.01 cm/sec is on the conservative side (*i.e.*, results in greater

Darcy Velocity) of the range of site surface soils hydraulic conductivity as given on page 3-35 of the DEIS [and page 3.4-14 of the ER]." A hydraulic conductivity value of 0.01cm/sec is consistent with published values for *clean* sand (0.005 to 1.0 cm/sec, Freeze and Cherry, 1979) (*see* LES Exhibit 7). Logs from the various boreholes drilled at the NEF site indicated that the alluvial soils below the site consist mainly of fine sand and silt. While minimal amounts of gravel were observed in certain zones, gravel is not consistently present throughout the site. Mr. Rice's choice of hydraulic conductivity is an attempt to demonstrate a potential maximum flow rate for ground water traveling along the surface of the red beds, when, in fact, a continuous gravel layer has not been documented to occur immediately above the red beds. Moreover, boring logs indicate that the depth to the alluvium/Chinle red bed contact may vary considerably across the site. Where the depth to the contact is particularly shallow, water movement is likely to be dominated by evapotranspiration and unsaturated flow conditions, *i.e.*, flow conditions of the type found in a saturated zone or aquifer would be unlikely. Finally, the use of a higher effective porosity value (*i.e.*, greater than the 0.25 value used by the Staff) would actually result in a lower estimated velocity, not a higher velocity.

Q54. Assuming that seepage of water from the Site Stormwater Detention Basin and/or septic leach fields could result in the formation of perched bodies of water or plumes that move down-gradient and eventually discharge at the surface, do you believe that adverse impacts on water resources would result?

A54. (GAH, RLP) No.

Q55. Please state the basis for this conclusion.

A55. (GAH, RLP) Runoff collected in the Site Stormwater Detention Basin, and sanitary wastewaters discharged to the site septic systems, are not expected to contain

contaminants in levels that exceed applicable regulatory limits. The NEF may not commence facility construction, discharge stormwater runoff, or discharge septic wastewaters prior to obtaining the requisite federal and state authorizations. And again, even if one accepts that NRC Staff's highly conservative estimate of pore velocity of 252 m/yr (0.16 mile/yr), the time required for discharge at the postulated locations identified by the Staff (approximately 25 miles and 3 miles from the NEF site) would be on the order of 156 and 19 years, respectively.

Q56. In Basis B of the amended contention, NIRS/PC assert that the DEIS should contain an estimate of "the probability and frequency of leakage through the liners of the treated effluent basin or the stormwater detention basin," and "show the fate of water and contaminants that leak from the basins." Do you agree with this assertion?

A56. (GAH) No.

Q57. Please state the basis for this conclusion.

A57. (GAH) LES has committed to construct the TEEB and install the liner system in a manner that will ensure optimum performance. The materials and construction methods used for the TEEB will be consistent with current New Mexico Environment Department ("NMED") guidelines for liner material and site preparation of synthetically-lined lagoons. Specifically, the TEEB will have two geosynthetic liners fabricated from material that is chemically compatible with potential liquid effluents to be discharged to the TEEB, resistant to sunlight deterioration, and of sufficient thickness to have adequate tensile strength and puncture resistance. The specific liner material will be selected during the final design and will have a projected service life in excess of the projected service life of the NEF. LES will take necessary actions to ensure that the liner stays within manufacturer's specifications throughout the required performance period. As required by the NMED guidelines, the liner material will be pre-approved by a

professional engineer and the NMED. The liner will be installed and tested by certified installers according to project specifications. LES will implement a monitoring plan that provides for periodic inspections and, if necessary, the implementation of corrective actions.

