D1021

PDR-1
LPDR- WM-10 (2)
WM-11 (2)
WM-16 (2)

SEP 15 1987

426.1/JP/9/11/87

Mr. Mark J. Logsdon, Project Manager
Nuclear Waste Consultants, Inc.
8341 S. Sangre de Cristo Road
Suite 14
Littleton, Colorado 80127

Dear Mr. Logsdon:

Richard Codell has prepared a draft Task Descriptive Summary for simulating the testing and analysis of a hypothetical high-level waste site in saturated media. This draft draws on several TDS's submitted by Williams and Associates, Nuclear Waste Consultants and Dr. Codell's own experiences with a preliminary exercise. The draft Task Descriptive Summary is enclosed for your review. I would like you to review it for technical content and appraise your ability to perform the required tasks. Also prepare a preliminary estimate of the contract time and actual time to complete the assignment. Because this would be a joint project with Williams and Associates, please contact them at your convenience to discuss the technical content of the draft and the necessary interfaces during the course of the study. We will arrange a meeting or conference call to discuss the proposal this fall. Please contact me or Dick Codell (301-427-4558) if you have any questions.

The action taken by this letter is considered to be within the scope of the current contract NRC-02-85-009. No changes to costs or delivery of contracted products are authorized. Please notify me immediately if you believe that this letter would result in a change to costs or delivery of contracted products.

Sincerely,

/s/

Jeffrey A. Pohle, Project Officer
Hydrology Section
Technical Review Branch
Division of High-Level Waste Management
Office of Nuclear Material Safety
and Safeguards

Enclosure:
As stated

WM-Res
Record File
D1021
NWCI

WM Project 10, 11, 16
Docket No.
PDR ✓
LPDR ✓ (B,N,3)

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WM Project: WM-10, 11, 16
PDR w/encl
(Return to WM, 623-SS)

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Rev 1 9/10/87
R Codell

DRAFT TASK DESCRIPTIVE SUMMARY

Title: SIMULATING RESPONSE TO TESTING AND EXPERIMENTATION ON DETERMINATION OF PATHS OF RADIONUCLIDE TRAVEL AND GROUNDWATER TRAVEL TIME

OBJECTIVE:

The objective of this work is to demonstrate through mathematical simulation of hydraulic tests, our ability to calculate the groundwater travel time at a typical High Level Waste site based only on observations of the response to hydrogeologic testing.

Technical Approach

None of the three HLW sites identified for characterization have sufficient data at this point in time to estimate the groundwater travel time along the fastest path of likely radionuclide travel. One alternative to the dilemma is to generate an "artificial reality" which is an analog of a real hydrogeologic system. Hydrogeologic testing can be simulated on the artificial reality, and the results interpreted to give estimates of the groundwater travel time along the fastest paths of likely radionuclide travel. The results could then be compared to groundwater travel times computed directly from the analog which will serve as the benchmark or "true" answers. A preliminary study of this nature has been conducted by Codell (1987).

The study will be restricted to saturated flow in two dimensions for the present, but approaches for studying a 3-dimensional case will be outlined as one of the tasks. Computer codes for the exercises will be chosen by consultation of the TA contractors, NRC staff and other professionals available to the staff (e.g., contacts to universities through the Office of Research).

Various hydrogeologic tests will be simulated with the computer model. The resulting responses to the simulated stresses on the model will be used to:

1. Conceptualize the hydrogeologic system
2. Estimate hydrogeologic parameters
3. Determine the likely paths of radionuclide travel, and
4. Estimate groundwater travel time along paths of likely radionuclide travel.

<u>Product</u>

The product will contain the assessments of the contractors on the experiences, problems and accuracy of forecasting the paths of likely radionuclide travel and groundwater travel time.

<u>Manpower</u>

Resources required for this report should include the expertise of both Technical Assistance contractors. Williams and Associates will have the main responsibility for running the computer codes. Daniel Stephens and Associates will have the main responsibility for generating the synthetic data base(s) for the site analog. Both contractors will be responsible for evaluating the results of synthesized testing of the computer model of the site, and using various simple and sophisticated techniques for giving their estimates of groundwater travel time and pathways of likely radionuclide travel. The estimated work load is unknown at this time.

<u>Schedule</u>: Monthly reports on the progress of the work, with final report due 9 months after commencement of the project.

<u>Interactions</u>: Contractors are expected to work closely, so that there will be continued peer review of their respective tasks before final issuance of the report.

