PHASE I REVIEW: DOE PLAN FOR REGIONAL HYDROLOGIC SYNTHESIS AND MODELING (STUDY PLAN 8.3.1.2.1.4, Revision 0)

by

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Introduction

This study plan provides a description of SCP Study 8.3.1.2.1.4, "Regional Hydrologic Synthesis and Modeling." This study includes four activities: (1) conceptualization of regional hydrologic flow models; (2) subregional two-dimensional areal hydrologic modeling; (3) subregional two-dimensional cross-sectional hydrologic modeling; and (4) regional three-dimensional hydrologic modeling.

The results of this study and other studies under Investigation 8.3.1.2.1 will be used to develop both conceptual and numerical models of the regional hydrologic system to help assess the site's suitability to contain and isolate waste. Regional models can help analyze the possible effects of changes in future stresses to the hydrologic system such as increased recharge from future climatic changes, potential increased withdrawal of groundwater, and changes in hydrogeologic system properties and geometry resulting from tectonic events.

In conducting this review, the NRC staff did not identify any objection-level concerns. Work under this study plan does not include any field tests and thus will have no physical impacts on the Yucca Mountain site or other site characterization activities. However, this study plan is a candidate for a detailed technical review because it meets criteria 1, 2, and 3 described in step 6 of part 4.2 of the Review Plan. It is also related to key site issues and a number of NRC open items. The study plan also addresses the important topics of model calibration, validation, and sensitivity studies.

The following concern regarding a deficiency in technical procedures should be brought to the attention of the DOE. For each activity, under QA requirements, it is stated that technical procedures do not apply to this activity because "...modeling is an analysis and interpretation activity, the appropriate application of which is assured by technical review..." and "...data used in modeling are collected partly under other activities...for which technical procedures are assigned." However, work under this study clearly meets the scope of the procedure for a scientific notebook system (YMP-USGS-QMP-5.05,

R2), which reads as follows: "This QMP applies to all USGS and contractor personnel assigned to perform the work related to QA graded technical activities that produce data, maps, or supports any other product that is a basis for the YMP site characterization or licensing. This procedure applies to experimental or research activities such as those largely requiring professional judgement, trial-and-error methods, or developing methodology..."

For each activity under this study, methods and technical procedures were briefly outlined in the DOE (1988) Site Characterization Plan (pages 8.3.1.2-138 to -147). At that time, procedure numbers and titles had not yet been identified, being listed as "to be determined." One of the content requirements for study plans (see Attachment B to Summary of NRC/DOE Meeting on Level-of-Detail for the SCP, May 1986) is to cite technical procedures relevant to the study. As an alternative to technical procedures, the scientific notebook system may be used. It is intended to provide a written record of work involving research or work that is non-repetitive, requiring extensive professional judgement, and trial-and-error methods. Because the subject study plan cites neither technical procedures nor the scientific notebook system, it appears that the work described will not be documented in an acceptable manner.

A Phase I review of the study plan was done with respect to (A) DOE/NRC agreement on the content of study plans: (B) identification of objections; (C) closure of NRC open Items; and (D) the need for a Detailed Review (See Review plan for NRC staff review of DOE study plans, revision I, 12/6/90).

Evaluation of Study Plans Relative to the Agreement and to the Responsible DOE Contractors QA Program (Objectives 1 and 5)

Criterion 1 The content of the study plan under review is reasonably consistent, as appropriate for the activities, tests and analyses described, with the Agreement (NRC-DOE meeting on the level of detail for site characterization plans (SCP) and study plans, May 7-8, 1986).

Staff Review: Attachment A is an itemized checklist of the study plan content as compared to the agreement on content resulting from the NRC/DOE level of detail meeting. The content of the study plan is deficient with respect to the fact that no procedures were cited to document the technical work.

It should be noted that for each type of analysis the study plan did not indicate the level of QA and provide the rationale for any analyses not classified as QA level one. Further the study plan did not reference the applicable specific QA requirements applied to the analysis or the levels of QA applied. The reason for this is that a determination of the quality status for the activities of this study will be made separately, according to AP-6.17Q, "Determination of the Importance of Items and Activities", which implements NUREG-1318, "Technical Position on Items and Activities in the High-Level Waste Geologic Repository Program Subject to Quality Assurance Requirements". The results of that determination will be

contained in the Q-List, Quality Activities List and Non-Selection Record, which will be controlled documents. Furthermore, QA grading packages for the activities of this study plan will be prepared separately, according to AP-5.28Q, "Quality Assurance Grading". The resultant Quality Assurance Grading Report will be issued as a controlled document.