Additionally, the TEEB will include an active liquid-sensor leak detection system for determining whether the primary (upper) liner has been breached. This system will have a drain/sump system consisting of collection pipes that will be routed to a monitored sump. If the sump is collecting liquid, then a level monitor will alert NEF site personnel. In the event that a failure of the primary or upper liner is detected by the leak detection system, site personnel will take appropriate mitigation measures, *i.e.*, assess any damage to the liner and restore liner integrity. Because the TEEB will be designed with two cells, the cell with the breached liner can be isolated, drained, and repaired, while discharges can continue to the intact cell. The secondary (lower) liner further serves to preclude discharge of TEEB liquids to subsurface in the event of a breach of the primary liner. In view of LES's commitment to carefully select liner materials and properly install in accordance with the manufacturer's recommendations and project specifications, test, and monitor the liner system, catastrophic failure of the liner system is not considered a credible event (*see* Attachment 1 to LES Exhibit 3, LES Exhibits 4 and 8).

The TEEB will contain only very low concentrations of uranic materials that are well within applicable regulatory limits. As I explained previously, if all of the uranium that would be discharged to the TEEB over 30 years were assumed to infiltrate into the soil to a depth of 20 feet below ground surface over an area equal to that of the TEEB, it would be equivalent to the uranium naturally occurring in NEF site soil (*see* LES Exhibit 10). Moreover, as Mr. Peery has explained, site hydrogeological conditions are such that that subsurface migration of any leakage from the TEEB – assuming such leakage were to occur – would be unlikely. Finally, LES will

implement a monitoring program designed to detect to any postulated releases to the environment. For these reasons, I do not believe that it is necessary to estimate of the probability and frequency of leakage through the liners of the TEEB, or to provide any additional analysis of the fate of any assumed leakage beyond that already provided by LES in the NEF Environmental Report and in this testimony.

The appropriate considerations described above that are applicable to the single-lined UBC Storage Pad Stormwater Retention Basin lead to the same conclusion that it is not necessary to estimate of the probability and frequency of leakage through the liner of the UBC Storage Pad Stormwater Retention Basin, or to provide any additional analysis of the fate of any assumed leakage beyond that already provided by LES in the NEF Environmental Report and in this testimony.

Q58. NIRS/PC have identified several documents in support of Basis B of the amended contention. Are you familiar with these documents?

A58. (GAH) Yes. The documents include the following: (1) EPA, 1994a, *The Hydrologic Evaluation of Landfill Performance (HELP) Model, User's Guide for Version 3,* EPA/600/R-94/168a (Sept. 1994); (2) Laine, D.L., and M.P. Miklas, Jr., 1989, *Detection and Location of Leaks in Geomembrane Liners Using an Electrical Method: Case Histories,* Southwest Research Institute, San Antonio, Texas, Proceedings of the 10th National Conference, Superfund '89, Washington, D.C., U.S.A. (Nov. 27-29, 1989); and (3) EPA, 2004a, *Survey of Technologies for monitoring Containment Liners and Covers,* EPA 542-R-04-013, June 2004.

Q59. Do these documents alter your conclusion regarding Basis B of the amended contention?

A59. (GAH) No. The first document is a user's guide intended to explain how to use Version 3 of the Hydrologic Evaluation of Landfill Performance (HELP) computer program, "a quasi-two-dimensional hydrologic model of water movement across, into, through and out of landfills." It is "a tool for both designers and permit writers," the "primary purpose [of which] is to assist in the comparison of design alternatives as judged by water balances." The user's guide discusses "data requirements, nomenclature, important assumptions and limitations, other fundamental information needed to run the program." It also describes the procedures and options available to input data, execute the model, and obtain results. In other words, it is not a definitive study specific to the issue of leakage of geosynthetic liners.

The EPA user's guide speaks in terms of "pinhole defects" generally resulting from manufacturing flaws such as polymerization deficiencies," and notes that "[t]he density of pinholes and installation defects is a subject of speculation." To the extent it provides "representative installation defect densities" for input purposes, it states that they are intended to be "reasonably conservative" so as to allow determination of "maximum probable leakage quantities." The document also indicates that the density of installation defects is "a function of the quality of installation, testing, materials, surface preparation, equipment, and QA/QC program," and that typical geomembranes may have about 0.5 to 1 pinholes per acre. The surface area of TEEB is approximately 0.75 acres at bottom of the basin and 1.75 acres at high water level. The area of the UBC basin is approximately 19 acres at high water level.

