Review of the NorthMet Mining Project and Land Exchange

Supplemental Environment Impact Statement, November, 2013

Donald W. Lee, Ph.D., P.E.

March 10, 2014

Overview

I am retired from a 31-year career of environmental research at Oak Ridge National Laboratory. My title at the time of retirement was Senior Research Scientist. My technical specialties are fluid mechanics, hydrology, environmental impact assessment and performance assessment applied to waste management facilities. My training is in applied mechanics, engineering science and mechanical engineering. My research areas are in waste management, safety analysis, and environmental impact analysis of major energy projects. I have over 150 publications as environmental impact statements, technical reports, refereed journal publications, and book chapters. I have performed research for the Nuclear Regulatory Commission, Department of Defense, Department of Army, Environmental Protection Agency, Department of Energy, and Federal Energy Regulatory Commission. I served as an expert witness for the U. S. Environmental Protection Agency Region II in the matter of National Discharge Elimination System Permits for Central Hudson Gas & Electric Corp., Roseton Generating Station, et al. in New York, New York. A detailed resume of my experience and training is attached.

I have prepared and reviewed numerous environmental impact statements for nuclear power stations, coal fired power plants, hydropower plants, uranium mining, chemical weapons destruction facilities, and energy conservation technologies. My technical focus for the majority of these activities has focused on the analysis of surface water and groundwater hydrology, and the impacts to surface water and groundwater resources from the proposed actions and their alternatives. I have also prepared mitigation strategies to minimize potential impacts to the environment. I am knowledgeable of the regulations for the National Environmental Policy Act in both their application to projects and the subsequent enforcement of the regulations. My review of this project is based on this experience. The review that follows identifies many of the regulatory and technical weaknesses that are present in the NorthMet Mining Project and Land Exchange Supplemental Environmental Impact Statement (SDEIS).

The SDEIS is not compliant with the regulations in 40 CFR 1500 – 1508, and is technically inadequate. The proposed action is conceptual and not specific, and is not compared to reasonable alternatives. The descriptions of the affected environment are not representative of the site specific conditions at the mine site or the plant site. The environmental consequences presented in the SDEIS are based on assumptions that are not substantiated or are unjustified. Consequently, the conclusions presented in the SDEIS are not defensible and should not be used as a basis for making decisions affecting the environment.

Failure to Respond to 40 CFR 1500 – 1508

The SDEIS fails to identify and assess the reasonable alternatives to the proposed action as required by 40 CFR 1500.2(e). Only one alternative is identified, underground mining, but it is dismissed as being not profitable in an analysis using generalized assumptions not representative of the NorthMet site (Appendix B, Attachment 1 of the SDEIS). A similar analysis for the proposed action, which would allow a comparison, is not presented. Alternative sites, waste management, water management, tailings management, monitoring, and mitigation measures are not considered or assessed. The consequences of potential accidents and alternatives for mitigating any potential accidents are not identified or assessed. The SDEIS does consider the alternatives for the exchange of land, but the SDEIS cannot be considered compliant with the regulations in 40 CFR 1500 – 1508 for the consideration of alternatives for the mining project.

"The primary purpose of an environmental impact statement is to serve as an action forcing device to insure that the policies and goals defined in the Act are infused in the ongoing programs and actions of the Federal government." (40 CFR 1502.1) This purpose has not been realized in the SDEIS. On page ES-42, the claim is made that alternatives were identified and screened in accordance with the requirements of 40 CFR 1505.1(e). This is an erroneous citation. The reference to 40 CFR 1505.1(e) refers to NEPA and agency decisionmaking procedures, not the preparation of an EIS. The correct citation is 40 CFR 1502.14, which states, "Alternatives including the proposed action. This section is the heart of the environmental impact statement. Based in the information and analysis presented in the sections on the Affected Environment (1502.15) and Environmental Consequences (1502.16), it should present the environmental impacts of the proposed action and the alternatives in comparison form, thus sharply defining the issues and providing a clear basis for choice among options by the decisionmaker and the public." 40 CFR 1502.14 goes on to require a rigorous exploration and objective evaluation of all reasonable alternatives. The SDEIS in Sect. 1.4.1.2 refers to the consideration of "practicable alternatives." This is simply incorrect. The SDEIS needs to consider all reasonable alternatives. Having not done so is a significant flaw in the SDEIS.

Sect. 3.2.3 provides a discussion of the screening of alternatives to the proposed action. Noteworthy in Sect. 3.2.3, the reference to reasonable alternatives is made in contradiction to Sect. 1.4.1.2. The result of the screening of alternatives in Sect. 3.2.3 was either to eliminate an alternative or incorporate an alternative into the proposed action. As a result, there is no other alternative to the proposed action other than the alternative of no action. This is specious reasoning that is not responsive to the purpose of an environmental impact statement or the requirements of 40 CFR 1502.2(g). Making environmental decisions is not a black or white matter, but is a decision based on making the best choice among the alternatives available to the decisionmaker. The SDEIS preparers have assumed the responsibility of the decisionmaker for each of the Federal agencies responsible for this SDEIS and have made the decision for the decisionmaker prior to receiving public input. This is a clear violation of NEPA and the requirements of 40 CFR 1502.2(g).

The fundamental purpose of the SDEIS is to comply with the requirements of 40 CFR 1500 – 1508. This statement needs to be included in Sect. 1.5 and incorporated into the SDEIS.

40 CFR 1502.7 specifies the page limits for an EIS should be less than 300 pages. 40 CFR 1502.2(a) states "Environmental impact statements should be analytic and not encyclopedic." 40 CFR 1502.2(c) says that "Environmental impact statements shall be kept concise and shall be no longer than absolutely necessary to comply with NEPA and with these regulations." The SDEIS is in excess of these page limits, is not concise, and is more encyclopedic than analytic. Redundant information that is often contradictory or irrelevant is included in every section. The history of the SDEIS presented in Sect. 2 is encyclopedic and should be an appendix at best. Sect. 2 does not contribute to the SDEIS or to understanding the information presented in the SDEIS.

40 CFR 1502.23 calls for a cost-benefit analysis when environmentally different alternatives are being considered. While not a requirement for every environmental impact statement, a cost-benefit analysis should be included as an appendix or by reference in evaluating the environmental consequences of the alternatives. The cost-benefit analysis need not display the relative merits and drawbacks of the alternatives in strictly monetary terms when there are important qualitative considerations. This analysis provides no comparison of the proposed action of open pit mining with the alternative of underground mining. The analysis in Appendix B strictly provides an estimate of profit using generalized assumptions applicable to underground mining, which are not site specific. This analysis provides no cost analysis for the proposed action for comparison with the costs of the alternative of underground mining. Furthermore, the consideration of legacy costs for closure, reclamation, monitoring and water treatment are not provided for either underground mining or open pit mining. Sect. 2.4 of Appendix B states, "Economic feasibility is based on the balance of costs and profit margins against the value of mineable material. Since PolyMet is a private sector for profit company, the value of the saleable material would need to provide sufficient income to cover operating cost (which includes but is not limited to the cost of mining, processing, transportation, and waste management), capital cost (to build and sustain facilities), an adequate return to investors, reclamation, and closure costs and taxes." This is a reasonable statement, but is not supported by the analysis of projected costs and the related benefits for the underground mining alternative. Consequently, the analysis presented in Appendix B is not complete. This analysis does not provide a basis to conclude the underground mining alternative is not profitable, and it is not responsive to the requirements of 40 CFR 1502.23.

Numerous assumptions are incorporated into the description of the affected environment and the environmental consequences. Some of the assumptions are stated as matters of fact, which they are not, while stated assumptions often are not justified. While the proposed action is complex and there are numerous unknowns that would only be quantified if site operations were to begin, 40 CFR 1502.22 provides the necessary requirements for addressing information that is incomplete or not available. In these circumstances, the environmental impact statement should make clear the information that is lacking. The SDEIS has not presented this in Sects. 3, 4, and 5. Furthermore, 40 CFR 1502.22(b) requires statements and analysis to be included in an environmental impact statement when obtaining information is too costly or methods are unknown. Incomplete or unavailable information has been insufficiently addressed in the SDEIS, but is an important factor in understanding the environmental consequences of the proposed action.

Failure to Describe the Proposed Action

The description of the proposed action is conceptual and not quantitative. While the process description in Sect. 3 is largely complete, the fluxes within the process are incomplete or missing. For example, on page 3-163, the makeup water is described as being between 20 – 810 gpm. At the least, this sort of description is confusing and leads to the conclusion the design is incomplete.

A large source of confusion is the categorization of the blasted material in the open pit into ore or one of the four waste rock classifications. Figure 3.2-2 suggests the segregation of materials into one of the five categories is performed in the pit after blasting. How can this possibly be done with the huge amount of rock after each blasting? Table 3.2-8 is not sufficient to justify the categorization of the materials. The segregation of the waste rock into Category 1 is of special importance since this material will be permanently placed in an unlined pile that can leach contaminants directly to the surficial materials and subsequently to bedrock.

The Category 1 waste rock pile is proposed to have a cutoff wall and a drainage collection system around the entire perimeter of the pile. The water collected by the system is to be sent to the WWTF. The collection efficiency of the collection system is alleged to be greater than 90% (pg. 3-46). This is simply an assumption not justified or supported by analysis or data. Such a drainage system would require routine maintenance to prevent clogging from fines or mineralization. This is not noted in Sect. 3 and is not considered in Sect. 5.

Figure 3.2-16 assumes the water table will be below the base of the Category 1 waste rock pile. This assumption is unjustified and unlikely to occur, especially as the pile ages and the performance of the collection system degrades. The performance of the Category 1 waste rock pile depends on the physical and chemical characteristics of the waste rock. These parameters have not been characterized for the Category 1 waste rock or any of the other categories of material, beyond stating their presumed sulfate concentrations. This lack of data regarding physical and chemical characteristics of the waste rock carries over to the design of the WWTF, which could be inadequate for the contaminants in the influent.

The proposed design for the tailings pile (a 200 ft. tall pile is not a basin) includes a cutoff wall and a drainage collection system around the some portions of the pile. The collected water from the drainage system is to be sent to the WWTP. The collection efficiency of this drainage system is assumed to be greater than 99%. This is an assumption that is not justified or supported by analysis. Similar to the Category 1 waste rock pile, there is no recognition of the need for routine maintenance of the system to ensure drains are not clogged with fines or mineralization either in Sect. 3 or Sect. 5.