Criterion 2 — All study plan references have been provided when the study plan was issued.

Staff Review: Most of the 13 cited references are available here at NRC. The remainder are considered readily obtainable through our library services.

Criterion 3 — Open items relative to the QA program of the DOE contractor responsible for the study plan that could call into question the quality of the study plan, have been resolved.

Staff Review: Based on a discussion with William Belke, Quality Assurance Section, there are currently no open quality assurance items that would call into question the quality of the study plan.

Identification of Objections (objectives 2 through 6)

Criterion 1 — Potential adverse effects on repository performance:

Staff Review: No field tests are planned under this study. Accordingly, adverse effects on repository performance cannot occur.

Criterion 2 — Potential significant and irreversible/unmitigable effects on characterization that would physically preclude obtaining information necessary for licensing.

Staff Review: No field tests are planned under this study. Accordingly, there is no potential for significant and irreversible/unmitigable effects on characterization.

Criterion 3 — Potential significant disruption to characterization schedules or sequencing of studies that would substantially reduce the ability of DOE to obtain information necessary for licensing.

Staff Review: No field tests are planned under this study, and the work will not affect the schedules of other planned testing activities. Therefore, there is no potential to significantly disrupt characterization schedules.

Criterion 4 Inadequacies in the QA program which must be resolved before work begins.

Staff Review: Based on a meeting with William Belke, Quality Assurance Section, there are currently no quality assurance inadequacies that have to be resolved before the work begins.

Closure of NRC Open Items (Objectives 8 and 11)

Staff Review: Not applicable - in its transmittal letter DOE did not propose to close any open items with this study.

Need for Detailed Technical Review

A study plan is a candidate for a detailed technical review if it meets any of the 5 criteria (described below) from step 6 of part 4.2 of the Review Plan. In summary, this study plan is a candidate for a detailed technical review because it meets criteria 1, 2, and 3. Each criterion is discussed below:

Criterion 1 The study plan may be related to one or more key site related issues.

Staff Review: Analyses performed under this study plan will apply to a number of key site-related issues. Relationships to the issues are briefly summarized below:

Issue 1.1 (total system performance) relates to calculating the complementary cumulative distribution function (CCDF) for estimating post-closure radionuclide releases. It is intended that the CCDF will incorporate all those natural and human-induced processes and events that are sufficiently credible to warrant consideration. These are addressed through the development of sets of scenarios grouped in scenario classes. The present study directly supports those scenarios related to regional hydrogeology and indirectly supports those related to site-scale hydrogeology.

Issue 1.3 (groundwater protection) requires the determination of whether the aquifer is a Class I source and a "special source" of groundwater. As stated in the study plan, this study supports the resolution of issue 1.3 through its indirect contribution to issue 1.6 through Study 8.3.1.2.3.3.

Issue 1.6 relates to pre-emplacement groundwater travel time. Regional saturated zone modeling under this study will not be used to directly estimate groundwater travel time at the site scale. Rather, the regional models will be used to identify appropriate boundary conditions for site-scale modeling of the saturated zone under study 8.3.1.2.3.3.

Issue 1.8 relates to favorable and potentially adverse conditions (siting criteria under 10 CFR 60.122) that are pertinent to regional hydrogeology. These include favorable condition 7 (groundwater travel time substantially exceeds 1000 yr.) and the following potentially adverse conditions (PAC):

PAC 2: potential for human activity to adversely affect the groundwater flow system
PAC 4: structural deformation that may adversely affect the regional groundwater flow system
PAC 5: potential for changes in hydrologic conditions that would affect the migration of radionuclides to the accessible environment (i. e., changes in hydraulic gradient, natural recharge, etc.)
PAC 6: potential for changes in hydrologic conditions from reasonably foreseeable climatic changes
PAC 8: geochemical processes that would reduce sorption of radionuclides, degrade rock strength, or adversely affect the engineered barrier
PAC 11: Quaternary structural deformation
PAC 15: post-Quaternary igneous activity
PAC 22: potential for the water table to rise and saturate a repository located in the unsaturated zone

Issue 1.9 is concerned with the DOE postclosure guidelines (qualifying and disqualifying conditions) and with two performance evaluations that are required to predict radionuclide releases 100,000 years after repository closure.

Criterion 2 The study plan pertains to some NRC open items.

Staff Review: Work under this study plan is related to SCA comments that address conceptual hydrogeologic models, scenario development, and aspects of groundwater travel time. These SCA comments are briefly described below:

SCA Comment 1 - This comment relates to the issue resolution strategy for Yucca Mt. It identified inconsistencies in scenario development and screening, and stated the need for a hypothesis testing table for total repository system performance.