Notably, a companion report to user's guide, the Engineering Documentation for Version 3, defines a composite liner as a low permeability soil liner covered with a geomembrane (The TEEB and UBC basins both meet this definition). The geomembrane component of a composite liner virtually eliminates leakage except in the area of defects, punctures, tears, cracks and bad

seams. In contrast, "pinhole" flaws are more commonly associated with the original, less sophisticated, geomembrane manufacturing techniques. Current manufacturing and polymerization techniques have made pinhole flaws less common. Indeed, this document recommends use of a flaw density of 1 flaw per acre for intensively monitored projects. Based on above, and given LES's commitments to install per NMED guidelines, potential leaks in the liners will be as low as is physically possible to achieve.

The second document cited by NIRS/PC, Laine and Miklas (1989), does not appear to contain data that are germane to the lined basins to be installed at the NEF. The authors of this report reportedly reviewed data for 61 geomembrane-lined facilities and concluded that leaks were detected at 58 of the 61 facilities. These facilities included: primary and secondary liners at landfills; concrete vaults for solid waste storage; wastewater storage ponds for sewage treatment facilities; above-ground steel tanks for storage of hazardous materials; brine storage impoundments; descaling ponds for natural gas transmission companies; and cooling water ponds. It is not clear from the report which data apply to a particular type of installation, or how much of data are even relevant to the proposed NEF lined basins. Moreover, the data provided in Laine and Miklas (1989) appear to be skewed, *i.e.*, they are heavily influenced by a few installations at which there were a very high number of detected leaks. For instance, two of the 61 installations accounted for 27% of all detected leaks in the data set. Seven of the 61 installations accounted for approximately 50% of all detected leaks (*see* LES Exhibit 72).

The third document referenced by NIRS/PC simply describes various methods for detecting leaks beneath lined landfills and impoundments. According to this document, the accepted practice or "industry standard" for monitoring the performance of liner systems is to install groundwater monitoring wells at the down-gradient edge of the unit and periodically test

the groundwater for changes in its quality that might indicate that a release is occurring. LES's proposed monitoring approach for the NEF is consistent with the accepted industry practice. Thus, this document in no way suggests that the liners to be installed at the NEF will not perform their intended function.

Q60. In Basis C of the amended contention, NIRS/PC assert that the DEIS should explain the presence of this moisture in two of the soil borings installed by LES at the NEF site. According to NIRS/PC, the presence of such moisture conflicts with the Staff's statement in the DEIS that "... no precipitation recharge (*i.e.*, rainfall seeping deeply into the ground) occurs in thick, desert vadose zones with desert vegetation." What is conclusion relative Basis C?

A60. (RLP) I strongly disagree with the conclusion reached by NIRS/PC is Basis C. Indeed, this is the same issue raised by NIRS/PC in their original contention relative to LES's alleged failure to adequately evaluate whether groundwater exists in the alluvium at the NEF site. I fully addressed this issue earlier. In short, the moisture observed in two soil samples likely represented some "residual" moisture attributable to the moisture storage capacity of the soil in the vadose zone. It did not reflect the existence of saturated conditions. This opinion is consistent with those of the individuals who logged the two borings at issue. Extensive boring data from both the NEF and WCS sites confirm that continuous saturated conditions do not exist in the alluvium beneath those sites, and that the first continuous saturated unit beneath the NEF site occurs at a depth of approximately 220 feet. Indeed, the "slightly moist" cuttings and "moist" clay descriptions were used only twice in the descriptions from the nine hydrogeologic and five geotechnical borings performed at the NEF site. All other determinations, 66 in number, were either "dry" or "very dry." Finally, the Staff's statement regarding the lack of

recharge correctly reflects site conditions, namely, the low rate of precipitation and high rate of evapotranspiration.

Q61. In Basis D of the amended contention, NIRS/PC states that two types of permeability measurements have been made on the Chinle Formation at or near the site: laboratory measurement of core samples and a slug test performed in MW-2. According to NIRS/PC, "[s]uch extremely limited measurements, where faults are present, cannot describe the permeability of the entire site, and NRC should explain its reliance on such restricted data." Please state your conclusion regarding this assertion.