Figure 3.2-28 of the tailings pile assumes the bedrock beneath the tailings pile is a no flow boundary (impermeable). This is not justified and is an incorrect interpretation of the local geology. On pg. 4-94, the SDEIS considers the geology of the Giants Ridge Granite to be mechanically similar to the Duluth Complex and to have similar hydrogeological characteristics. The Duluth Complex is fractured and faulted as evidenced by the high wall in the Dunka Pit. Accepting the geologic description of Giants Ridge Granite in the SDEIS, a no flow boundary beneath the tailings pile is an unjustified assumption that leads to misleading results in Sect. 5. The flawed assumptions in the tailings pile design lead to errors in the determination of the environmental impacts. The tailings pile is currently discharging water and contaminants to surface water, surficial deposits, and bedrock. Placing a cutoff wall around some portions of the tailings pile is insufficient to contain all of the water currently discharging to the surficial deposits and bedrock. Water and contaminants from the tailings pile discharging to the surficial deposits is likely to discharge to the Partridge and Embarrass Rivers. Water discharging to the fractured bedrock could discharge to surface water at any location depending on the nature of the fractures in the rock.

The proposed action manages water at the mine and plant sites with only storm water being released to surface water. There is no provision for managing accumulated water within the tailings pile or the material piles at the mine site to drain in the event of excessive rainfall, snowmelt, or excessive discharges from the mine site or the plant site. As a result, the potential for significant consequences from reasonably foreseeable accidental events needs to be considered in the SDEIS as required by 40 CFR 1502.22(b)(4).

A significant weakness of the description of the proposed action is the dependence of the design on assumptions presented in Sect. 5. The determination of fluxes of water and contaminants are important to understand the proposed design, but the fluxes are not provided. As a result, the consistency of the design with the consequence analysis is not established. A water balance for the proposed action has not been provided, and mass balances for various elements of concern are also not available. Lacking these fundamental analysis tools, the reasonableness of the results presented in the SDEIS cannot be assessed.

The alternatives presentation in Sect. 3 is flawed. The preparers of the SDEIS have decided among all of the alternatives which are acceptable and which should be eliminated, rather than allowing the decisionmaker to make the decision after the public comment on the alternatives. As noted earlier, this is a direct violation of 40 CFR 1502.14. Additionally, the alternatives eliminated by the preparers of the SDEIS were not analyzed for their environmental consequences, which preclude any real comparison of alternatives.

Failure to Describe the Affected Environment

The description of the affected environment includes many implied assumptions that lead to misrepresentations of the environment. For example, at the beginning of the section, references are made to pump tests performed in the bedrock. The text and references allow that the bedrock is fractured with faults and joints. Pump tests in fractured rock are difficult to interpret, because the standard model for the interpretation of pump test data assumes a porous media, not a fractured media. Fractured media are very conductive in the fractures but not conductive in the unfractured portion of the media. Consequently, pump test data interpreted as porous media yield an average value that underestimates the transport rate in the fractures. The connectivity of the fractures is also difficult to interpret simply from pump testing. Tracer testing is best used to establish the connectivity of fractures, but there is no indication that tracer testing was performed at the mine site in the Duluth Complex, or in the Giants Ridge Complex at the tailings pile site.

Figures 4.2.2-5 and 4.2.2-6 are identified as estimated contours. The wells used as ground truth for the estimated contours are not incorporated into the figures. Given the resolution presented in these figures, understanding the actual data points is important to understanding the initial conditions of the mine and plant site that form the inputs to the modeling in Sect. 5.0. The implicit assumptions in these figures influence the accuracy of the modeling. Importantly, Figure 4.2.2-6 shows the existing groundwater mounds at the tailings pile. These mounds will only get higher as additional tailings are added to the tailings pile. The text (pg. 4-53) uses the classical aquifer description of the water table being a subdued replica of the topographic surface. This is a reasonable assumption for the surficial deposits, but extending this assumption to the bedrock is unjustified. While the bedrock groundwater is connected to the groundwater in the surficial deposits, the behavior of groundwater in the bedrock is controlled by the structural properties (i.e. fractures, joints, and faults) of the bedrock, not the topographic surface. This erroneous assumption misrepresents the nature of the groundwater

XPSWMM, MODFLOW and GoldSim are models. On pg. 4-60, XPSMM outputs are referred to as predictions. At best, the outputs are simulations. At worst, the outputs are misrepresentations. The outputs most certainly are not predictions. This comment applies to numerous other misuses of the word prediction in Sect. 4 and Sect. 5.

Table 4.2.2-23 clearly illustrates the tailings pile and its associated waters are a significant source of sulfate in water at the present and could remain a long-term source of sulfate contamination if not remediated. The addition of sulfate to the tailings pile from sulfide mining provides little room for additional sulfate without violating water quality criteria and exceeding the wild rice criteria. The average sulfate content in Spring Creek currently exceeds the MN water quality criteria (Table 4.2.2-29). This is a compliance issue being addressed, but the addition of the tailings and contaminated water to the tailings pile from the PolyMet mine and plant sites is likely to increase sulfate discharges from the tailings pile. The SDEIS hypothesis that adding tailings and process water from copper-nickel processing will reduce sulfates and other solutes of concern is unjustified and inherently unreasonable.

The text discusses the hydrology of the mine site and suggests surface water and groundwater in the surficial deposits drain to the south and the Partridge River. However, on pg. 4-149 runoff from the northernmost portion of the mine site is said to drain into the 100-mile swamp. Mining will affect the quantity of runoff available to the ephemeral drainage of the mine site and subsequently affect the hydrology of the 100-mile swamp. This portion of the affected environment has not been quantified and the impacts to the 100-mile swamp have not been analyzed in Sect. 5.

The nature of the interaction of groundwater between the surficial deposits and the bedrock is important to understand in terms of the transport of contaminants. On pg. 4-149, the statement is made "Because of the low permeability of the bedrock, the interaction between the surficial deposits and the bedrock aquifer is assumed to be insignificant, according to Seigel and Ericson (1980) and Barr (2010d)." In this example, the answer is assumed without the benefit of site-specific data or any analysis. No tracer tests have been conducted. Additionally, during modeling in Sect. 5 the interface between the two systems is assumed to be a no-flow boundary. Not too surprisingly, adverse impacts to the bedrock aquifer do not occur. This is an important, but simple, misrepresentation of the affected environment.

The unanswered question in Sect. 4.2.14 is the stability of the existing tailings pile. If the existing tailings pile is not stable, then placing additional tailings on top of the tailings pile leads to potentially serious impacts. Similarly, are the landfilled materials and underlying compressed peat at the HRF stable?

A misrepresentation of note in this section is the presentation of the bedrock aquifer. Figure 3.2-28 identifies bedrock materials as a no flow zone beneath the tailings pile, which means the conductivity is zero. Table 4.2.2-5 makes reference to pump tests performed in the bedrock aquifer of the Duluth Complex that have a mean conductivity of 2.3×10^{-3} feet/day, which is certainly greater than zero. These two formations are supposed to have the same hydrogeological characteristics. There is no explanation for this contradiction. Figure 3.2-16 suggests water flows upward from the bedrock to the seepage collection system. Seepage is driven by gravity and cannot flow upwards. The discussion of the hydrogeology of the bedrock at the mine site and the plant site does not consider the effects of glaciation and glacial rebound, which leads to the development of fractures in the bedrock of both the mine site and the plant site. Importantly, the tailings pile and the Category 1 waste rock pile are significant sources of sulfate contamination and have no liner. These are major sources of contamination that will discharge to bedrock. The direction and flux of this leachate cannot be assumed not to enter bedrock from the tailings pile or to be minimized as discussed on pg. 4-45 at the mine site.

Failure to Justify the Environmental Consequences of the Proposed Action

The environmental consequences of the proposed open pit mine and the associated plant site are not justified, and the SDEIS misrepresents the reasonable impacts to be expected.

The notion of collection efficiency greater than 90% of seepage from the Category 1 waste rock and greater than 99% from the tailings pile is simply an assumption that cannot be justified (pg. 5-6). The Category 1 waste rock pile and the tailings pile have no liner, which could provide some mitigation for sulfates generated in the piles. But the piles are not lined. Sulfates will be generated from the waste rock and tailings. The contaminants will migrate into the underlying surficial materials and bedrock. Some of the leachate will be collected by the drainage works around the piles for a while (far less than the projected performance period), but some of the contaminants will enter the bedrock, which is fractured. The text in this section is of the opinion that the fracturing is limited. A visual review of the high wall of the Dunka Pit, where all of the formations are visible, illustrates to even the most casual observer, that the Duluth Complex is fully fractured, as is the Virginia formation. This simple observation points out the assumed efficiency of both the unlined Category 1 waste rock pile and the tailings pile collection systems are not representative of the site characteristics. The environmental consequences of the proposed action are misleading and misrepresent the reasonable impacts of the proposed action.

In a similar fashion, the performance period for treatment at the mine site is modeled as 200 years and the performance period for the plant site as 500 years. These periods are again simply assumptions that are not justified. Not only are they not justified, they are unreasonable. There is no evidence that the engineered systems proposed can reasonably be expected to perform as built for 500 years. There is no discussion or analysis to support the long-term performance of the WWTP. There is no analysis of accidents or failures over these extended performance periods. There is no consideration of alternatives that would not require these extended performance periods. To accept these extended performance periods without the consideration of alternatives is contrary to the requirements of 40 CFR 1500 – 1508 and renders the SDEIS unacceptable.

As mentioned in this review of Sect. 4, models do not provide predictions, especially of the future. Models do provide simulations when they are done well, within the constraints of the model, and the input data available. Lacking sufficient data or incorporating unjustified assumptions leads to misleading and misrepresentative results. This is illustrated graphically in the approach to addressing fractures and fracture flow. In Sect. 3 the figures and text point to the bedrock beneath the Category 1 waste rock and tailings piles as no flow or nearly no flow boundaries. This presumes the contamination generated in the Category 1 waste rock pile and the tailings pile cannot be transported to groundwater in the model. In contrast, in Sect. 4, permeability of the bedrock at the mine site and plant site is determined using pump testing and slug testing. The data developed by these tests are analyzed using models that assume the bedrock is porous media.