<u>Tasks</u>:

A tentative breakdown of tasks for the two contractors is given below:

1. Investigate the relationship of heterogeneity and anisotropy in a two dimensional aquifer to the scale of hydrogeologic testing used for quantification of coefficients. A series of model experiments will be performed with the ultimate aim of establishing how well the artificial site can be characterized for the determination of groundwater travel time.

   a. Through consultation with the staff, both contractors should determine the parameters which will specify the boundaries and variability in the synthetic site to be studied.

   b. Decide on the computer codes to be used or written for the exercise.

   c. Prepare a "test plan" first, using knowledge of the geology and professional judgement in locating test holes.

   d. Generate a field of spatially correlated random properties of the hydrogeologic system. Parameter values for the repository scale model will be generated by means of a multivariate random number generator such as the turning band method, and may be conditioned or unconditioned by point data. These synthetic data will include hydraulic conductivity, storativity and porosity. The field of data may be fashioned to include hydrogeologic features such as zones of high permeability or barriers to flow, which might in practice be difficult to identify from the testing.

Daniel Stephens and Associates will be responsible for the generation of the stochastic data base for input to the model. Since the experiment will have to consider several different scales of testing, techniques should be explored whereby both small-scale testing and large scale testing can be accommodated. For example, a coarse grid may be generated for the large scale pumping test and a fine grid generated within the coarse grid at certain locations to accommodate the small scale tests.

2. Using the synthetic data base perform a variety of steady-state and transient tests typical of those which would be performed at at site. The decision on the type and number of tests will be discussed in the test plan, and based on considerations such as expense (both real expense in terms of contractor, computer and staff resources, and simulated testing expenses for actually performing and interpreting the results in the field).

   a. Simulate a number of single hole hydraulic tests.

b. Use the same data to simulate one or more transient large-scale tests.

3. Interpret the results of the pump tests monitoring well data gathered from the synthetic experiment to get hydraulic conductivities and other hydrogeologic properties of the units.

   a. Analyze the results of the small-scale tests

   b. Analyze the results of the simulated large-scale tests.

   c. Compare the results from the large scale and small scale tests for any obvious relationships.

   d. Explore the use of variance reduction techniques such as Vanmarke (1983) to combine fine grid data into large scale data for the purposes of simulating the large scale pump test.

   e. Methods will be explored to test ways in which effective porosity could be measured from the synthetic experiments.

4. Compute paths of likely radionuclide travel and groundwater travel time based on data collected at each scale. For the purposes of comparing the groundwater travel times calculated in the steps above, the "true" groundwater travel time shall be the arrival time distribution to the accessible environment of a small

quantity of water releases along the disturbed zone. Alternatively, the mean or other indicator of the distribution such as the 15th percentile could be used as the criterion for comparison.

a. Investigate the prediction of groundwater flow paths and groundwater travel time from a deterministic analysis based on professional assessment of the distributions of coefficients. Calculations for this phase of the estimates should include but not be limited to interpretations of transmissivities and storativities from graphical techniques (e.g., Theis), the construction of flow nets based on transmissivities and heads, hand-fitting of head and transmissivity surfaces and possibly non-stochastic inverse modeling.

b. Predict groundwater travel paths and groundwater travel time using a stochastic Monte Carlo approach with conditional, unconditional and completely random fields (these studies will be based only on the data collected from the simulated testing, not the original analog data). Use geostatistical techniques such as kriging to generate a field of hydraulic conductivities based on the data collected from the synthetic experiments from steps a and b. Simple kriging, cokriging with head data (e.g., Kitinidis) or other geostatistical inverse methods could be used. Daniel B. Stephens and Associates will have the primary responsibility for the geostatistical analyses of the data measured from the synthetic tests.

c. Calculate the "true" groundwater travel time directly from the synthetic reality.

d. Compare the deterministic groundwater travel times from (a) above, the distribution of the stochastically determined groundwater travel time distributions from (b) and the true groundwater travel time from (c). This comparison should be reported in terms of the relative work involved to improve the estimate of the groundwater travel time in terms of types and numbers of wells, testing of the wells and expenses of computation.

4. Scope an analysis for a continuation of this study dealing with a three-dimensional case. Considerations for continuing the study should include cost to NRC,

availability of computer codes for generating and solving the transient responses and suitability of available computers to solve the problem in sufficient detail (e.g., grid size) to give meaningful results. This phase of the analysis should take advantage of the regional and site-scale models already available for the Hanford and Permean Basin sites investigated by Sandia National Laboratories and HYDROCOIN.

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OFFICIAL CONCURRENCE AND DISTRIBUTION RECORD

LETTER TO: Mr. Mark J. Logsdon, Project Manager
Nuclear Waste Consultants, Inc.
8341 S. Sangre de Cristo Road
Suite 14
Littleton, Colorado 80127

FROM: Jeffrey A. Pohle, Project Manager
Hydrology Section
Technical Review Branch
Division of High-Level Waste Management, NMSS

SUBJECT: DRAFT REVIEW TDS

DATE: September , 1987

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