SCA Comments 3 and 7 - These comments relate to the formal use of expert judgement. It recommended that criteria for the formal use of expert judgement be identified to assure that objective, quantitative analyses based on empirical data are used in preference to expert elicitation wherever possible.

SCA Comments 6 and 9 - These comments address inconsistencies in the hypothesis testing tables in the SCP. These tables present alternative conceptual models related to the Yucca Mt. site.

SCA Comment 10 - This comment stated that the technical basis for

initial assessments of hydrogeologic features and processes was not discussed in the SCP, and that the regional and site hydrogeologic systems were not well described.

SCA Comment 95 - This comment recommended that DOE redo its approach to scenario analysis so that the approach will be both systematic and complete.

Criterion 3 The study plan describes unique, state-of-the-art tests or analysis methods that do not have a supportive scientific history of providing data usable in licensing.

Staff Review: The work described in this study plan does not include any field testing and thus will not result in the collection of new field data. The key analyses to be performed include groundwater modeling of the region that encompasses the Yucca Mt. site. Although mathematical and numerical modeling have always played an important role in licensing, there are no previous examples where performance projections over thousands of years have had to be made as part of an NRC license application. These projections include long-range effects of climate change and aquifer resource utilization on groundwater flow systems.

Criterion 4 The study plan describes a study critical to the evaluation of site performance that cannot be repeated for a number of years due to its disruption of the natural baseline.

Staff Review: The work described in this study plan does not include any field testing. Therefore, it cannot result in disruption of any baseline conditions.

Criterion 5 The study has some other critical relationship to potential licensing concerns.

Staff Review: The staff has not identified any licensing concerns in regard to this study plan other than those listed above.

REFERENCES

U. S. Dept. of Energy, 1988. Site Characterization Plan, Yucca Mountain Site, Nevada Research and Development Area, Nevada: DOE/RW-0199, Office of Civilian Radioactive Waste Management, December, 1988.

U. S. Nuclear Regulatory Commission, 1989. NRC Staff Site Characterization Analysis of the Department of Energy's Site Characterization Plan, Yucca Mountain Site, Nevada, August 1989.

U. S. Nuclear Regulatory Commission, 1991. Review of DOE Responses To NRC Point Papers On Site Characterization Plan/Consultation Draft, December 1988.

ATTACHMENT A
ITEMIZED CHECKLIST OF STUDY PLAN CONTENT
REGIONAL HYDROLOGIC SYSTHESIS AND MODELING

I. PURPOSE AND OBJECTIVE

Is the information to be obtained in the study described?
Yes__X__ No____ N/A____

Is the rationale for information to be obtained provided?
Yes__X__ No____ N/A____

II. RATIONALE FOR STUDY/INVESTIGATION

Does the study plan provide the rationale for analyses, indicating alternatives considered and options, advantages, and limitations?
Yes__X__ No____ N/A____

Does the study plan provide the rationale for the number, location, duration and timing of tests, considering uncertainty, and identify obvious alternatives?
Yes_____ No_____ N/A__X__

No field tests are planned under this study.

Does the study plan describe the constraints for the study?
Yes__X__ No_____ N/A____

In describing the constraints for the study, does the study plan consider potential site impacts?
Yes_____ No_____ N/A__X__

No site impacts can occur because no field tests are planned under this study.

In describing the constraints for the study, does the study plan consider the need to simulate repository conditions?
Yes____ No_____ N/A__X__

Simulation of repository conditions is not relevant to this study, which focuses on regional groundwater modeling.

In describing the constraints for the study, does the study plan consider the required accuracy and precision?
Yes____ No_____ N/A__X__

This study does not involve the collection of new field data.

In describing the constraints for the study, does the study plan consider the limits of analytical methods?
Yes__X__ No_____ N/A_____

In describing the constraints for the study, does the study plan consider the capability of analytical methods?
Yes__X__ No_____ N/A_____

In describing the constraints for the study, does the study plan consider time required vs. time available?
Yes_____ No_____ N/A__X__

There should be no time constraints because there are no tests under this study; thus, analyses are not tied to a test schedule.

In describing the constraints for the study, does the study plan consider the scale of phenomena and parameters?
Yes__X__ No_____ N/A_____

In describing the constraints for the study, does the study plan consider interference among tests?
Yes_____ No_____ N/A__X__

No field tests are planned under this study.

In describing the constraints for the study, does the study plan consider interference between tests and exploratory shaft
Yes_____ No_____ N/A__X__

No field tests are planned under this study.