In Sect. 5, bedrock impacts are stated. On pg. 5-26, MODFLOW is said to be used as a two layer model with one layer for the surficial materials and one layer for bedrock for the mine site. On pg. 5-27, MODFLOW is said to be used at the mine site with one layer for the surficial materials and seven layers for the bedrock. On pg. 5-33, there is discussion to suggest the presence of fractures in the Duluth Complex could affect transport rates, but the significance of the fractures is not considered to be significant. The discussion states that the Duluth Complex is highly competent with very low conductivities. This is not a justifiable remark. These contradictory discussions are simply unacceptable and at best yield misrepresentations of the proposed action, the affected environment and the environmental consequences of the proposed action.

Figure 5.2.2-4 does not show any groundwater flow to the north from the East Pit. As noted in Sect. 4, there is discharge to the north from the East Pit area to the 100-Mile Swamp. There is no attempt to analyze the impacts to the 100-Mile Swamp from the effects of mining.

The numbers presented in Table 5.2.2-8 show very small recharge fluxes for the East and West Pits. These rates can be no more than assumptions that are not justified. Not only are the materials in the East and West Pits fractured, their fractures are certain to be further enhanced by the blasting associated with open pit mining. The assumed low conductivities result in lowered fluxes of contaminants from the pits with reduced concentrations. The information contained in this Table is misleading.

The conductivities presented in Table 5.2.2-9 appear to be very low. The low conductivities presented will result in low transport rates in the surficial materials and extended periods of time before concentrations of contaminants decline. There is no comparison presented between the MODFLOW results with equivalent monitoring data. Additionally, there is no comparison of the bedrock conductivity with actual data. The proper consideration of fractured materials would lead to a dual porosity model with high conductivities in the fractures and very low conductivities in the unfractured material. With the consideration of fractures, concentrations of contaminants will be higher and of shorter duration. The slimes that are present in the tailings pile are not included in this table. The results presented here are misrepresentative of the impacts that can reasonably be expected.

Table 5.2.2-9 also presents information for the East and West cells of the tailings piles. The horizontal conductivities differ by a factor of two between the West and East tailings piles and the vertical conductivities differ by a factor of ten. Since the current piles are from the same source, how can there be factors of two and ten difference between the two? This leads to confusion.

Fig. 5.2.2-6 does not incorporate the historical creeks that are present beneath the existing tailings pile. Tailings were simply placed on top of the ground from the previous mining project. Even though the creeks are buried, they are likely to still functioning hydrologically. Failure to consider the existence of these creeks in the MODFLOW and GoldSim models underestimates the leakage from the pile both currently and in the future. No justification is provided for failing to consider future discharge to the south from the tailings pile. The creek associated with the discharge to the south originates beneath the pile. Without major geotechnical work, discharges from the south of the tailings pile will continue into the future. The proposed collection system for Second Creek will collect some but not all of the leakage from the tailings pile. The leakage flux will increase as the height of the tailings pile is increased and as degradation of the collection system occurs over time.

Table 5.2.2-11 presents information for modeling that is difficult to understand. The recharge flux from the tailings pile is 0.765 in/yr as noted in this table. The excess of precipitation over evapotranspiration in St. Louis County, MN is 6 in/yr (MDNR, "Climate's Impact on Water Availability"). This leaves 5.235 in/yr of water that has to go somewhere. If the collection efficiencies actually perform to drain in excess of 99% of the available water in the tailings pile, there are still an extra 0.05 in/yr which would be left to accumulate in the tailings pile. With annual and seasonal fluctuations to be expected, this design is marginal at best. The assumption of 99% collection efficiency is necessary to make the tailings pile operations plausible. No consideration of any alternative operational efficiency is considered. No water budget is presented for this proposed project. The results presented indicate that even a simple water balance raises doubts. Again, this simple observation underscores the misrepresentation of the project presented in this section.

Table 5.2.2-11 also provides an estimate of when contaminated groundwater from the tailings pile would reach groundwater evaluation points or surface water. The estimates range from 343 to 208 years. Contaminated groundwater from the tailings pile is currently being discharged to groundwater and surface water after less than fifty years. The contrast between reality and these precise estimates illustrate the depth of the assumptions of performance incorporated into the analysis. Given the lack of field demonstration of the significant assumptions invoked in this analysis, the obvious conclusion is the results are misleading.

On pg. 5-55 the text says, "However, due to the very low bulk hydraulic conductivity of the bedrock, groundwater flow rates in these flow paths were not large enough to affect water quality at the groundwater and surface water evaluation locations." This statement may be correct for results of this modeling exercise, but the assumptions put into the model such as a no flow boundary beneath the Category 1 waste rock and tailings piles simply makes this conclusion unwarranted and a misrepresentation of the impacts of the proposed action.

The presentation of results from all of the modeling performed to evaluate impacts is not clear. Meaningful results would include a simple plot of model results that would show the concentration of contaminants over time with special emphasis on sulfates at various locations at the mine site and the plant site. The maximum values determined by the modeling should be presented. While the notion of a concentration cap or solubility limit is chemically feasible, there is no justification for imposing such limits to this analysis. If concentration caps were imposed in this analysis, what are they and to which elements were they applied? Failure to present these assumptions is a failure of this analysis. Utilizing such constructs is not necessarily conservative. To use non-conservative assumptions results in misleading results.

On pg. 5-68 the text reads “Due to the very low hydraulic conductivity of the bedrock, and the slurry trench would be keyed into the bedrock, the GoldSim model assumes the bypass of groundwater via bedrock is negligible compared to that occurring in the surficial unit.” This is nonsense. GoldSim by itself cannot assume anything. The analysis assumes that contaminant flow in fractures can be ignored, without any data to support the assumption. Consequently, this is another example of the analysis misrepresenting the proposed action.

On pg. 5-78 another description of the water management system is presented. This description includes many subtle refinements not present in Sect. 3. This section suggests that the design for the plant is either evolving or incompletely disclosed. More assumptions are introduced that are associated with the anticipated performance of the WWTF and the WWTP. However, this lengthy description fails to provide a simple water budget.

The water management system description seems to show that there is sufficient water to operate the mine and processing facility using the collected and appropriated water resources. However, once the mine is closed, there is too much water for plant operations; thus, the design of the facilities becomes a significant issue. The text assumes the WWTP with reverse osmosis has the capacity to address the excess water from the plant site, but no design parameters are provided. This lack of analysis renders the presentation incomplete.

The description of what happens after mine operations cease is simply a narrative and not an analysis. There is no basis to conclude what the environmental consequences would be following the end of operations. The narrative is merely a projection of desired outcomes.

Fig. 5.2.2-18 presents a GoldSim result that has a maximum concentration of sulfate at 2500 mg/L, which precipitously drops to approximately 250 mg/L by year 35. The SDEIS does not explain the constant sulfate concentrations for 20 years, the order of magnitude reduction in the sulfate concentration over 15 years, or the constant sulfate concentration for the next 165 years. These abrupt changes in sulfate concentrations are not the result of some physical or chemical changes, but are the result of unsubstantiated assumptions with respect to treatment plant performance and subaqueous disposal that are built into the model. These implicit assumptions must be explicitly disclosed and substantiated, since they are the likely basis for this improbable set of results.

The bullet list on pg. 5-105 of variables that influence groundwater transport should make important modeling assumptions apparent. The bullets should include, "the assumptions in the model that characterize the bedrock as impermeable and that no advection of contaminants occurs from the West and East pits." Also another bullet should be added that states, "The WWTF is assumed to operate as built for at least 100 years without any degradation." Failing to include these assumptions is a misrepresentation of the proposed action.

Table 5.2.2-22 lists potential contaminant sources, but either does not consider any releases from the west equalization basins at the WWTF, or allows for arbitrarily low leakage rates. Assuming no releases or minimal releases from the WWTF is an implicit assumption that is not justified. The WWTF West Equalization basins will contain reject concentrate with extremely high sulfate concentrations. The liner systems for these basins are assumed to either not leak or have minimal leakage during operations. This is unrealistic, especially for the long periods of time assumed for WWTF operations. The impacts to the environment from the construction and operation of the WWTF are not addressed in the analysis. In addition, any accidents at the WWTF that would result in significant impacts to the environment are not addressed. Lacking a detailed consideration of the potential impacts from the WWTF is a significant weakness of the analysis and leads to unwarranted conclusions of the proposed action and any potential alternatives.

On Pg. 5-121 the capture of seepage from the south side of the tailings pile and the flow augmentation of Second Creek is described. For this description to be valid the existing pumping system for capturing seepage to Second Creek would have to be assumed to operate perfectly. The WWTP would have to operate without accidental disruption for hundreds of years, the pumping system would also have to work without failure for hundreds of years, the addition of approximately 100 ft. of saturated tailings to the tailings pile could not significantly increase the leakage from the tailings pile, and the natural drainage of Second Creek which originates under the tailings pile could not discharge beneath or around the collection system. This set of implicit assumptions have not been disclosed or justified in the analysis.

Table 5.2.2-26 identifies the WWTF as a source term for mine years 0 – 35. However, the WWTF is intended to operate for hundreds of years. The WWTF will remain a source term throughout operations and long after the termination of operations as a result of the legacy of leakage from the equalization basins, even if reject concentrate is no longer transported from the plant site. This table contributes to misleading results as evidenced by Table 5.2.2-22.

Table 5.2.2-29 suggests that background groundwater, non-contact stormwater and the Northshore Mine operations contribute to the sulfate loading in the Partridge River at SW-004a. The table also suggests that no PolyMet sources contribute to the sulfate loading except a 4.3% increase resulting from water treated at the WWTF in closure year 200. To reach this conclusion, implicit assumptions that are not conservative must have been built into the GoldSim model. These implicit assumptions need to be identified since they are the likely basis for this improbable set of results.

On pg. 5-128 the water quality at SW-001 is eliminated from consideration by assumption. However, drainage from the East Pit area currently discharges to the North near SW-001. Again the assumptions incorporated into the analysis have defined the result without the benefit of any analysis. The results are simply unjustified.

