From: James A Davis <jadavis@usgs.gov>
To: <jdr@nrc.gov>, <WRO1@nrc.gov>, <ALS2.twf5_po.TWFN_DO@nrc.gov>
Date: 2/22/06 5:31PM
Subject: Fw: Comments on Draft Report NUREG/CR-6870

5/2/05
70FR22728
(2)

These comments would take the most work to respond to. The commenters are correct; the report should have a lot more data and consider a lot more scenarios. However, I would say it would have been useful for the NRC to have contacted these guys up front and ask them for data so that they can't complain about it now. As I said in a previous email, I had trouble getting operators to provide any data that was of the type that was needed. Now they say there is a wealth of data and well-known industry practice.

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----- Forwarded by James A Davis/WRD/USGS/DOI on 02/22/2006 02:25 PM -----

"John Randall" <jdr@nrc.gov>
09/16/2005 04:42 AM

To
<gpcurtis@usgs.gov>, <jadavis@usgs.gov>
cc

Subject
Fwd: Comments on Draft Report NUREG/CR-6870

----- Message from "FARRELL, Clifton" <cwf@nei.org> on Wed, 31 Aug 2005 09:45:24 -0400 -----
To:
<jdr@nrc.gov>
Subject:
Comments on Draft Report NUREG/CR-6870
August 31, 2005

Dr. John D. Randall
Mail Stop T9C34
U.S. Nuclear Regulatory Commission
11545 Rockville Pike
Rockville, MD 20852

REFERENCE: Comments on Draft Report NUREG/CR-6870 ?Consideration of

SISP Review Complete
Template = ADM-013

E-RIDS = ADM-03
Add = A. Schwartzman (ALS2)

Geochemical Issues in Groundwater Restoration at Uranium In-Situ Leach Mining Facilities? [Federal Register Vol. 70, No. 118, p. 35744 dated June 21, 2005]

Dear Mr. Randall:

The Nuclear Energy Institute[1] (NEI) on behalf of its industry members is pleased to submit the following comments on draft NUREG/CR-6870. The U. S. Nuclear Regulatory Commission (NRC) commissioned the U.S. Geological Survey (USGS) to run a geochemical modeling program with data from a sole in-situ leach (ISL) mine to simulate the restoration and long-term stabilization of aquifers from which uranium has been extracted. The USGS attempted to determine what volumes (?pore volumes?) of water would have to be circulated through mined zones to achieve NRC or State groundwater quality restoration standards. The NRC seeks to refine its estimates of what numbers of pore volumes of water are necessary to adequately restore aquifer water quality and to assess whether licensees are allocating sufficient decommissioning funds for achievement of this goal.

[1] NEI is the organization responsible for establishing unified nuclear industry policy on matters affecting the nuclear energy industry, including the regulatory aspects of generic operational and technical issues. NEI?s members include all utilities licensed to operate commercial nuclear power plants in the United States, nuclear plant designers, major architect/engineering firms, fuel fabrication facilities, materials licensees, and other organizations and individuals involved in the nuclear energy industry.

CC: Gary P Curtis <gpcurtis@usgs.gov>

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Subject:	Fw: Comments on Draft Report NUREG/CR-6870
Creation Date:	2/22/06 5:30PM
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August 31, 2005

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<u>REFERENCE</u>: **Comments on Draft Report NUREG/CR-6870 "Consideration of Geochemical Issues in Groundwater Restoration at Uranium In-Situ Leach Mining Facilities" [*Federal Register* Vol. 70, No. 118, p. 35744 dated June 21, 2005]**

Dear Mr. Randall:

The Nuclear Energy Institute[1] (NEI) on behalf of its industry members is pleased to submit the following comments on draft NUREG/CR-6870. The U. S. Nuclear Regulatory Commission (NRC) commissioned the U.S. Geological Survey (USGS) to run a geochemical modeling program with data from a sole *in-situ leach* (ISL) mine to simulate the restoration and long-term stabilization of aquifers from which uranium has been extracted. The USGS attempted to determine what volumes ('pore volumes') of water would have to be circulated through mined zones to achieve NRC or State groundwater quality restoration standards. The NRC seeks to refine its estimates of what numbers of pore volumes of water are necessary to adequately restore aquifer water quality and to assess whether licensees are allocating sufficient decommissioning funds for achievement of this goal.

Regrettably, NUREG/CR-6870 fails to provide the NRC with the guidance it seeks. The study authors have tweaked the PHREEQC model with varying input parameters and assumptions to try and replicate the groundwater behavior at <u>one</u> ISL mine. The study does not attempt to make any generic recommendations as to how many pore volumes of water are required to achieve groundwater restoration, although current industry practice of circulating ~1 pore volume of groundwater sweep followed by ~1-5 pore volumes of reverse osmosis (RO) permeate seems to be supported by the results of the simulations. Extrapolation of the modeled results

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from one small test ISL mine to other deposits would indeed prove very foolhardy. Appreciable differences in geology, host strata mineralogy (pre- and post-mining), hydrologic characteristics, wellfield design, depth and, most importantly, licensee mining practices make such an estimate impossible to reliably establish. The study results do, very fortunately, confirm what the industry has known for decades — that aquifer restoration requires anoxic conditions that are generally achieved through introduction of a reductant.

Parameter uncertainties are a serious concern with the PHREEQC model and the results of the restoration simulation at one mine should not be uncritically extended to application at other mines. While the study does acknowledge that reducing conditions are necessary, the authors make no references to much more cost-effective biological approaches now being very successfully implemented at ISL mines. The model does not acknowledge use of wellfield patterns (e.g. line drives) that are in common use at other mines and whose design would profoundly impact aquifer restoration planning. The authors also fail to acknowledge current mining practices whereby wellfields are sequentially mined and restored while the mine permits and licenses are active; the old practice of completely mining an orebody and then undertaking restoration no longer fits with modern mine economics which favor ongoing mining and restoration. This modern practice will profoundly impact the funds that a licensee must set aside for mine decommissioning.