A61. (RLP) Neither LES nor the NRC Staff relied on "restricted data" in assessing the potential for "fractures or other fast flow pathways" to exist below the NEF site. This issue was assessed through review of NEF site boring logs (nine hydrogeologic and five geotechnical) and three monitor wells, the extensive information in WCS reports, the existence of the dense Chinle (red bed) clay under the site and familiarity of this structure in the vicinity of the site, hydraulic conductivity and permeability data obtained from both NEF and WCS sites, and the confined siltstone layer, at approximately 220 to 230 feet below ground surface, with measured high piezometric levels (reflecting confined conditions). This information, particularly when viewed in the aggregate, does not indicate that fractures and fast flow paths exist under the National Enrichment Facility site.

Q62. In Basis E of the amended contention, NIRS/PC allege that the Site Stormwater Detention Basin will discharge runoff containing numerous contaminants, and that the DEIS neither adequately identifies these contaminants nor explains how they will be monitored. According to NIRS/PC, the presence of these contaminants should be disclosed and the

stormwater should be monitored for such contaminants. Please state your views regarding this basis.

A62. (GAH) LES will conduct monitoring of site stormwater runoff in accordance with applicable Federal/State requirements. The ER specifically states that the "monitoring program will be refined to reflect applicable regulatory requirements," and that "the Site Stormwater Detention Basin will adhere to the requirements of the Groundwater Discharge Permit/Plan from the [New Mexico Water Quality Board]."

Section 6.2 of the NEF Environmental Report sets forth LES's proposed physiochemical monitoring program, which encompasses the Site Stormwater Detention Basin. In particular, Table 6.2-2, "Stormwater Monitoring Program for Detention and Retention Basins," sets forth the various parameters to be monitored by LES (as well as the monitoring frequency, sample type, and lower limit of detection) with respect to stormwater detention basin discharges. These parameters include oil and grease, total suspended solids, 5-day biological oxygen demand, chemical oxygen demand, total phosphorus, total Kjeldahl nitrogen, pH, nitrate plus nitrite nitrogen, and metals. The proposed monitoring program meets or exceeds NPDES Multi-Sector General Permit stormwater monitoring requirements. It also exceeds monitoring requirements at two nuclear power plants with which I am familiar. LES believes this proposed plan to be adequate in view of applicable regulatory requirements and site conditions, and the fact that the applicable permitting processes are still in progress.

Q63. In support of Basis E, NIRS/PC cite two references: (1) Barrett, M.E, et al., "Review and Evaluation of Literature Pertaining to the Quality and Control of Pollution from Highway Runoff and Construction," Technical Report CRWR 239 (April 1993); and (2) Mahler, B.J. et al., "Concentrations of Polycyclic Aromatic Hydrocarbons (PAHs) and Major and Trace

Elements in Simulated Rainfall Runoff from Parking Lots, Austin, Texas, 2003" United States Geological Survey, Open File Report 2004-1208 (2004). Have you reviewed these documents?

A63. (GAH) I have reviewed an updated (second edition) of document (1) published in 1995 as well as document (2).

Q64. Does your review of these documents alter your conclusion regarding the adequacy of LES's proposed plan for monitoring Site Stormwater Detention Basin Discharges?

A64. (GAH) No. The first report (second edition) provides a review and evaluation of the literature associated with the quantity and control of pollution from highway runoff and construction. The report notes that studies "which have shown minimal effects on groundwater quality have been located in areas with fairly thick soils, which immobilize many of the pollutants in runoff." The report notes that even thin soils can result in significant attenuation and that no obvious impact of highway runoff on groundwater was found. The report provides information that shows that potential groundwater contamination would be more likely to occur where the runoff is immediately available to shallow groundwater systems, which is not the case at the NEF site (*see* LES Exhibit 71). The soils at the NEF site will provide similar attenuation of any runoff constituents from the paved vehicle roadways or parking lots at the NEF site and no impacts on groundwater are expected. This conclusion would apply to the conveyance systems, basin and outfall areas. The second report looked at polycyclic aromatic hydrocarbons ("PAHs") that might wash off of seal-coated parking lots that might be transported to surface bodies of water. Given the depth of soil to groundwater and the conclusions of the first study described above, no impacts to groundwater from PAHs – even assuming they were present – are expected at the NEF site. Likewise, this conclusion would apply to the conveyance systems, basin and outfall areas.