Fig. 5.2.2-27 is physically unrealistic. For this result to have any basis in reality, a continuous, constant source term would have to be associated with the model. Except for a natural source, such a source term does not exist, and will not exist as a result of this project. The nature of the open pit mine will lead to a significant increase in sulfates from releases from the mine plant areas to the surrounding environment that will decline over time. This figure and the subsequent figures which show constant concentrations of sulfate over hundreds of years are misleading and unjustified. Instead of invoking unrealistic and unsubstantiated assumptions, an attempt to provide a realistic set of results is needed.

Table 5.2.2-36 is yet another example of the use of implicit assumptions to provide a result which is misleading. The notion that the addition of 100 ft. of saturated tailings to the tailings pile will not affect groundwater seepage is physically unrealistic. The notion of partial containment structures around the tailings pile collecting nearly all of the drainage from the tailings pile that has no liner is also unrealistic. These results are simply misleading.

On pg. 5-210 the concept of an Adaptive Water Management Plan is introduced. The fact that a plan to mitigate impacts is deemed necessary in spite of the multitude of modeling previously claimed to show no significant impacts to water quantity or water quality, suggests a lack of confidence in the model results. Mitigation measures described on pg. 5-213 to 5-216 are described as contingency measures, but not analyzed as mitigation measures for the project. The long list of modifications to the water management design since the DEIS is described on pg. 5-210 to 5-211 suggests that any other mitigation alternatives have been rejected from consideration or analysis. Taken together, these discussions preclude the consideration of any mitigation alternatives to the proposed action; this notion is contrary to 40 CFR 1502.14.

On pg. 5-227 the discussion suggests that MODFLOW cannot be used to determine the effects of pit dewatering on wetlands. While an analog approach may give a reasonable basis for evaluating wetlands, such an analog approach would have to be validated, and no such validation is provided in the SDEIS. Actually, MODFLOW has the capability to calculate the effects of pit dewatering providing the appropriate input is incorporated into the model. At this stage of the SDEIS, where MODFLOW has already been used extensively to evaluate the consequences of the proposed action, suggesting MODFLOW cannot be used for wetlands assessment discredits all of the preceding analysis of hydrology and water quality. Suggesting MODFLOW cannot be used because of the nature of the surficial deposits is to say MODFLOW has not been appropriate to evaluate all of the preceding impacts of the proposed action contained in the SDEIS. This internal contradiction is sufficient to reject the analysis of hydrology and water quality in the SDEIS as inadequate.

In the discussion of wetlands in Sect. 5.2.3, effects of developing the East Pit, potential alteration of the current discharge to the North of the mine site, and the impacts to the 100-mile Swamp are not presented. Given the current drainage to the 100-mile Swamp and the significance of this resource, the impacts to this particular wetlands area need to be addressed in the SDEIS.

Summary

This review of the NorthMet Mining Project and Land Exchange Supplemental Environmental Impact Statement has focused on the adequacy of the SDEIS with respect to the regulations in 40 CFR 1500 – 1508 and the adequacy of the analyses presented in the SDEIS. The SDEIS is not responsive to the regulations as noted in this review, and should be rejected solely on the basis of the lack of regulatory compliance. The analyses presented in the SDEIS are not based on an analytical or scientific review of the proposed action and the reasonable alternatives to the proposed action. Instead, the analyses are based on a conceptual description of the proposed action and an extensive set of assumptions of the environment and the performance of the conceptual design. The SDEIS is technically inadequate as a result of the numerous omissions and flaws in the analyses presented in the SDEIS. In my experience of reviewing and preparing environmental impact statements, the SDEIS is the least defensible and most technically flawed environmental impact statement I have encountered.

DONALD W. LEE

Winter Address

6400 Brandywine Dr.
Lenoir City, Tennessee 37772
(865) 986-2775 (H)
donaldwlee@bellsouth.net

Summer Address

515 East James Street
Ely, Minnesota 55731
(865) 696-8416 (C)

Technical Specialties:

Fluid Mechanics
Hydrology
Environmental Impact Analysis
Performance Assessment

Work Experience:

2000 – 2008 OAK RIDGE NATIONAL LABORATORY

Senior Research Scientist, Energy Division (2000 – 2001), Environmental Sciences Division (2001 – 2008). Research in waste management and safety analysis, preparation of Environmental Impact Statements for energy related projects.

1997 – 2000 OAK RIDGE NATIONAL LABORATORY

Program Manager, Waste Management and Safety Analysis Program, Center for Energy and Environmental Analysis, Energy Division. Manager of Division work in radioactive, hazardous, industrial, and mixed waste management and safety analysis. Major activities include performance assessment and safety analysis reports for DOE sites.

1989 – 1997 OAK RIDGE NATIONAL LABORATORY

Research and Development Group Leader, Applied Physical Sciences Group, Environmental Analysis and Assessment Section, Energy Division. Manager of Section work in radioactive waste management and safety analysis. Focus of research was on geologic and hydrologic analysis. Preparation of performance assessments fpr DOE low-level radioactive waste disposal facilities. Conduct of site-specific analyses for waste management, Safety Analysis Reports, Environmental Restoration, and Environmental Impact Statements. Manager of a staff of 7 with a budget of $2 million.

1982 – 1989 OAK RIDGE NATIONAL LABORATORY

Research Staff, Energy Division. Preparation of technical analyses of water resource issues in radioactive waste management, in-situ uranium mining, uranium milling, synfuels technologies, and hydropower. Development of waste management strategies for Lockheed Martin facilities, performance of site characterization studies of low-level radioactive waste disposal sites. Preparation of Environmental Impact Statements and Environmental Assessments for energy related projects.

1977 – 1982 OAK RIDGE NATIONAL LABORATORY

Research Associate, Energy Division. Preparation of Environmental Impact Statements, Environmental Assessments, and environmental analyses of nuclear, coal, geothermal, and conservation technologies. Conduct research investigations in environmental monitoring, surface water hydrology, and groundwater hydrology using theoretical, numerical, and field methods.

1971 – 1976 UNIVERSITY OF MICHIGAN

Research/Teaching Assistant. Performance of laboratory research in the field of tire mechanics, Instructor for rigid body dynamics, statics, strength of materials, and advanced numerical analysis.

1975 – 1976 WAYNE STATE UNIVERISTY

Instructor in physics, energy, energy policy, values, and microbiology.

1970 – 1971 CLARKSON COLLEGE OF TECHNOLOGY

Teaching Assistant for Mechanical Engineering Laboratory.

1969 – 1970 FORD MOTOR COMPANY

Product Design Engineer, Engine and Foundry Division, Research and Development Center.

Education

1977 Ph. D., Applied Mechanics, University of Michigan, Ann Arbor, Michigan.
1973 M. S., Engineering Science, Clarkson College of Technology, Potsdam, New York.
1969 B. S., Mechanical Engineering, Clarkson College of Technology, Potsdam, New York.

Professional/Academic Honors

Pi Tau Sigma, Mechanical Engineering Honor Fraternity, 1969
Registered Professional Engineer,
State of Michigan, 1977
State of Tennessee, 1978
Significant Event Award, Martin Marietta Energy Systems, 1991
Significant Event Award, Lockheed Martin Energy Systems, 1995
Board Certified, American Academy of Environmental Engineers, 1996 – 2007
In Appreciation, American Society of Civil Engineers, Environmental Engineering Division, 1992
In Appreciation, American Society of Civil Engineers, Environmental Engineering Division, 1999
Certificate of Appreciation, Defense Logistics Agency, Department of Defense, 2005
Who's Who in Science and Engineering, 2007
Who's Who in America, 2007
Who's Who in the World, 2007
Retirement Certificate, Oak Ridge National Laboratory, 2008

Professional Activities

Reviewer, American Society of Civil Engineers, Hydraulics Division (1982 – 1996)
Reviewer, Elsevier Publishing Co. (1987)
Reviewer, Nuclear and Chemical Waste Management (1986 – 1995)
Member, American Society of Civil Engineers
Member, American Society of Mechanical Engineers
Member, Sigma Xi
Member, DOE Waste Classification Working Group, 1987
Member, DOE Task Force on Uranium Waste Problems, 1988
Member, DOE Low-Level Radioactive Waste Technical Resource Group for 40 CFR 193, 1988
Member, DOE Low-Level Radioactive Waste Peer Review Committee for DOE Order 5820.2A, 1988 – 1997
Member, DOE Performance Assessment Technical Resource Group for DOE Order 5820.2B, 1994 – 1995
Member, DOE Federal Facilities Compliance Act Disposal Work Group, 1994 – 1996
Member, DOE Defense Nuclear Facilities Safety Board Recommendation 94-2, Site Assessment Team, 1995
Member, DOE Defense Nuclear Facilities Safety Board Recommendation 94-2, Research and Development Task Team, 1995
Member, DOE Defense Nuclear Facilities Safety Board Recommendation 94-2. Working Group Assessment Team, 1995
Member, DOE Order 435.1 Revision Team, 1996 – 2000
Adjunct Associate Professor, North Carolina State University, Department of Mechanical and Aerospace Engineering, 1987 – 2000

Ph. D. Dissertation Committee Co-Chairman, North Carolina State University, Department of Mechanical and Aerospace Engineering, 1987 – 1993

Secretary, Air and Radiation Management Committee, Environmental Engineering Division, American Society of Civil Engineers, 1989 – 1990

Vice-Chairman, Air and Radiation Management Committee, Environmental Engineering Division, American Society of Civil Engineers, 1990 – 1981

Chairman, Air and Radiation Management Committee, Environmental Engineering Division, American Society of Civil Engineers, 1991 – 1992

Secretary, Programs Committee, Environmental Engineering Division, American Society of Civil Engineers, 1992 – 1994

Member, American Society of Civil Engineers Task Committee on Mixed Waste, 1988 – 1993

Vice-Chair, Professional Activities Committee, Environmental Engineering Division, American Society of Civil Engineers, 1994 – 1996

Chair, Professional Activities Committee, Environmental Engineering Division, American Society of Civil Engineers, 1996 – 1999

Secretary, Conference and Exhibits Council, Environmental and Water Resources Institute, American Society of Civil Engineers, 2001 – 2003

Member, Conference and Exhibits Council, Environmental and Water Resources Council, American Society of Civil Engineers, 1999 – 2001, 2003 – 2005

Session Moderator, Radiation Management, National Conference on Environmental Engineering, Reno, Nevada, 1991

Session Moderator and Organizer, Management of Low-Level Radioactive Waste, 1996 ASCE Annual Convention and Exposition, Washington, D.C.