III. DESCRIPTION OF TESTS AND ANALYSIS

For each type of test does the study plan describe the general approach that will be used?
Yes_____ No_____ N/A__X__

No field tests are planned under this study.

For each type of test does the study plan describe the key parameters that will be measured in the test and experimental conditions under which the test will be conducted?
Yes_____ No_____ N/A__X__

No field tests are planned under this study.

For each type of test does the study plan indicate the number of tests and locations?
Yes_____ No_____ N/A__X__

No field tests are planned under this study.

For each type of test, does the study plan summarize the test methods? If non-standard procedure, does the plan summarize steps of the test, how it will be modified, and reference technical procedure?

Yes_____ No_____ N/A__X__

No field tests are planned under this study.

For each type of test does the study plan indicate the level of QA and provide the rationale for any tests not QA level one?
Yes_____ No_____ N/A__X__

No field tests are planned under this study.

For each type of test does the study plan reference the applicable specific QA requirements applied to the test?
Yes_____ No_____ N/A__X__

No field tests are planned under this study.

For each type of test does the study plan specify the tolerance, accuracy, and precision required in the test?
Yes_____ No_____ N/A__X__

No field tests are planned under this study.

For each type of test does the study plan indicate the range of expected results and the basis for those results?
Yes_____ No_____ N/A__X__

No field tests are planned under this study.

For each type of test does the study plan list the equipment requirements, briefly describing special equipment?
Yes_____ No_____ N/A__X__

No field tests are planned under this study.

For each type of test, does the study plan describe the techniques to be used for data reduction and analysis?
Yes_____ No_____ N/A__X__

No field tests are planned under this study.

For each type of test does the study plan describe the representativeness of test, indicating limitations and uncertainties that apply to use of results?
Yes_____ No_____ N/A__X__

No field tests are planned under this study.

For each type of test, does the study plan provide illustrations of test locations?
Yes_____ No_____ N/A__X__

No field tests are planned under this study.

For each type of test does the study plan discuss the relationship of the test to set performance goals and confidence levels?
Yes____ No____ N/A__X__

No field tests are planned under this study.

For each type of analysis does the study plan state the purpose of analysis, indicate conditions to be evaluated and describe any uncertainty analysis?
Yes__X__ No____ N/A____

For each type of analysis does the study plan describe the methods of analysis, including analytical expressions and numerical models to be used?
Yes__X__ No____ N/A____

For each type of analysis does the study plan reference the technical procedures document that will be followed during analysis?
Yes____ No__X__ N/A____

Various QMP documents were cited under NQA1 criterion #3, "Scientific investigation control and design." However, neither technical procedures nor QMP-5.05 (Scientific Notebook System) were cited.

For each type of analysis does the study plan indicate the levels of QA applied?
Yes____ No__X___ N/A____

QA grading packages for the activities of this study plan will be prepared separately, according to AP-5.28Q, "Quality Assurance Grading." The resultant Quality Assurance Grading Report will be issued as a separate controlled document.

For each type of analysis does the study plan identify data input requirements?
Yes__X__ No____ N/A____

For each type of analysis does the study plan describe the expected output and accuracy?
Yes__X__ No____ N/A____

As stated on page 2.2-1 of the study plan, the accuracy of the modeling activities will be difficult to quantify prior to the implementation of the methods. The degree of accuracy and/or precision of each test and method within activities is a qualitative, relative judgement based on the investigators' assessment of the applicability of the methods."

For each type of analysis does the study plan describe the representativeness of the analytical approach, indicating limitations and uncertainties that apply to results?
Yes__X__ No____ N/A____

IV. APPLICATION OF RESULTS

Does the study plan briefly discuss where results from study will be used for support of other studies?
Yes__X__ No_____ N/A_____

Does the study plan refer to specific performance assessment analyses?
Yes__X__ No_____ N/A_____

Does the study plan describe where information from the study will be used in construction equipment and engineering system design and development?
Yes_____ No_____ N/A__X__

The topic of regional groundwater modeling addressed in this study plan is not related to engineering system design.

Does the study plan describe where information from the study will be used in planning other characterization activities?
Yes__X__ No_____ N/A_____

V. SCHEDULES AND MILESTONES

Does the study plan provide durations of and interrelationships among principal activities associated with this study?
Yes__X__ No_____ N/A_____

Does the study plan list key milestones including decision points associated with study activities?
Yes__X__ No_____ N/A_____

Does the study plan describe the timing of the study relative to other studies and other program activities?
Yes__X__ No_____ N/A_____

Does the study plan provide dates for activities for the study plans: reference section 8.5 in SCP?
Yes__X__ No_____ N/A_____

A summary of activities with respect to fiscal years is provided.