Q65. Please state your overall conclusions relative to Contention NIRS/PC EC-1 (including all bases admitted in support of the contention).

A65. (GAH/RLP) The potential for NEF operations to have adverse impacts on water resources is very low in view of the lack of any surface waters, LES's proposed treatment of effluents prior to discharge and use of other preventive measures designed to preclude contamination of effluents and site runoff, LES's proposed use of engineered basins/systems to collect facility discharges and runoff, favorable site hydrogeological conditions, and LES's proposed environmental monitoring program.

Contention NIRS/PC EC-1, in effect, represents a "parade of horribles" scenario that rests on the postulated occurrence of a series of events, each of which, in its own right, is unlikely to occur. This unlikely series of events would include contamination of facility discharges and runoff at levels that would exceed applicable regulatory limits; faulty performance of facility engineered basins and systems; substantial infiltration of facility discharges and/or site runoff, despite high evaporation/evapotranspiration rates and the presence of low-permeability soils; and the transport of contaminants either along the alluvium/Chinle contact or to water-bearing units no less than 200 feet below ground surface through postulated, but unobserved, "fast flow paths."

Q66. Does this conclude your testimony?

A66. Yes.

FRAMATOME ANP

GEORGE A. HARPER, P.E.
FRAMATOME ANP

Title/Position: Manager
Regulatory Compliance Programs

Years of Experience: 25

SUMMARY

Mr. Harper has over 25 years of nuclear industry experience in analyzing environmental, hydrologic, hydraulic, seismic, geotechnical, groundwater, tornado and tornado missile, and probabilistic risk assessment (PRA) issues relating to nuclear power plants. He currently manages over 60 scientists, engineers and technicians in the Regulatory Compliance Programs Department. This department provides services in areas including; environmental, health and safety, environmental engineering, health physics, radiation protection, quality assurance, environmental laboratory and emergency planning.

Mr. Harper has recently participated in development of a license application for a uranium enrichment facility. Responsibilities included overall management of the environmental report, development of portions of the environmental report, integrated safety analysis (ISA) and the portions of the security threat assessment. He was also responsible for the external events portion of the ISA. Mr. Harper has participated in siting evaluations for dry independent spent fuel storage installations (ISFSI) at the Vermont Yankee and Yankee Rowe nuclear plants, which included participating in environmental and geotechnical assessments at both locations. He has recently completed a similar effort for Seabrook Station. These assessments involved addressing environmental, seismic, soil amplification, liquefaction and slope stability issues. He also provided geotechnical and environmental field support during ISFSI construction at Yankee Rowe and also supported preparation of the 10CFR72.212 evaluation. Mr. Harper is experienced at performing TNT blast equivalent evaluations for determining safe separation distances between design basis threats and critical facilities.

Mr. Harper has also performed many environmental studies including; environmental effects of plant power level uprates, heat dissipation in receiving waters, storm water runoff, dilution of plant effluents in receiving waters and NPDES supporting studies. Performs and manages various analyses and safety evaluations in support of nuclear plant engineering, environmental, licensing, design and operations. Mr. Harper participated on a task force at Seabrook Station to determine the root cause and identify corrective actions after tritium was discovered in the groundwater near the spent fuel pool. His areas of responsibility included identifying the extent of groundwater contamination and the likely groundwater travel paths. He developed a recommended groundwater remedial plan which is presently being implemented.