National Abstract Review Committee, 1991 National Conference on Environmental Engineering, American Society of Civil Engineers

Reviewer, Journal of Environmental Engineering, American Society of Civil Engineers, 1995 – 2005

Session Moderator and Organizer, Low-Level Radioactive Waste, American Society of Civil Engineers National Meeting, 1996

National Abstract Review Committee, 1999 National Conference on Environmental Engineering, American Society of Civil Engineers

Technical Organizing Committee, 2000 National Conference on Environmental Engineering, American Society of Civil Engineers

Organizing Committee, International Water Congress 2001, American Society of Civil Engineers

Conference Chairman, 2002 Joint CSCE/ASCE International Conference on Environmental Engineering, Niagara Falls, Ontario

Session Moderator, Risk, 2002 Joint CSCE/ASCE International Conference on Environmental Engineering, Niagara Falls, Ontario

Session Moderator, Remediation, 2002 Joint CSCE/ASCE International Conference on Environmental Engineering, Niagara Falls, Ontario

Publications

"Final Environmental Impact Statement, Destruction of Chemical Weapons at Pine Bluff Army Depot, Pine Bluff, Arkansas," U. S. Army, Program for Chemical Demilitarization, Aberdeen, MD (with others)

"Draft Environmental Impact Statement, Destruction of Chemical Weapons at Pine Bluff Army Depot, Pine Bluff, Arkansas," U. S, Army, Program for Chemical Demilitarization, Aberdeen, MD (with others)

"Final Environmental Impact Statement, Destruction of Chemical Weapons at Tooele Army Depot, Tooele, Utah," U. S. Army, Program for Chemical Demilitarization, Aberdeen, MD (with others)

T. D. Hylton, W. H. Hermes, D. W. Lee, P.T. Singley, J. W. Terry. "Thorium Nitrate Stockpile Drum Characterization Report," ORNL/TM-2003/53, Oak Ridge National Laboratory, 2003

John Tauxe, Paul K. Black, Bruce M. Crowe, Donald W. Lee, "Modeling Uncertainty: Reality vs. Conservatism in Radiological Performance Assessment," 2003 National Groundwater Association Mid-South Focus Conference, Nashville, Tennessee

"Review Team Report for the Idaho National Engineering Laboratory CERCLA Disposal Facility Landfill Compliance Demonstration for DOE Order 435.1 Radioactive Waste Management, Performance Assessment and Composite Analysis, U. S, Department of Energy EM-40, 2003 (with others)

"Final Environmental Impact Statement, North Umpquah Hydroproject, Oregon, (FERC 1927)," FERC/FEIS-0147F, Federal Energy Regulatory Commission, Office of Energy Projects, 2003 (with others)

"Final Environmental Impact Statement, Destruction of Chemical Weapons at Blue Grass Army Depot, Kentucky," U. S. Army Program for Chemical Demilitarization, Aberdeen, MD, 2003, (with others)

D. W. Lee, K. W. Wills, "Accident Analysis for 9204-4 Facility (U)," DAC-FS-920202-Aoo3, BWXT Y-12 LLC, 2002 (Classified – Secret Restricted Data)

"Draft Environmental Impact Statement, North Umpquah Hydroelectric Project, Oregon, (FERC Project No. 1927)" FERC/DEIS – 0147D, Federal Energy Regulatory Commission, Office of Energy Projects, Washington, D. C., 2002 (with others)

"Draft Environmental Impact Statement, Destruction of Chemical Weapons at Blue Grass Army Depot, Kentucky," U. S, Army, Program for Chemical Demilitarization, Aberdeen, MD, 2002 (with others)

"Final Report for the Nevada Test Site Area 5 Radioactive Waste Management Site Low-Level Waste Radiological Composite Analysis Review," U. S, Department of Energy, Washington, D. C. , 2001 (with others)

D. A. Walker, D. W. Lee, "Y-12 Generic Threshold Analysis for Consequence Comparisons (U)," DAC - FS – 900000 – A004, BWXT Y-12 LLC, 2001 (Unclassified)

R. L. Miller, T. J. Blasing, D. W. Lee, "Y-12 Generic Threshold Dispersion Analysis Using ARCON96 for Use in Hazard Analysis (U)," DAC – 900000 – A003, BWXT Y-12 LLC, 2001 (with others)

D. A. Walker, D. W. Lee, R. L. Miller, "Use and Application of the ARCON96 Dispersion Model at the Y-12 Complex," in Proceedings of EFCOG 2001, U. S, Department of Energy, 2001

K. S. Gant, D. W. Lee, "Unclassified Hazardous Material Information for Use in Safety Basis Documentation(U), DAC – 900000-A001, Rev. 1, BWXT Y-12 LLC, 2001 (unclassified).

A. G. Croff, J. R, Hightower, D. W. Lee, G, E, Michaels, N. L. Ranek, "Assessment of Preferred Depleted Uranium Disposal Forms," ORNL/TM-2000/161, Oak Ridge National Laboratory, 2000

D. W. Lee, L. N. McCold, D.P. Vogt, K. L. Yurako, "Evaluation of Hazardous Materials Management Practices for Application to Range Residue Management," ORNL/TM-2000/87, 2000

"Depleted Uranium Storage and Disposal Trade Study Summary Report," ORNL/TM-2000/10. Oak Ridge National Laboratory, 2000 (with others)

"Final Report for the Idaho National Engineering and Environmental Laboratory Radioactive Waste Management Complex low-Level Radiological Composite Analysis Review, U. S, Department of Energy, Washington, D. C, 2000 (with others)

"Low-Level Waste Disposal Facility Review Group Manual," U. S, Department of Energy, Washington D.C., 1999 (with others)

"DOE Order 435.1, Radioactive Waste Management," U. S. Department of Energy, Washington D.C., 1999 (with others)

"DOE M 435.1-1, Radioactive Waste Management Manual," U. S. Department of Energy, Washington, D.C. 1999 (with others)

"DOE G 435.1-1 Implementation Guide for use with DOE M 435.1-1." U. S. Department of Energy. Washington, D. C., 1999 (with others)

"Appendix A, Technical Basis and Considerations for DOE M 435.1-1," U.S. Department of Energy, Washington, D. C. , 1999 (with others)

"Final Report for the Savannah River Site Composite Analysis Review," U. S, Department of Energy, Washington, D. C., 1998 (with others)

“Performance Assessment for Continuing and Future Operations at Solid Waste Storage Area 6,” ORNL-6783/R1, Vol. 1 and 2, Oak Ridge National Laboratory, 1997 (with others)

“Composite Analysis for Solid Waste Storage Area 6,” ORNL-6929, Oak Ridge National Laboratory, 1997 (with others)

“Performance Assessment for the Class L-II Disposal Facility,” ORNL/TM-13401, Oak Ridge National Laboratory, 1997 (with others)

“Safety Analysis Report, Paducah Gaseous Diffusion Plant, Paducah, Kentucky,” KY/E174, Lockheed Martin Energy Systems, 1996 (with others)

M. L. Socolof, D. W. Lee, “Radiological Dose Assessment of Department of Energy Pinellas Plant Waste Proposed for Disposal at Laidlaw Environmental Services of South Carolina, Inc.,”ORNL/TM-13234, Oal Ridge National Laboratory, 1996

M. L. Socolof, D. W. Lee, D. C. Kocher, “Radiological Dose Assessment of Department of Energy Pinellas Plant Waste Proposed for Disposal at United States Pollution Control Inc. in Tooele County, Utah,” ORNL/TM=1323, Oak Ridge National Laboratory, 1996

J. C. Wang, T.O. Johnson, D. W. Lee, “Risk Criterion and Index of Risk, in Proceedings of the International Topical Meeting on Probabilistic Safety Assessment, Park City, Utah, 1996

“Performance Evaluation of the Technical Capabilities of DOE Sites for Disposal of Mixed Low=Level Waste,” DOE/ID-10521/2, Sand-0721/2, Sandia National Laboratory, 1986 (with others)

D. W. Lee, D. C. Kocher, J. C. Wang, “Operating Limit Evaluation for Disposal of Uranium Enrichment Plant Wastes,” NORM, NARM Regulation and Risk Assessment, in Proceedings of the 29th Midyear Topical Meeting, Health Physics Society, Scottsdale Arizona, 1996

J. D. Tauxe, D. W. Lee, J. C. Wang, G. P. Zimmerman, “A Comprehensive Subsurface Transport Analysis for Radioactive Waste Disposal at Various DOE Sites,” 1993 Fall Meeting of the American Geophysical Union, San Francisco, California, 1995

R. O. Johnson, J. C. Wang, D. W. Lee, “Maximum Ponding Depths on Urbanized Surfaces During Extreme Storms,” in Proceedings of the 5th DOE Natural Phenomena Hazards Mitigation Conference, Denver, Colorado, 1995

J. C. Wang, J. D. Tauxe, D. W. Lee, “Estimation of Contaminant Transport in Groundwater Beneath Radioactive Waste Disposal Facilities,” in Transactions of the American Nuclear Society, Vol. 73 , pp. 505-506, 1995

J. C. Wang, J. D. Tauxe, D. W. Lee, Estimation of Contaminant Transport in Groundwater Beneath Radioactive Waste Disposal Facilities," in Eleventh Proceedings of Nuclear Thermal Hydraulics, American Nuclear Society, LaGrange Park, Illinois, 1995

R. D. Waters, M. M. Gruebel, M.S.Y. Chu, D. W. Lee, "DOE's Performance Evaluation Project for Mixed Low-Level Waste Disposal," in Waste Management '95, University of Arizona, 1995

D. W. Lee, J. C, Wang, D. C. Kocher, "Operating Limit Study for the Proposed Solid Waste Landfill at Paducah Gaseous Diffusion Plant," ORNL/TM-13008, Oak Ridge National Laboratory, 1995

D. W. Lee, "Performance Assessment Experience at Oak Ridge National Laboratory," in Proceedings of the 16th Annual DOE Low-Level Radioactive Waste Management Conference, CONF-941214, 1994

J. C. Wang, D. W. Lee, R. H. Ketelle, R. R. Lee, D. C. Kocher, "Determination of Operating Limits for Radionuclides for a Proposed Landfill at Paducah Gaseous Diffusion Plant," in Transactions of the American Nuclear Society, Vol. 71, pp. 561-561, 1994