NEI is particularly concerned with the authors' assertion that groundwater restoration represents approximately 40% of the cost of decommissioning of an ISL uranium mine. Data from several ISL projects are presented in Table 1 of the report without any critical review of their accuracy, relevance, methodology, applicability or restoration standards. In fact, these data are superfluous to the principal object of the study, which was to estimate the volumes of water that are needed to demonstrate aquifer restoration. Had the purpose been to estimate groundwater restoration <u>costs</u>, then a very critical assessment of the date in Table 1 and forecast aquifer restoration costs for the test Ruth mine would have been warranted. As noted earlier, modern mining practices (concurrent mining and aquifer restoration and operating strategies) can not be compared to what was accomplished decades ago in former ISL mines. That the authors should encourage the NRC to adopt the 40% "rule-of-thumb" aquifer restoration costs with minimal supporting analyses is disingenuous and indefensible. The authors may be tacitly acknowledging the inability of the PHREEQC simulations to reliably predict the number of pore volumes of groundwater sweep/RO permeate to restore mined-out aquifers by omitting any quantitative estimates from the study's conclusions. The simulations in §5.2 seem to support industry practice, but no mention of this revelation is included in the study summary. Confidence in the capabilities (and calibration) of the model could have been enhanced through consideration of available long-term monitoring data from other ISL mines. Simulations of long-term aquifer stability in §5.3 reveal that some re-dissolution of uranium and other associated metals may occur after passage of anywhere from ~5-40 additional pore volumes of groundwater influx over a period of years to hundreds of years. Again, the authors offer the NRC no guidance on this matter.

NEI has identified other less worrisome issues that should be corrected in the report. These include, for example, (i) reference to oxidants that industry has not used in decades (sodium chlorate, potassium permanganate), (ii) overly conservative characterization of the geometry of ISL ore zones (look, for example, at the great thicknesses and lateral extents of central Asian deposits), (iii) incomplete characterization of wellfield patterns (p. 1), (iv) confused references and an apparent misunderstanding of hydrological terminology (porosity and permeability on p. 15 & 16), and (v) many instances of unclear English construction that a comprehensive technical edit would correct.

The *Federal Register* announcement requests comments on the utility of the PHREEQC model. Simulations of geologic behavior are always challenging and model results come with high margins of uncertainty simply due to incomplete knowledge of aquifer characteristics (hydrologic properties, mineralogy, adsorption coefficients, water chemistry, etc.). Simulations can be used to place outer, albeit rather large, bounds on forecast aquifer behavior. Results of the PHREEQC model generally confirm the numbers of pore volumes licensees use to meet aquifer restoration standards. However, simulations of post-reclamation aquifer behavior are fraught with such huge uncertainties due to input parameter unknowns, aquifer parameter unknowns and regional hydrologic setting unknowns, that they have little practical value. In both instances – groundwater sweep and long-term aquifer stabilization -- the NRC should better rely on demonstrated reclamation practices and successes which have convincingly demonstrated achievement of aquifer restoration standards, rather than on simulations of unknown accuracy. Simulations of long-term aquifer behavior with a variety of input parameters to attempt duplication of natural aquifer behavior is of academic interest that warrants continued attention as our understanding of aquifer behavior improves. But with our current, very limited understanding of post-mining aquifer behavior, the results of simulations are of such doubtful validity that they should never be used as a basis for establishing regulations or post-mining performance standards.

Draft NUREG/CR-6870 should be significantly revised to focus solely its stated purpose – to report on the results of geochemical modeling of the restoration of one mined-out aquifer at one test mine. Parts of Chapter 1 which address aquifer reclamation costs, a topic which lies outside of the study scope, should be struck. None of the results of the study provide any basis to support the 40% figure for groundwater restoration costs, and the data cited in Table 1 are themselves of questionable validity and relevance. That the groundwater sweep simulations do confirm industry practice is comforting, but are such simulations really necessary to justify successfully-applied industry practice? The authors should not limit their analysis to addition of H_2S as a reductant, but rather consider impacts of other reductants, such as biological reductants, that have been successfully used at

Wyoming mines and that develop naturally in Texas ISL-mined aquifers. The failure (or inability) of the computer models to address long-term biological reduction in mined-out aquifers is a serious flaw in the study. Section 6 ('Conclusions') of the study should clearly state the results of the simulations and address what the NRC seeks – that 1-2 pore volumes of groundwater sweep followed by several more of RO permeate -- are adequate to meet restoration standards. Results of the long-term simulations should also be presented, if nothing else, to show their breadth (uncertainty) dependence on long-term hydrologic assumptions. Inclusion of post-restoration groundwater quality data from other ISL mines would certainly have enhanced the reader's confidence in the computer model's utility and validity.

NUREG/CR-6870 offers an interesting application of the PHREECQ computer model. The study shows that input parameters and assumptions can be chosen that that will demonstrate the effectiveness of industry's aquifer restoration methodology. The model does not, however, provide guidance that can assist the NRC in establishing what fraction of decommissioning costs should be allocated to aquifer restoration. As such, the study provides interesting, academic reading, and some measure of confidence in the evolution of aquifer restoration simulation models. Unfortunately, the heterogeneity of ISL-exploited aquifers and the absence of accurate subsurface field data will limit the usefulness, utility and feasibility of models such as PHREEQC.

NEI appreciates the opportunity to comment upon draft NUREG/CR-6870 and should be pleased to answer any questions that you may have concerning our preliminary evaluation of this study.

Sincerely,

Clifton W. Farrell

Dr. Clifton W. Farrell