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U.S. Nuclear Regulatory Commission
ATTN: Mrs. Deborah A. DeMarco
Office of Nuclear Material Safety and Safeguards
Program Management, Policy Development, and Staff
Office of the Director
Mail Stop 8D–37
Washington, DC 20555

Subject: Programmatic Review of Abstracts

Dear Mrs. DeMarco:

The enclosed abstracts are being submitted for programmatic review. These abstracts will be submitted for inclusion in the Pinder Volume of Advances in Water Resources. If accepted by Advances in Water Resources for the Pinder Volume, full papers will be written for U.S. Nuclear Regulatory Commission (NRC) review prior to submission to Advances in Water Resources. These abstracts are:

> "Estimating Uncertainty in Modeled Mean Annual Infiltration Arising From Uncertain Parameters" by S. Stothoff and R. Fedors
>
> "Event-based Hillslope Sediment Balance Modeling at Millennial Time Scales" by S. Stothoff and R. Fedors

These abstracts document work performed for the Unsaturated and Saturated Flow Under Isothermal Conditions Key Technical Issue. Net infiltration has consistently been shown to be one of the most important parameters governing performance of the proposed repository at Yucca Mountain, Nevada. The technical content of both abstracts relate directly to uncertainty of parameters for estimating net infiltration fluxes above the repository. The first abstract addresses the suite of uncertain parameters used to estimate spatially variable net infiltration. The second abstract addresses one parameter directly, soil depth, to which net infiltration flux estimates are highly sensitive. Parameter uncertainty of net infiltration is the topic addressed in U.S. Department of Energy (DOE) and NRC technical agreements USFIC.3.01 and USFIC.3.02. The approaches developed in these abstracts are part of our ongoing efforts to test and evaluate the adequacy of DOE estimates of net infiltration.

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These abstracts are products of the CNWRA and do not necessarily reflect the view(s) or regulatory position of the NRC.

Please advise me of the results of your programmatic review. Your cooperation in this matter is appreciated.

Sincerely,

Budhi Sagar
Technical Director

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Enclosures

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Estimating uncertainty in modeled mean annual infiltration arising from uncertain parameters

S. Stothoff and R. Fedors

Estimates of mean annual infiltration (MAI) in a heterogeneous domain are difficult and computationally expensive to calculate using Richards-equation-based numerical simulators. A long simulation period is needed to reliably assess MAI in arid and semiarid locations, and a 1D simulation might represent just a few square meters in a heterogeneous area. Grid and time step requirements may force simulation times of days or weeks for an adverse parameter combination. Thus, direct estimation of distributed MAI in large, heterogeneous regions can be prohibitively expensive without simplifying assumptions, and all but the simplest sensitivity analyses may be out of reach. The difficulty is exacerbated when the input parameters are known with levels of uncertainty typical at a field site. With relatively few but well-selected simulations, however, a response surface for MAI as a function of hydraulic and climatic parameters can be developed. Using the response surface, the effect on model predictions due to uncertain parameters and their correlations can be quickly assessed through Monte-Carlo analysis. An example is developed for Yucca Mountain, NV, which features about a dozen watersheds and 10 bedded-tuff subunits cropping out (each with their own hydraulic characteristics and fracture patterns) in the region of interest. The response surface for this example was built with about 500 simulations. Methods for estimating the input parameter distributions are presented, including bedrock, soil, and fracture hydraulic properties as well as climatic forcing. Estimated first and second moments of MAI are assessed for each grid block on a fine grid under both present-day and hypothetical wetter and cooler climatic conditions. For simplicity, neither vegetation nor runon are considered in the example, although these can be considered within this framework. The methodology is easily extended to examine spatial variability patterns (e.g., frequency of infiltration "hot spots").

Event-based hillslope sediment balance modeling at millennial time scales

S. Stothoff and R. Fedors

Soil depth and texture on hillslopes in semiarid environments is dynamic at millennial time scales. Changes in climate influence erosion, vegetation, and sediment sources, which in turn influence each other and the subsurface water balance. A hillslope water balance over millennial time scales may be of interest in bounding water fluxes through geologic repositories for high-level nuclear waste, implying that changes in soil profiles and their spatial distribution over the millennial time scale may also be of interest. Some processes are relatively continuous in time, such as creep and dust deposition; however, other processes are episodic, such as overland flow and landslides. An approach to quantifying the soil balance is developed that time-averages episodic processes into equivalent continuous processes by simulating a set of representative events (such as rainstorm/runoff events) capturing the range of conditions important for transport. Water and sediment fluxes for these representative events are estimated at their natural time scale and multiplied by the time fraction over which the episode is active. Overall mass balance is achieved by simultaneously considering all of the time-averaged processes. A simple equilibrium example, using a digital elevation model-based grid with one characteristic sediment class, one characteristic storm, present-day dust deposition rates, and a film-flow characterization for soil creep, provides a reasonable estimate of present-day hillslope soil thicknesses at Yucca Mountain, NV. Relationships between local soil thickness, local contributing area, and local slope from the equilibrium example for Yucca Mountain (time-averaged approach) appear to be consistent with published relationships, including the familiar topographic characterization, $A/\tan\beta$ (upslope area/slope gradient), criterion used in estimating runoff area in watershed studies.