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Gregory-Frost, L	X	X
Lovelett, T.	X	X
Smith, R.	X	X
CORRES CONTROL	X	X
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IN REPLY TO RFP CC NO

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LTR APPROVALS

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EG&G ROCKY FLATS

EG&G ROCKY FLATS, INC
ROCKY FLATS PLANT, P O BOX 464, GOLDEN, COLORADO 80402-0464 • (303) 966 7000

January 24, 1995 95-RF-01030

Jessie M Roberson
Acting Director of
Environmental Restoration
DOE, RFFO

Attn N I Castenada

RESPONSE TO WRITTEN REVIEW COMMENTS FOR THE GROUNDWATER RECHARGE STUDY AND SEEPAGE CHARACTERIZATION WORK PLAN - LAG-005-95

Action Concurrence requested to descope groundwater recharge project from Work Package 12802

This letter is written in response to verbal U S Department of Energy (DOE) comments received in a meeting between EG&G Rocky Flats, Inc (EG&G), Advanced Sciences Inc , and DOE on November 21, 1994, and written DOE comments received on December 21, 1994, to the Work Plan for the above referenced project EG&G's response is organized in Attachment 1 as follows

1 General discussion of DOE comments This section provides a background discussion of the recharge project and presents a brief summary of the rationale used for collecting recharge data
2 Itemized responses to general and specific comments indicating how we plan to address these comments in the revised Work Plan

After careful consideration of DOE's recommendation that the recharge project should be discontinued for the various technical reasons presented in the written comments, EG&G now concurs with this recommendation based on the apparent incompatability of this project with the specific data requirements of current groundwater modeling efforts at the site The Work Plan will, therefore, be revised to exclude all further recharge activities unless otherwise directed by the DOE In addition, Work Plan revisions for the remaining seepage characterization projects will be made to address and clarify the review comments raised in this review and earlier correspondence received from N I Castenada (11945) dated November 23, 1994

RF-46469 (Rev 6/94)

A-0U05 000659

We appreciate the thoroughness paid to the Work Plan by the reviewers Please feel free to contact Robert Smith at extension 8705 with any further questions regarding these projects

L A Gregory-Frost
Environmental Operations Management
EG&G Rocky Flats, Inc

RGS bk

Orig and 1 cc - J M Roberson

Attachment
As Stated (1)

RESPONSE TO COMMENTS

General Discussion of DOE Comments

The comments made by the DOE reviewers are generally valid It is also agreed that the Work Plan as presented should be modified to more clearly present the objectives of the proposed studies

It is true that the recharge project appears to be unresponsive to the current needs at Rocky Flats Environmental Technology Site (Site) The primary reason involves delays between the design of this study and the implementation of its components The recharge project at the Site was first proposed and designed as Task 22 of the Zero-OffSite Water Discharge Study in 1989, with the Site selected by EG&G Since that time, the project has been delayed by various factors, including funding, security, permitting, contracting and other issues Groundwater modeling activities at the Site have progressed since the recharge study began and the recharge issue has become more focused on quantitative estimation of groundwater recharge and less on understanding moisture movement near the alluvial/bedrock interface, which was one of the original objectives of the recharge study Current groundwater modeling at the Site represents the groundwater system as one layer This layer includes the Rocky Flats Alluvium, other surficial materials, and permeable bedrock sandstone where it is in contact with alluvium Consequently, information on moisture movement at the bedrock/alluvial interface is not needed for direct support of the groundwater modeling

There is widespread agreement among EG&G and subcontractor modelers that quantitative information on recharge rates is needed to support the modeling, because calibration of the models involves a balancing of recharge rates and hydraulic conductivities The result of this tradeoff is that models can probably be calibrated equally well with different sets of these two parameters Recharge rates used in the models need to be supported by field data to increase confidence in the calibrated hydraulic conductivities produced by the groundwater modeling The importance of this issue is due to the relationship between hydraulic conductivity, groundwater velocity, and contaminant transport While it would have been better to complete recharge studies before groundwater modeling began, field data on recharge is still needed to verify the recharge rates used in the models and increase confidence in the results of the modeling The need for recharge data has recently been highlighted by Operable Unit 5 (OU5) modeling It is a long-held belief at the Site that there is little to no recharge to the groundwater system through Site-wide diffuse recharge However, the OU5 model was successfully calibrated using rates of over seven inches per year based on Blaney-Criddle calculations The water budget of this calibration is consistent with flows of Woman Creek and inflow of most precipitation occurring in late winter and spring, a credible scenario While the OU5

model may be recalibrated at a lower recharge rate, the importance of supporting the selection of a lower rate has been demonstrated