Mr. Harper completed a Federal Energy Regulatory Commission (FERC) research project on flood studies associated with dam safety. Recently, Mr. Harper served on a FERC-approved Board of Consultants overseeing dam safety evaluations for some regulated dams in the State of New York. He previously served on a similar FERC-approved Board of Consultants for two dams in the State of Maine. He was responsible for updating the equipment inventory for

Seabrook Station's decommissioning cost estimate study. In addition, he has managed several design changes at Millstone and Seabrook Station. He also provides routine engineering support to Seabrook on various operational, design and system issues.

Mr. Harper has completed external event design basis reviews on flooding, tornado, seismic and potential effects from nearby facilities at Seabrook Station in support of their response to the Nuclear Regulatory Commission's (NRC) 10CFR50.54(f) request concerning licensee licensing basis compliance. He also completed similar reviews at Millstone Unit 3, and served as the Lead Engineer for Millstone Unit 3's Chapter 2 Updated Final Safety Analysis Report (UFSAR) verification. In addition, he developed and presented a three-day training course to Ukrainian nuclear engineers on methodologies for evaluating nuclear power plant external flooding.

Mr. Harper has completed various tornado venting analyses to support design changes at several plants. He has also performed individual plant examinations of external events (IPEEE) for probable maximum flooding (PMF) at eight nuclear power plants. He has also participated in numerous PMF studies for hydro power dams. Mr. Harper has also been extensively involved in decommissioning activities and waste siting issues. He planned and performed media sampling efforts in support of decommissioning site characterization. He performed various geotechnical and slope stability assessments associated with hauling heavy equipment and components during decommissioning. He also provided engineering support for decommissioning studies and for radiological evaluations, including ingestion pathway, liquid pathway, and on-site and off-site disposal. In addition, Mr. Harper has provided engineering and environmental support for low level radioactive waste (LLRW) siting issues in Vermont and Maine.

EDUCATION/TRAINING

MS, Civil Engineering, University of Massachusetts, 1978
BS, Civil Engineering, University of Massachusetts, 1975
Integrated Safety Analysis Leader Training, Process Safety Institute, 2002
Managing Projects with Microsoft Project2000, 2001
Computer-Aided Hydrology and Hydraulics, American Society of Civil Engineers (ASCE), 1994
MODFLOW for Simulation of Groundwater Flow and Advective Transport, National Groundwater Association, 1992
Calculating Explosion Hazards, American Institute of Chemical Engineers (AIChE), 1990
Soil Dynamics and Foundation Engineering, University of Missouri, 1987
Wind Loads on Buildings and Structures, Texas Tech University, 1984
Seismic Design and Analysis of Earth and Rockfill Dams, University of Missouri, 1982
Analytical Techniques for HEC-1 and DAMBRK, Pennsylvania State University, 1982
Flood Predictions, Estimations and Forecasting, Colorado State University, 1981
Statistical Computer Techniques in Hydrology and Water Resources, Colorado State University, 1980
Flood Plain Hydrology HEC-1, Pennsylvania State University, 1979
Embankment Dams, Design and Construction, Massachusetts Institute of Technology (MIT), 1979
HEC-2 Advanced, Pennsylvania State University, 1978
Flood Flow Frequency Analysis, Pennsylvania State University, 1978

FRAMATOME ANP

PROFESSIONAL AFFILIATIONS/CERTIFICATIONS

Registered Professional Engineer: Massachusetts, New Hampshire, Maine
American Society of Civil Engineers (ASCE), Member

EXPERIENCE

Manager, Regulatory Compliance Programs	1/03-present
General Manager, Environmental Health & Safety Department	10/01-12/02
Manager, Environmental Services Group	10/00-10/01
Consulting Engineer	12/97-10/00

Framatome ANP Inc. / Duke Engineering & Services

Performs and manages various analyses and safety evaluations in support of nuclear plant engineering, environmental, licensing, design and operations. Led the design team performing marine mammal barrier system design work for the submerged offshore intakes of Seabrook Station's circulating water system. This system was successfully installed in 1999 and has successfully eliminated the entrapment of seals.