J. C, Wang, D. W. Lee, R. H. Ketelle, R. R. Lee, D. C. Kocher, "Determination of Operating Limits for Radionuclides for a Proposed Landfill at Paducah Gaseous Diffusion Plant," in Tenth Proceedings of Nuclear Thermal Hydraulics, American Nuclear Society, La Grange, Illinois, 1994

D. W. Lee, M. W. Yambert, D. C. Kocher, "Uncertainty Analysis for Low-Level Radioactive Waste Disposal Performance Assessment at Oak Ridge National Laboratory," in Proceedings of the International Topical Meeting on Nuclear and Hazardous Waste Management, Spectrum '94, American Nuclear Society, LaGrange, Illinois, Vol. III, pp. 1534-1538. 1994

"Performance Assessment for Continuing and Future Operations at Solid Waste Storage Area 6," ORNL-6783, Oak Ridge National Laboratory, 1994 (with others)

R. O. Johnson, J. C, Wang, D. W. Lee, "Local Drainage Analysis for the Paducah and Portsmouth Gaseous Diffusion Pants During Extreme Storms," in Proceedings of the Fourth DOE Natural Phenomena Hazards Mitigation Conference, CONF-9310102, Vol. I, pp, 431-440, 1993

D. Munaf, A. S. Wineman, K. R. Rajagopal, D. W. Lee, "A Boundary Value Problem in Groundwater Motion Analysis – Comparison of Predictions based on Darcy's Law and the Continuum Theory of Mixtures," in Mathematical Models and Methods in Applied Sciences, Vol. 3, No. 2, PP. 231-248, World Scientific Publishing Company, 1993

R. O. Johnson, J. C. Wang, D. W. Lee, "Local Drainage Analysis of the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, During an Extreme Storm," K/GDP/SAR-30, Martin Marietta Energy Systems, 1993

R. O. Johnson, J. C, Wang, D. W. Lee, "Local Drainage Analysis of the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio, During an Extreme Storm," K/GDP/SAR-29, Martin Marietta Energy Systems, 1993

D. W. Lee, D. C. Kocher, J. M. Bownds, "Interpretation of Results for Performance Assessments of Low-Level Radioactive Waste Disposal Facilities," in Proceedings of 14th Annual Department of Energy Low-Level Radioactive Waste Management Conference, CONF-921137-PROC, 1993

"System Safety Analysis, Suspension of Highly Enriched Uranium Production, Portsmouth Gaseous Diffusion Plant, Portsmouth, Ohio," K/GDP/SAR-20, Martin Marietta Energy Systems, 1993 (with others)

D. W. Lee, D. C. Kocher, "Use of Pathways Analysis as a Tool for Effective and Safe Waste Management," in Effective and Safe Waste Management, ed. R. Jolley, and R. Wang, Lewis Publishers, 1992

D. C, Kocher, D. W. Lee, "Disposal of Low-Level Radioactive Wastes on the Oak Ridge Reservation, I. Preliminary Screening Analysis for Identification of Important Radionuclides," in Radioactive Waste Management and the Nuclear Fuel Cycle, Harwood Academic Publishers GbmH, Vol. 16 (2), pp. 83-99, 1992

D. W. Lee, D. C, Kocher, "Disposal of Low-Level Radioactive Wastes on the Oak Ridge Reservation, II. Proposed Classification of Wastes for Management and Disposal," in Radioactive Waste Management and the Nuclear Fuel Cycle, Harwood Academic Publishers GbmH, Vol. 16 (2), PP. 161-171, 1992

R. O. Johnson, J. C, Wang, D. W. Lee, "Regional Flood Assessment of the Paducah and Portsmouth Gaseous Diffusion Plants," in Proceedings of third DOE National Hazard Mitigation Conference, CONF-9110122, pp. 302-311, 1992

J. C. Wang, R. O. Johnson, D. W. Lee, "Extreme Flood Estimates Along the Scioto River Adjacent to the Portsmouth Gaseous Diffusion Plant," K/GDP/SAR-6, Martin Marietta Energy Systems, 1992

R. O. Johnson, J. C. Wang, D. W. Lee, " Probable Maximum Flood Calculation for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, K/GDP/SAR-7, Martin Marietta Energy Systems Inc., 1992

"Thermal Engineering: Emerging Technologies and Critical Phenomena," National Science Foundation Report, Washington, D. C., 1002 (with others)

"Performance Assessment Review Guide for DOE Low-Level Radioactive Waste Disposal Facilities," DOE/LLW-93, EG&F Idaho, Idaho Falls, Idaho, 1991, (with others)

"Complex 21 – A Proposal for the Nuclear Weapons Complex Reconfiguration Site, Vol. 4, Environment, Safety and Health," Oak Ridge Operations Office, U. S. Department of Energy, 1991 (with others)

"Gaseous Diffusion Plant Safety Analysis Report Upgrade Program Plan," K/GDP/ SAR-102, Martin Marietta Energy Systems, 1991 (with others)

D. W. Lee, A. S. Wineman, "Groundwater phenomena and the Theory of Mixtures," in Recent Advances in Mechanics of Structured Continua, ed. M. Massoudi and K. R. Rajgopal, AMD – Vol. 117, American Society of Mechanical Engineers, 1991

W. R. Brock, D. W. Lee, "Proceedings of the Information exchange Workshop – Design Basis Floods, March 20, 1990, Oak Ridge, Tennessee," K/GDP/ SAR-2, Martin Marietta Energy Systems Inc., 1990

D. W. Lee, D. C. Kocher, "Scoping Analysis for the Performance Assessment of SWSA 6." ORNL/CF – 90/67, Oak Ridge National Laboratory, 1990

"Geosciences." In Energy Technology R&D, What Could Make a Difference? ORNL – 6541/V!/P3, Oak Ridge National Laboratory, 1989 (with others)

D. W. Lee, "Applied Exposure Modeling for Residual Radioactivity and Release Criteria," in Residual Radioactivity and Recycling Criteria, EPA 520/1-90-013, U. S. Environmental Protection Agency, 1989

D. W. Lee, D. C. Kocher, "Performance Assessment for Future Low-Level Waste Disposal Facilities at ORNL," in Proceedings of the 11th DOE Low-Level Waste Management Conference, CONF-890854, Vol. 1, U. S, Department of Energy, 1989

D. C. Kocher, D. W. Lee, "A preliminary Performance Assessment for Near-Surface Land Disposal of Low-Level Radioactive Wastes," in Proceedings of the 11th DOE Low-Level Waste Management Conference, CONF-890854, Vol. 1, U. S. Department of Energy, 1989

G. E. Butterworth, M. J. Morris, D. W. Lee. "Radioactive Waste Management Implementation Plan for Paducah Gaseous Diffusion Plant, ES/ESH-9, KY/H-86, Paducah Gaseous Diffusion Plant, Paducah, Kentucky, 1989

G. E. Butterworth, M. J. Morris, D. W. Lee, "Radioactive Waste Management Implementation Plan for Portsmouth Gaseous Diffusion Plant, ES/ESH-10, POEF-2011, Portsmouth Gaseous Diffusion Plant, Portsmouth, Ohio, 1989

"Recommended Formant and Content for DOE Low-Level Waste Disposal Facility Radiological Assessment Reports," DOE/LLW-81, DOE National Low-Level Waste Management Program, Idaho National Engineering Laboratory, 1989 (with others)

"Development of Riprap Design Criteria by Riprap Testing in Flumes: Phase II," NUREG/CR-4651, ORNL/TM-10100/V2, U. S. Nuclear Regulatory Commission, Washington, D. C., 1988 (with others)

“Environmental Assessment, Navy TACAMO Squadrons, Tinker Air Force Base, Oklahoma,” Department of Air Force, Logistics Command, Wright Patterson Air Force Base, Ohio, August 1988, (with others)

D. W. Lee. “Low-Level Radioactive Waste Disposal at a Humid Site,: in Proceedings of the Joint CSCE-ASCE National Conference on Environmental Engineering, Canadian Society of Civil Engineers, Montreal, Quebec, Canada, 1988

C. W. Francis, M. P. Maskarinec, D. W. Lee. “Physical and Chemical Methods for Characterization of Hazardous Wastes,” in P. Baccini ed. Swiss Workshop on Land Disposal, Springer-Verlag, pp. 229-326, 1988

R, H, Ketelle and D. W. Lee, “Identification of Sites for the Low-Level Waste Disposal Development and Demonstration Program,” ORNL/TM-10221, Oak Ridge National Laboratory, 1988

J. M. Bownds, D. W. Lee, M. M. Stevens, “A new Analytical Model for a Pumped Leaky Aquifer System,” in International Ground Water Modeling Center, Newsletter, Vol. VII, No. 1, Holcomb Research Institute , Butler University, Indianapolis , Indiana. 1988

“Draft Environmental Assessment, Navy TACAMO Squadrons, Tinker Air Force Base, Oklahoma,” Department of Air Force, Headquarters, Air Force Logistics Command, Wright Patterson Air Force Base, Ohio. 1987 (with others)

“Development of Riprap Design Criteria by Riprap Testing in Flumes: Phase I,” NUREG/CR-4651, ORNL/TM-10100/V1, U. S. Nuclear Regulatory Commission, 1987 (with others)

D.W. Lee, ”An Analysis of Groundwater Contamination from the Operation of a 6-GeV Electron Beam Accelerator,” in Health Physics of Radiation Generating Machines, Proceedings of the Twentieth Midyear Topical Symposium of the Health Physics Society, CONF-8602106, 1987

“Remedial Investigation Plan for the Subsurface Characterization of the ORNL Hydrofracture Sites, ORNL/RAP-7, Oak Ridge National Laboratory, 1987 (with others)

Environmental Assessment, Continuous Electron Beam Accelerato0r Facility, Newport News, Virginia, DOE/EA-0257, Oak Ridge Operations, U. S. Department of Energy, 1987, (with others)

J. B. Cannon, D. W. Lee, “Defense Waste Management: Shallow Land Burial Handbook,” in Waste Management Research Abstracts No. 17, IAEA/WMRA/17, International Atomic Energy Agency, Vienna, Austria, 1986