As the current recharge program was designed to estimate diffuse recharge, it must be concluded that this procedure will underestimate total recharge, given the likelihood that a significant component of total recharge is due to preferential or macropore flow Measurement of total natural recharge is problematical because of the complexities introduced by quantifying preferential flow at depth It is believed that none of the anion, stable isotope, or radioactive isotope methods available in the literature can be successfully applied at the Site based on consideration of local conditions Construction of a large lysimeter is possibly the only method available that could provide reliable recharge rates, however, this approach is costly and beyond the scope of the current project Therefore, we concur with DOE's recommendation to discontinue the current project based on technical reasons Should model calibration and better understanding of the potential for contaminant transport in the unsaturated zone be deemed important enough to warrant further study, it is recommended that a recharge project be designed to quantify total recharge using conventional lysimeter and water balance methods

The following comment responses have been written assuming that the current recharge project will be cancelled However, responses to comments involving recharge are made in support of the need for this type of data and to clarify technical issues for future reference

Responses to General Comments/Recommendations of Tim Reeves, ER/SAIC

1 a It is true that the scope described in the recharge project was not originally coordinated to the data needs and timing of OU remedial investigation modeling efforts While schedules require OU2, OU5, and OU6 modeling be completed before a groundwater-recharge study can be completed, such a study would provide information that may reduce the uncertainty associated with these models and future modeling efforts, including OUs 8, 9, 10, 12, 13, 14 (industrial area), ecological risk assessment for OUs 5 and 6, groundwater flux calculations to determine treatments for remediation activities (feasibility studies), and groundwater mass balance calculations related to water rights issues at the Site In addition, it is anticipated (based on past experience) that additional projects needing recharge information will arise as Site clean-up efforts progress This may include activities related to decommissioning and decontamination of the industrial area, future land use planning, or, if approved, the proposed groundwater OU

Currently, considerable uncertainty is associated with recharge rates supplied as model input This uncertainty translates to uncertainty in risk analysis and any other potential uses of the models including design of remediation

strategies and systems Reduction of uncertainty would benefit future acceptance of estimates of risk, and would tend to reduce costs of remediation systems that are sensitive to the rate of movement of groundwater contaminants It is noteworthy that groundwater model calibration involves a balancing of recharge rates and hydraulic conductivities If the model recharge rates of the calibrated models are supported by an independent study, the hydraulic conductivities will also be supported The hydraulic conductivities influence contaminant transport rates, estimation of risk, and the design of remedial systems

Additionally, groundwater modeling of OUs within the protected area (PA) has not yet been undertaken The unconsolidated material of the PA is predominantly Rocky Flats Alluvium (also the predominant material in OU2, the location of the two existing recharge study Sites) Modeling will also be conducted as part of numerous OU feasibility studies, the Comprehensive Risk Assessment (Sitewide) and the Ecological Risk Assessment (Sitewide) Furthermore, it is a common practice to perform post-audits at some time in the future These post-audits are performed as an evaluation of the predictions made by groundwater modeling at least 10 years prior to the post-audit Recharge data would be a valuable asset to performing these post-audits

1 b No useful information on infiltration and unsaturated flux was found when developing recharge estimates for models at the Site M Z Litaor's study at the Site was geared to look at macropore flow of actinides in the near surface soils of colluvial deposits Recharge information for groundwater modeling is required which looks at aqueous advection and travel directions much deeper in the system (up to 30 feet deep) As far as we know, no such study has been conducted from deep soils, with the exception of N J Kiusalaas' M S Thesis at CSM (Kiusalaas, 1992) His study was conducted near North Table Mountain and provided insights into the use of neutron-probe access tubes to measure soil moisture and the impacts of naturally-occurring precipitation on recharge in this portion of Colorado

1 c It is likely that recharge at Rocky Flats takes place only during a short portion of the year, when evapotranspiration demands are low and precipitation and snow melt are high, in late winter and early spring For a steady-state model, this value is used as an average It is true that optimal recharge data would also describe the spatial distribution of recharge since recharge is rarely uniform across a Site However, recharge is highly correlated with vegetation type because it is precipitation minus consumptive use where surface runoff does not occur Furthermore, inspection of consumptive use coefficients suggests that recharge may indeed, be fairly uniform across the Site