Provided support to Seabrook Station on thermal impact on ocean cooling water temperature rise for two-pump versus three-pump circulating water system operation. Also, addressed state and Environmental Protection Agency (EPA) issues associated with adequacy of plankton entrainment sampling system for Seabrook's circulating water system. He also participated in a siting study to select a dry fuel storage location at Seabrook Station.

Participated in the siting process for a dry storage ISFSI at the Vermont Yankee Nuclear Power Station, which resulted in the selection of a preferred site. Subsequently, managed the geotechnical assessments that included seismic evaluations of underlying soils at the selected location for amplification and liquefaction potential. Participated in the overall siting process for a dry storage ISFSI at the Yankee Rowe Nuclear Power Plant, which is presently being decommissioned. This process resulted in the selection of a preferred site. Completed soil amplification, liquefaction, slope stability, geotechnical assessments and site flooding evaluations in support of the detailed design. Provided field support during construction of the ISFSI facility.

Recently served on a FERC-approved Board of Consultants overseeing dam safety evaluations on two dams located in New York. Previously completed a similar project in Maine. Performed probable maximum flood (PMF) studies for a New Hampshire dam owned by the State of New Hampshire and a New York dam owned by the New York Power Authority (NYPA). Recently assisted in developing an updated PMF study at a Duke Power dam in South Carolina. Held responsibility for a design change that designed and installed roof scuppers on all safety-related structures at Millstone Unit 2. Also, provides technical support for Seabrook Station's decommissioning cost estimate. In addition, performs safety evaluations in support of design changes and external event issues that could impact plant operations.

FRAMATOME ANP

Principal Engineer 04/79-11/97
Yankee Atomic Electric Company

Performed configuration management reviews at Millstone and Seabrook for external event design bases. Managed and assisted in Millstone Unit 3's Chapter 2 UFSAR verification. Provided ongoing geotechnical and sampling support for decommissioning activities. Performed external flooding evaluations for the individual plant examination of external events (IPEEE) at eight nuclear power plants. Completed a major research program under contract to the Electric Power Research Institute (EPRI) to develop an extreme rainfall probability methodology. Compiled and evaluated site-specific severe weather data in support of blackout evaluations at the Seabrook, Vermont Yankee and Yankee Rowe nuclear power stations. Redesigned and licensed a major modification to Seabrook's flood protection system. Formulated groundwater radiological travel time estimates to surface water bodies at the Yankee Rowe, Vermont Yankee, Maine Yankee and Seabrook nuclear power stations to support licensing requirements and evaluate unplanned liquid radiological releases to the environment. Performed groundwater modeling at the Yankee site using MODFLOW to support decommissioning activities.

Lectured at the Harvard School of Public Health on "Radionuclide Transport Evaluations: Terrestrial and Aquatic." Provided training to Ukrainian nuclear engineers on nuclear plant flooding evaluations. Developed testimony and testified before the Vermont Public Service Board on licensing requirements for siting a low level radioactive waste (LLRW) disposal site. Supported Vermont Yankee and Maine Yankee on site characterization issues for siting a LLRW disposal facility in Vermont and Maine, respectively. Provided engineering support for Vermont Yankee's LLRW storage facility safety evaluation. Projected LLRW disposal costs for New Hampshire in support of a decommissioning study.

Performed explosion hazard evaluations for the on-site storage of various gases, and probabilistic evaluations of tornado missile impacts on safety-related equipment. Developed technical input for plant decommissioning cost estimates and storm drainage system hydraulic modeling. Developed site-specific tornado wind and pressure drop probabilistic hazard curves, and building venting calculations for tornado induced pressure drop evaluations. Produced a major update to Seabrook's decommissioning study.

Supported the Yankee Rowe Nuclear Power Station Systematic Evaluation Program (SEP). Successfully resolved all external flooding and tornado missile issues. Developed tornado and wind hazard descriptions, and determined structure and system wind fragilities as part of the tornado and wind cost/benefit analysis.

Engineer 09/77-03/79
DuBois & King, Inc.