D. W. Lee, J. M. Bownds, “Hydrodynamics of Partially Penetrating Wells in a Leaky Aquifer System,” ORNL/NRC/LTR-86/14, Oak Ridge National Laboratory, 1986

"Revised Final Environmental Assessment, Seaway Complex, DOE/EA-0252, U. S. Department of Energy, 1986 (with others)

D. W. Lee, "Impacts of Continuous Electron Beam Accelerator Operations on Groundwater and Surface Water," in Proceedings of CEBAF Workshop on Radiation Safety, Southeastern Universities Research Association, Newport News, Virginia, 1986

D. B. Hunsaker, Jr., D. W. Lee, "Environmental Impact Assessment of Abnormal Events: A Follow-up Study," in Audit and Evaluation in Environmental Assessment: Canadian and International Experience II, Environment Canada, Ottawa, Ontario, Canada, 1985

"Environmental Assessment, Strategic Petroleum Reserve; Seaway Complex Distribution Enhancements, Brazoria, Galveston, and Harris Counties, Texas," DOE/EA-0252, U. S. Department of Energy, 1985 (with others)

"Shallow Land Burial of Low-Level Radioactive Waste, ORNL/TM-9496, Oak Ridge National Laboratory, 1985 (with others)

F. G. Pin, J. P. Witherspoon, D. W. Lee, J. B. Cannon, R. H. Ketelle, "Radionuclide Migration Pathways Analysis for the Oak Ridge Central Waste Disposal Facility on the West Chestnut Ridge Site," ORNL/TM-9231, Oak Ridge National Laboratory, 1984

"Draft Environmental Impact Statement, Susitna Hydroelectric Project, Alaska, FERC No. 7114," FERC/DEIS-0038, Office of Electric Power Generation, Federal Energy Regulatory Commission, Washington, D. C., 1984 (with others)

D. W. Lee, R. H. Ketelle, "A Methodology for Selecting Low-Level Radioactive Waste Disposal Sites with Application to the Oak Ridge Reservation," in Proceedings of Facility Siting and Routing'84, Energy and Environment, Environment Canada, Ottawa, Ontario, Canada, 1984

"Procedures and Technology for Shallow Land Burial of Low-Level Radioactive Waste, ORNL/NFW-84/10, Oak Ridge National Laboratory, 1984 (with others)

D. W. Lee, R. H. Ketelle, F. G. Pin, G. S. Hill. "Environmental Pathways Analysis for Evaluation of a Low-Level Waste Disposal Site," in Radioactive Waste Management, Vol. 4, International Atomic Energy Agency, Vienna, Austria, 1984

R. D. Roop, W. P. Staub, D. B. Hunsaker, R. H. Ketelle, D. W. Lee, F. G. Pin, A. J. Witten, "Corrective Measures to Stabilize Subsidence in Low-Level Waste Trenches," in Proceedings of Sixth Symposium on Uranium Mill Tailings Management, Colorado State University, Fort Collins, Colorado, 1984

"Procedures and Technology for Shallow Land Burial, Low-Level Radioactive Waste Management Handbook Series, National Low-Level Radioactive Waste Management Program," DOE/LLW-13Td, U. S. Department of Energy, 1983 (with others)

D. W. Lee, R. H,. Ketelle, L. H. Stinton, "Use of DOE Site Selection Criteria for Screening Low-Level Waste Disposal Sites on the Oak Ridge Reservation," ORNL/TM-8717, Oak Ridge National Laboratory, 1983

R. D. Roop, W. P. Staub, D. B. Hunsaker, Jr., R. H. Ketelle, D. W. Lee, F. G. Pin, A. J. Witten, "A Review of Corrective Measures to Stabilize Subsidence in Shallow-Land Burial Trenches," ORNL/TM-8715, Oak Ridge National Laboratory, Oak Ridge National Laboratory, 1983

R. Blumberg, J. B. Cannon, G. S. Hill, R. H. Ketelle, D. W. Lee, F. G. Pin, "GCEP Waste Pathways Analysis Study," K/D-5375, Union Carbide Corporation-Nuclear Division, Oak Ridge, Tennessee, 1983

"Environmental Analysis of the Operation of Oak Ridge National Laboratory (X-10 Site)," ORNL-5870, Oak Ridge National Laboratory, 1982 (with others)

"Environmental Assessment, Low-Level Waste Disposal, Barnwell, South Carolina," NUREG-0879, U. S. Nuclear Regulatory Commission, 1982 (with others)

L. W. Barnthouse, W. Van Winkle, J. Golumbek, G. D. Cada, C.P. Goodyear, S. W. Christiansen, J. B. Cannon, D. W. Lee, "The Impact of Entrainment and Impingement on Fish Populations in the Hudson River Estuary," NUREG/CR-2220, Vol. II, ORNL/NUREG/TM-385/V2, Oak Ridge National Laboratory, 1982

D. W. Lee, "Analytical Model of the Round Buoyant Jet," ASME81-FE-10, American Society of Mechanical Engineers, New York, New York, 1981

"Environmental Assessment, Aquifer Thermal Energy Storage Program," DOE/EA-0131, U. S. Department of Energy, 1981 (with others)

C. F. Baes Jr., S. E. Beall, D. W. Lee, G. Garland, "The Collection, Disposal and Storage of Carbon Dioxide," in Interactions of Energy and Climate, ed. W. Bach, J. Pankrath, J. Williams, D. Reidel Publishing Co. 1983

D. W. Lee, "Programmatic Environmental Assessment (Documentation)," in Proceedings of Mechanical, Magnetic, and Underground Energy Storage, 1980 Annual Contractor's Review, CONF-801128, U. S. Department of Energy, 1980

D. W. Lee, "An Analytical Model for a Vertical Buoyant Jet," ORNL/TM-7140, Oak Ridge National Laboratory, 1980

"Strategies for Ecological Effects Assessment at DOE Energy Activity Sites," ORNL/TM-6783, Oak Ridge National Laboratory, 1980 (with others)

G. D. Pine, D. W. Lee, R. P. Intemann, “Commuter Transportation Options for Oak Ridge National Laboratory,” ORNL/CF-80/10, Oak Ridge National Laboratory, 1980

D. W. Lee, “Analysis of Potential Salt Water Intrusion at NEP I& II Power Station,” ORNL/TM-7138, Oak Ridge National Laboratory, 1980

C. F. Bases, Jr., S. E. Bell, D. W. Lee, G. Marland, “Options for the Collection and Disposal of Carbon Dioxide,” ORNL 5657, Oak Ridge National Laboratory, 1980

J. B, Cannon, G. F. Cada, K. K. Campbell, D. W. Lee, A. T. Szluha, “Fish Protection at Steam Electric Power Plants: Alternative Screening Devices,” ORNL/TM-6472, Oak Ridge National Laboratory, 1979

“Draft Environmental Impact Statement Related to Construction of New England Power Units 1 and 2 (NEP1&2) Docket Nos. STN-50-568 and STN-50-569,” NUREG-0529, U. S. Nuclear Regulatory Commission, Washington, D. C., 1979 (with others)

D. W. Lee, “Suppression and Amplification of Lee Waves,” in Developments in Theoretical and Applied Mechanics, Vol. , ed. R. M. Hackett, Vanderbilt University, Nashville, Tennessee, 1978

“Environmental Analysis for Pipeline Gas Demonstration Plants,” ORNL/TM-6235, Oak Ridge National Laboratory, 1978, (with others)

Environmental Monitoring Handbook for Coal Conversion Facilities,” ORNL-5319, Oak Ridge National Laboratory, 1978 (with others)

D. W. Lee, “Lee Wave Annihilation Over Two Barriers,” in Symposium on Modeling of Transport Mechanisms in Oceans and Lakes, Manuscript Report Series No. 43, Department of Fisheries and Environment, Ottawa, Ontario, Canada, 1977

S. K. Clark, R. N. Dodge, D. W. Lee, J. R. Luchini, “Proof Pressure Evaluation of Worn Passenger Car Tire Carcasses,” UM-0100654-6-F, U. S. Department of Transportation Cambridge, Massachusetts, 1975

S. K. Clark, R. N. Dodge, D. W. Lee, J. R, Luchini, “Pressure Effects on Worn Passenger Car Tire Carcasses,” UM-010154-4-1, U. S. Department of Transportation, Cambridge Massachusetts, 1975

S. K. Clark, R. N. Dodge, D. W. Lee, J. R. Luchini, “Pressure Effects on Worn Passenger Car Tire Carcasses,” UM-010654-2-1, U. S. Department of Transportation, Cambridge, Massachusetts, 1974

S. K. Clark, R. N. Dodge, D. W. Lee, R. N. Larson, “Measurements of Stress States in 20x4.4 Aircraft Tire,” AFFDL-73-24. U. S. Air Force Flight Dynamics Laboratory, Wright Patterson Air Force Base, Dayton, Ohio, 1973

Technical Presentations

“Long Term Performance of Radioactive Waste Disposal Facilities,” Civil and Environmental Engineering Department, Vanderbilt University, September 8, 2003 (invited)

“Y-12 Dispersion Analysis Training Workshop,” Y-12 Plant, September 20 – 21, 2001 (with R. L. Miller and A. L. Sjoreen)

“Evaluation of Hazardous Materials Management Practices for Application to Range Residue Management,” 29th Biannual Meeting of the Department of Defense Explosives Safety Board, New Orleans, Louisiana, July 14, 2000 (invited)

“Composite Analysis of Oak Ridge Disposal Sites,” as part of Management of Disposal of Radioactive Waste by Dade Moeller & Associates for DOE-ORO, December 10, 1998

“Legal Disposition before Randy McDowell, Attorney, Commonwealth of Kentucky, Paducah, Kentucky on the matter of the Commonwealth of Kentucky vs. U. S. DOE,” Paducah, Kentucky, June 4, 1998

“Savannah River Site Composite Analysis Training,” DOE SRO, March 12, 1998

“Solid Waste Storage Area 6 – Performance Assessment and Composite Analysis – Implications to CERCLA and Land Use Planning,” DOE-ORO, March 6, 1998

“Solid Waste Storage 6 – Performance Assessment and Composite Analysis – An Overview,” Low-Level Waste Federal Review Group, Oak Ridge, TN, January 21, 1998

“Oak Ridge Reservation Composite Analysis Overview,” DOE Composite Analysis Workshop, Gaithersburg, Maryland, August 20, 1996

“Progress Toward the Implementation of the Operating Limit for the PGDP Landfill,” Paducah, Kentucky, June 11, 1996

“Performance Assessment of Low-Level Radioactive Waste Disposal Facilities – Oak Ridge Perspective,” Scientific Delegation from the United Kingdom, DOE – ORO, April 2, 1996

“Performance Assessment for All Sources for the Oak Ridge Reservation,” DOE All Sources Workshop, Gaithersburg, Maryland, January, 30 1996

“Operating Limit Evaluation for Disposal of Uranium Enrichment Plant Wastes,” 29th Midyear Meeting of the Health Physics Society, Scottsdale Arizona, January 9, 1996

“Implementation of the Operating Limit for the New Solid Waste Landfill,” DOE Paducah Field Office, Paducah, Kentucky, December 6, 1995

‘Performance Assessment Experience at Oak Ridge National Laboratory,” Scientific Delegation from the Republic of Korea, Oak Ridge National Laboratory, May 5, 1995

“Operating Limit Study for the Proposed Solid Waste Landfill at Paducah Gaseous Diffusion Plant,” Commonwealth of Kentucky, Frankfurt, Kentucky, February 2, 1995.