One or two measurement locations will certainly not provide information directly applicable across the Site However, these measurements, plus information relating the relative infiltration rates across the Site (such as obtained from soil survey maps and from existing tension infiltrometer measurements), can provide a basis for establishing initial spatial recharge patterns for modeling projects Without some actual field measurements, however, the appropriate ranges for these recharge patterns cannot be established Field measured recharge data, even from a single locale, will allow us to make intellegent decisions about expected ranges of recharge for other areas of the Site Without this information any assumptions about recharge rates could be questioned ad infinitum

1 d Agreed See the above responses

1 e The calibration of the groundwater models involves a tradeoff between hydraulic conductivity and recharge as a means to adjust the elevation calculated heads This is a potentially controversial issue that relates to uncertainty to the representation of hydraulic conductivity Hydraulic conductivity, in turn affects the prediction of the movement of groundwater contaminants and their future concentrations Knowledge of the proportion of spring precipitation that recharges the groundwater could reduce this uncertainty and strengthen confidence in groundwater modeling results At present only a qualitative idea of recharge at the Site exists The uncertainty of recharge rates is not likely to go away, whether models have been completed or not What is needed is an evaluation of the ranges of recharge used for previously completed models and reliable data for the models not yet developed

1 f The purpose of this project is not to describe or study details of the processes above the ground surface, such as erosion or runoff and the physical variations of the ground surface which control these processes, or their relationship to the process of infiltration However, by selecting a representative Site, these details will be implicitly included in the recharge estimates Addressing these details explicitly would not be cost-effective

The language in the Work Plan may be confusing, leading to the reviewer's misunderstanding of the intent of the artificial moisture application The intent was artificial moisture application rather than artificial precipitation

2 The reviewer states that he generally agrees with the scope of the Seepage Characterization Work Plan The objectives section will be revised as suggested by the reviewer

3 The objectives section will be revised as suggested by the reviewer

4 The document will be revised as suggested by the reviewer

Responses to Specific Comments/Recommendations of Tim Reeves, ER/SAIC

1 Section 1 1 - Agreed This section will be revised as suggested by the reviewer

2 Section 1 1 - Agreed Justification language will be removed

3 Section 1 1 and Globally - All references stated as "ASI, 199x" will be revised

4 Section 1 1 - This statement refers specifically to the purposes of modeling taking place at the Site with regard to risk assessment within operable units An overestimation of recharge can lead to a simulation with too much water in the system, an underestimation of recharge can lead to too little water in the system, yet both can be calibrated models of the same system Due to the relationship of hydraulic conductivity to recharge, this is a difficult problem to overcome, particularly if no other flow information is available to constrain the values If a recharge value which is too high is used, resulting in high heads, then a method of bringing heads down is to increase the hydraulic conductivity, thereby resulting in high fluxes through the system, i e , too much water This problem cannot be recognized without some measurement of system fluxes and this information is not available

5 Section 1 1 - Site-specific data on unsaturated zone moisture-characteristic curves, unsaturated hydraulic conductivity curves, and selected geotechnical properties of the alluvial materials (grain-size distribution, moisture content, bulk density, and particle density) are available for up to 28 soil and bedrock samples from the boreholes drilled for the installation of the neutron-probe access tubes at the two Sites These data are summarized in the Interim Report, Groundwater Recharge Study, October 30, 1993, which is incorporated into the Work Plan by reference Some of the data are available from CSM in a yet-to-be published manuscript Data from other parts of the Site are, in our opinion, not transferrable to the two OU2 Sites because they are not from the Rocky Flats Alluvium These data are available from the on-going studies at the Americium Site (colluvial materials) by M Z Litaor, and from the Building 881 Hillside area (colluvial materials) (Fedors and Warner, 1993) Data available from OU4 unsaturated-zone investigations will be reviewed to determine its transferability to other areas of the Site

6 Section 1 2 - This paragraph will be corrected based on the information provided in the comment

7 Section 1 3 - Agreed

8 Section 1 4 - Agreed This section will be revised based on information reported in the 1993 Site Environmental Report

9 Section 1 5 1 and globally - A hydroprobe is a neutron probe In previous years, EG&G and DOE reviewers objected to the use of the words "neutron probe" because of issues raised regarding the use of a neutron source Therefore, the more generic "hydroprobe" was adopted

10 Delete Section 1 6 - Section 1 6 will be deleted This section was originally included based on direction on the content of the Work Plan in the Statement of Work for the recharge contract

11 Section 3 0 - This section will be revised per the comment

12 Section 3 0 - This section will be revised per the comment

13 Section 3 0 - Section 6 0 will be incorporated into Sections 3 0 and 4 0 Section 6 0 was distinguished as a result of an earlier reviewer's comment on an earlier draft of this Work Plan which indicated that the format and content of the Work Plan should follow APM guidance The Environmental Restoration Program Division (ERPD) Administrative Procedures Manual Section 5 03 provides an example Table of Contents which lists Section 6 0, Field Sampling Plan as a required component of a Work Plan