Performed data collection, engineering analysis, computer modeling of rivers, flood forecasting, design of hydraulic structures, and report preparation work. Also, negotiated contracts with local, state and federal agencies.

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RESUME

ROGER L. PEERY

EDUCATION

1989-92 Master of Science in Water Resources (1992)
University of New Mexico, Albuquerque, NM

1984-87 Bachelor of Science in Geology (1987)
University of New Mexico, Albuquerque, NM

EXPERIENCE

1988- CEO/Senior Hydrogeologist, John Shomaker & Associates, Inc.

Water-resource evaluations, water-resource development, and water-well siting.

Project manager for regional and local water planning, including two regional water plans accepted by the New Mexico Interstate Streams Commission.

Project management and field supervision of water-well and monitor drilling and construction for wells completed at depths exceeding 3,000 feet, deep-aquifer discrete-interval zone sampling, well development/sampling, infiltration testing, injection wells completed at depths exceeding 3,500 feet, and injection testing.

Related well experience also includes development of drilling specifications for wells drilled up to 3,000 ft below ground level, wells completed using casing path design method, and artesian wells.

Ground-water flow modeling, aquifer test pumping and interpretation of test data, and evaluation of ground water in storage.

Project manager for site investigations and remediation of contamination associated with leaking underground-storage tanks.

Evaluation of hydrogeology for aquifer storage and recovery projects.

PROFESSIONAL DEVELOPMENT

1992	Hydrologic Evaluation for Landfill Performance Modeling (HELP), University of Milwaukee, Wisconsin
1993	Applying Ground Water Flow Modeling Techniques to Field Problems, Environmental Education Enterprises Institute and the Association of Engineering Geologists
1993	Borehole Geophysical Techniques for Water Wells, Hughbert A. Collier, Ph.D.
1994	A Design Workshop for Soil and Groundwater Remediation, University of New Mexico, College of Engineering
1997	Risk Based Corrective Action Applied at Petroleum Release sites, ASTM
1998	Fractured Rock Hydrogeology, University of Arizona, Shlomo Neuman, Ph.D.
1999	Applied Transport and Fate Modeling for Risk-Based Soil Screening and Cleanup Levels Using SESOIL and AT123D, National Ground Water Association
2000	Visual MODFLOW, National Ground Water Association
2002	Applications in Risk Assessment, Remediation, Modeling, and GIS, National Ground Water Association
2002	Estimating Times of Remediation Associated with Monitored Natural Attenuation and Contaminated Source Removal, National Ground Water Association
2004	Artificial Recharge of Ground Water, National Ground Water Association

PROFESSIONAL REGISTRATION

- American Institute of Professional Geologists, CPG-9808
- State of Wyoming Professional Geologist, PG 2363 (New Mexico does not register geologists)
- New Mexico Environment Department Underground Storage Tank Bureau Certified Scientist, No. 002
- State of New Mexico Regulation and Licensing Department Construction Industries Division, GS29 No. CQ064612
- State of Texas Licensed Professional Geologist, No. 2222

MEMBERSHIPS

- Association of Ground Water Scientists and Engineers
- American Water Resource Association, New Mexico Section, President 1998

EXPERT TESTIMONY

Provided sworn testimony before Santa Fe County Development Review Committee, Santa Fe County Commissioners, Sandoval County Planning and Zoning Committee, Sandoval County Commissioners, Socorro County Commissioners, San Miguel County Commissioners, and New Mexico Office of the State Engineer hearing examiners.

PUBLICATIONS

Finch, S. T., Jr., and **Peery, R. L.**, 1995, Soil investigations and installation of shallow ground-water monitoring wells using a hand-held auger: National Ground Water Association, Preceding for the Ninth National Outdoor Action Conference/Expo, May 2-4, 1995.

Peery, R. L., 1995, The importance of hydrogeologic evaluation and water resource assessment in subdivision planning, Santa Fe County, New Mexico, AWRA 1995 Annual Meeting and Field Trip.

Author and Co-Author of numerous ground-water studies available in the public record as consultant's reports.