“Solid Waste Landfill Operating Limits Study,” DOE-ORO, January 11, 1995

“Performance Assessment Experience at Oak Ridge National Laboratory,” 16th Annual U. S. Department of Energy Low-Level Radioactive Waste Management Conference, Phoenix, Arizona, December 13, 1994

“Industrial Landfill Study – Radionuclide Operating Limits – Results,” Paducah Gaseous Diffusion Plant, Paducah, Kentucky, September 19, 1994

“Uncertainty Analysis for Low-Level Radioactive Waste Disposal Performance Assessment at Oak Ridge National Laboratory,” Spectrum ’94, Atlanta, Georgia, August 17, 1994

“Environmental Transport,” FFCA Disposal Evaluation Workshop, Clearwater, Florida, August 10, 1994

“Performance Assessment Methodology,” FFCA Disposal Evaluation Workshop, Clearwater, Florida, August 10, 1994

“Performance Assessment for Continuing and Future Operations at Solid Waste Storage Area 6,” State of Tennessee, Tennessee Department of Environment and Conservation, Oak Ridge, Tennessee, March 7, 1994

“Evaluation of Disposal Site Capabilities on the Oak Ridge Reservation,” National Governor’s Association, Tucson, Arizona, March 3, 1994

“Scoping Calculations for Estimating Disposal Site Capabilities,” DOE – FFCA Disposal Work Group, Dallas, Texas, February 17, 1994

“Performance Assessment for Continuing and Future Operations at Solid Waste Storage Area 6,” DOE – ORO, January 21, 1994

“Safety Analysis Upgrade Program, What is It? Where Have We Been? Where Are We Going?” Energy Division Advisory Meeting, Oak Ridge National Laboratory, May 15, 1993

“DOE Order 5820.2A Performance Assessment Overview,” State of Tennessee, Tennessee Oversight Agreement Office, Oak Ridge, Tennessee, April 13, 1993

“Performance Assessment,” Japan Scientific Visitors Exchange Group, Oak Ridge National Laboratory, February 26, 1993

“SWSA 6 Performance Assessment Status,” DOE Low-Level Waste Management Program Steering Committee, Oak Ridge, Tennessee, February 2, 1993

“Performance Assessment for SWSA 6,” DOE-ORO, Oak Ridge, Tennessee, January 14, 1993

“Integration and Interpretation of Results from Performance Assessments of Low-Level Radioacitve Waste Disposal Facilities,” 14th Annual Department of Energy Low-Level Radioacitive Waste Management Conference, Phoenix, Arizona, November 20, 1992

“Program Highlights, Facility Safety/Waste Management Chapter,” GDP/SAR Upgrade Program Review, Oak Ridge, Tennessee, May 7, 1992

“Performance Assessment of Low Level Radioactive Waste Disposal at Oak Ridge National Laboratory,” Waste Management ’92, Tucson, Arizona, March 3,1992

“Groundwater Phenomena and the Theory of Mixtures,” Applied Mechanics Conference, American Society of Mechanical Engineers, The Ohio State University, Columbus, Ohio, June 1991

“Interpretation of Results of SWSA 6 Performance Assessment,” DOE Peer Review Panel, Oak Ridge, Tennessee, March 1991

“Use of Pathways Analysis as a Tool for Effective and Safe Waste Management,” American Chemical Society, 200th National Meeting, Washington, D. C., August 1990

“Applied Exposure Modeling for Residual Radioactivity and Release Criteria,” EPA Workshop on Residual Radioactivity and Release Criteria, St. Michaels, Maryland, September 1989

Performance Assessment for Future Low-Level Waste Disposal Facilities at ORNL,” 11th Annual DOE Low-Level Waste Management Conference, Pittsburgh, PA, August, 1989

“Workshop ion Pathways Analysis,”State of Tennessee, Department of Health and Environment, Nashville, TN, June 1989

“Classification of Groundwaters at Portsmouth Ohio,” DOE Steering Group for 40 CFR 193, Washington, D. C., January 1989

“Performance Based Model for Portsmouth Facility,” Workshop on the Management of Contaminated Soils, Knoxville, Tennessee, November, 1988

“DOE Model Strategy for BRC Uranium Wastes,” DOE Model Conference, Oak Ridge, Tennessee, October 1988

“Low-Level Radioactive Waste Disposal in a Humid Environment: A Site Specific Approach with Generic Application,” Joint CSCE/ASCE National Conference on Environmental Engineering, Vancouver, Canada, July, 1988

“The Role of the Intruder in the Management of Low-Level Radioactive Waste,” Oak Ridge Waste Management Advisory Committee, Oak Ridge, Tennessee, June, 1988

“LLWDDD Strategy for BRC Uranium Wastes,” Workshop on the Management of Uranium Bearing Wastes, Oak Ridge Associated Universities, Oak Ridge, Tennessee, May, 1988

“Evaluation of Uranium Leaching from Solid Wastes, Solid Waste Forms: Characteristics and Evaluations,” Workshop on Waste Forms, Oak Ridge National Laboratory, April, 1988 (with R. B. Clapp, J. E. Cline)

“Impact of Below Regulatory Concern on LLWDDD Strategy,” Oak Ridge Waste Management Advisory Committee, Chattanooga, Tennessee, March 1988

“Below Regulatory Concern Pathways Analysis,” Oak Ridge Waste Management Advisory Committee, Chattanooga, Tennessee, March, 1988

“Review of LLWDDD Program Waste Management Strategy,” Ad-Hoc Industry Waste Management Advisory Committee, Oak Ridge, Tennessee, October, 1987

“Low-Level Radioactive Waste Disposal Strategy for the Oak Ridge Reservation,” Southeastern Compact States Association, Oak Ridge, Tennessee, April, 1987

“LLWDDD Waste Disposal Strategy,” Oak Ridge Waste Management Advisory Committee, Oak Ridge, Tennessee, March, 1987

“Pathways Analysis Considerations for Disposal of Melton Valley Storage Tank Waste in SWSA 6,” Oak Ridge Waste Management Advisory Committee, Oak Ridge, Tennessee, March, 1987

“An Analysis of Groundwater Contamination of a 6-GeV Continuous Electron Beam Accelerator,” Twentieth Midyear Topical Symposium of the Health Physics Society, Reno, Nevada, February, 1987

“Hydrodynamics of Leaky Groundwater Systems with Partially Penetrating Wells,” Energy Division Annual Information Meeting, Oak Ridge National Laboratory, August, 1986 (with J. M. Bownds)

“Siting Considerations for Disposal of Low-Level Radioactive Waste on the Oak Ridge Reservation,” Oak Ridge Waste Management Advisory Committee, Chattanooga, Tennessee, June, 1986

“Impacts of Continuous Electron Beam Accelerator Facility Operations on Groundwater and Surface Water,” CEBAF Workshop on Radiation Protection, Newport News, Virginia, April, 1986

“Assessment of Greater Confinement Disposal Systems for Transuranic Waste,” TRU Waste Update Meeting #11, Las Vegas, Nevada, October, 1985

“”Hydrodynamics of Partially-Penetrating Wells in Leaky Aquifer Systems,” Symposium on Fluid Mechanics Honoring C. S. Yih, University of Michigan, Ann Arbor, Michigan, 1985

“Greater Confinement Disposal Systems for Transuranic Waste,” TRU Update Meeting #10, Denver, Colorado, April, 1985

“Site Selection for Disposal of Low-Level Radioactive Waste,” Oak Ridge Waste Management Advisory Committee, Chattanooga, Tennessee, April, 1985

”Groundwater Transport and Radioactive Waste Disposal – Research Applied to National Issues,” Department Seminar, Department of Mechanical and Aerospace Engineering, North Carolina State University, Raleigh, North Carolina, November, 1984

“A Methodology for Selecting Low-Level Radioactive Waste Disposal Sites with Application to the Oak Ridge Reservation,” Facility Siting and Routing ’84, Energy and Environment, Banff, Alberta, Canada, 1984

“Environmental Pathways Analysis for Evaluation of Low-Level Waste Disposal Site,” IAEA International Conference on Radioactive Waste Management, Seattle, Washington, May 1983

“An Analytical Model for a Round Buoyant Jet,” Joint ASME/ASCE Conference on Mechanics, Boulder, Colorado, June, 1981

“An Analytical Model for a Vertical Buoyant Jet,” Department Seminar, Department of Chemical and Environmental Engineering, Rensselaer Polytechnic Institute, Troy, New York, September, 1980

Expert Witness for U. S, Environmental Protection Agency Region II, in the matter of National Pollutant Discharge Elimination System Permits for Central Hudson Gas & Electric Corp., Roseton Generating Station, et al., New York, New York, February 1980

“Suppression and Amplification of Lee Waves,” Ninth Southeastern Conference on Theoretical and Applied Mechanics, Vanderbilt University, Nashville, Tennessee, May 1978

“Lee Wave Annihilation over two Barriers,” Symposium on Modeling and Transport Mechanisms in Oceans and Lakes, Canada Centre for Inland Waters, Burlington, Ontario, October 1975