ACNWC-0031

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MEMORANDUM

TO: Lynn G. Deering
Advisory Committee on Nuclear Waste
Nuclear Regulatory Commission

FEB 1

FROM: Ken Foland, Consultant

DATE: 25 January, 1995

RE: Comments on the "Questions for Consultants"

This memo is a brief report to provide written response to the two questions that you and Bill Hinze pose. Please relay this information to interested ACNW people. Please also contact me in the event that any clarification is needed or you have any follow up. I am sorry that I wasn't able to respond earlier but I think you understand the situations that have prevented it.

1. Is it likely that isotopic methods of dating groundwater will be sufficiently credible that they will provide believable information on GWTT at Yucca Mountain by 1995, 1996, and 1997?

It certainly is reasonable to expect that isotopic methods will provide important and "believable information on GWTT" in the near future. This information will be indispensable for understanding the travel of water in both space and time. This has already proven to be the case. However, the methods are not likely to produce precise and well constrained "ages" or "travel times" for water for two basic reasons. The first is that the basic methods are not fully developed at the current time and have substantial inherent uncertainties. The second is that the concepts of water ages and travel times are ones that do not hold up well in terms of real world behavior.

With respect to the first reason, it is reasonable to expect continued improvement in methodology will accompany a better understanding some of the inherent difficulties. However, it is not reasonable to expect that some new method will come to the rescue within a couple of years. The basic ones that are now being used (^{3}H, ^{14}C, ^{36}Cl, U disequilibrium) are appropriate and reasonably well developed and will need to suffice. The measurement technologies are generally sufficiently refined although improvements are continuing. New experience is adding quickly to understanding of the behavior in the context of interpreting results. And, some new routines for modeling are available and under development. In short, while these developments are important to the success of dating methods at Yucca Mountain, I don't see anything dramatic that is going to result in any sort of quantum jump.

It seems clear that the second reason above is the basic limiting factor of the methods rather than such methodological factors. Water mixing and reaction appear ubiquitous in a situation such an environment as Yucca Mountain and other processes (evaporation and vapor

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transport) are also important. These basic processes we know stand between determining groundwater "ages" and "travel times" in the fundamental context of definition of the terms. As a result, the basic system does not lend itself to be characterized well in terms of age or GWTT. Indeed, any expectation of "believable" GWTT ought to start with a reasonable conception of GWTT. So, in part the problem of the isotopic methods is due to the expectations in terms of ages and travel times that are defined or viewed too simply.

2. If isotopic methods are not going to be available are there alternative credible methods for ascertaining GWTT, and if so, what data are required?

Two other approaches that are obvious are using anthropogenic compounds (e.g., CFC's, chlorofluorcarbons) or modeling. The CFC's will produce important information but the timeline is going to be too short and they cannot be expected to produce definitive information for water at great depth. Obviously, modeling can predict GWTT using the data being gathered in the basic Site Characterization program. However, this approach alone is unlikely to produce "believable" results at Yucca Mountain. Clearly, this is not going to be sufficient with the complexity of the site and the likely state of fracture characterization, etc. This is already demonstrated by the isotopic results. In sum, there are no obvious alternative methods that are going to substitute for isotopic data.

The information of travel times will require input from isotopic methods and the data will need to be put into realistic hydrologic models and viewed in context of the processes beyond the simple concepts of dates and travel times. In short, the approach is going to require careful isotopic dating albeit the systems are imperfect. There are some avenues that can be explored to improve the dating measurements.

The methods are available but the value of the results that will be produced will, in part, depend upon the application of them at Yucca Mountain. For example, it is very important that the isotopic work be fully integrated. This should include the measurement of various cosmogenic nuclides (^{3}H, ^{14}C, ^{36}Cl, perhaps others) on the same samples to the degree possible. Such integration offers great advantages because of the different half lives and different bomb-pulse signals as well as disparate reaction of water "components" during transport. It also seems highly advantageous to use the radiogenic ^{3}He along with ^{3}H and He measurements should be considered. Additionally, it is important to integrate other investigations on these same samples, for example, stable isotope characterization of H, O, and C, perhaps also Sr isotopes, and measurement of the full spectrum of dissolved components. This is essential and only with such work will it be possible to evaluate such processes as mixing and matrix reaction. A certain amount of such integration appears to be taking place presently but it appears that much more would be valuable. In sum, the sort of integrated approach that extends far beyond merely measuring a specific radionuclide is demanded in order to constrain as well as possible the range of processes that affect the groundwater system. Additionally, more measurements will be very important for example, in providing more detail of fast pathways and the potential flux that they provide.