14 Section 3 1 - Soil- and access-tube-specific calibrations for the hydroprobe were made as part of the previous study at the two Sites (DOE, 1993) This calibration was done using techniques described by the U S Soil Conservation Service (SCS) (Kiusalaas, 1992, Dickey, 1990a, 1990b) All data used for the calibrations are presented in DOE (1993)

15 Section 3 1 - Hydroprobe calibrations have been done for both the aluminum and two sizes of Schedule 40 PVC access tubes installed at the two Sites (DOE, 1993) While the reviewer was not aware of hydroprobe calibrations being done in PVC tubes, these types of materials have been previously used and calibrations successfully performed in them The reviewer is referred to Allen and Segura (1990) and Kiusalaas (1992) for information on calibration techniques in various tube materials Documentation of the calibration in the PVC tubes is presented in DOE (1993)

16 Section 3 1 Hydroprobe measurements for moisture content were selected for two reasons (1) hydroprobe access tubes are in place at the two Sites installed as a part of the 1993 study, and (2) TDR technology for deep holes (up to 30 feet in this case) was not a proven technology at the time the original

design was developed in 1989 Additionally, the cost of purchasing TDR technology was not within the budgeted cost for the study at the time the instrumentation was finally installed in 1993 The extent to which TDR technology is "more accurate" over neutron probe technology is a professional judgement Both methods require calibration of the instruments Our professional judgement was to use the hydroprobe for this phase of the study because this instrument was readily available at the Site, had already been calibrated to the OU2 Sites, and personnel had been trained in its use

17 Section 3 2 The tensiometers are used to assess the matric potential of the soil as the wetting front progresses downward immediately after a naturally occurring precipitation event or an artificial moisture application These instruments could be abandoned for the reasons outlined by the reviewer without compromising the intent of the study Tensiometers may be beneficial in estimating parameters for the vadose zone modeling

18 Section 3 2 If the tensiometers are abandoned for the study, then this comment need not be addressed If the existing tensiometers are kept as part of the study instrumentation, maintenance measures will be added to the Work Plan which address freezing temperatures and other maintenance procedures (such as air bubbles)

19 Section 3 4 Use of artificial moisture application would be specifically to move the applied tracers downward beneath the root zone, so they may be monitored to assess migration The intent of the artificial applications was **not** to imply that recharge would occur, but rather to assess its fate if it did occur The tracer tests would assess the movement and dispersivity of a contaminant in the vadose zone and, in this respect, would be available for use in calibration of the VS2D/VS2DT model

20 Section 3 4 As discussed above, no attempt to simulate specific rainfall intensities or recurrence-interval storm events are meaningful for this study Because deep percolation is of interest here, the individual storm event impact on recharge will be dampened by many feet of overlaying unsaturated materials The intent of the artificial moisture application is to move the applied tracers downward below the root zone so that dispersion data may be obtained

21 Section 3 4 Poor wording in the Work Plan has led the reviewer to make a conclusion not commensurate with the intent of the artificial moisture applications Again, the intent of the artificial moisture applications using the drip system is to move applied tracer downward beneath the root zone

22 Section 3 4 Please see the response to Comments 19 through 21, above

23 Section 3 5 Moisture-characteristic curves are available for 27 samples from the two Sites These were determined in a previous study (DOE, 1993) using both conventional geotechnical laboratory techniques (ASTM, 1992) and a new technique developed as part of the previous study by CSM (DOE, 1993) Moisture-characteristic curves were developed for both the Rocky Flats Alluvium (25 samples) and the underlying sandstone and claystone at the Site (2 samples)

24 Section 3 5 Depending upon the sample and the laboratory technique used (ASTM vs CSM), the range of matric potentials was from 0 (saturation) up to approximately 5 bars Van Genuchten relationships were fit to each set of data to obtain a continuous function of volumetric moisture content versus capillary pressure (matric potential) Draining curves were developed using the ASTM procedure (although we have successfully used wetting techniques in other soils) and wetting procedures were used in the CSM tests We have not fully analyzed the data to determine the extent of hysteresis in the samples A future technical publication, jointly with CSM, will address and compare these laboratory tests (Kunkel and et al, 1995)

25 Section 3 6 Potential evapotranspiration will be calculated using the Penman-FAO model (Doorenbos and Pruitt, 1977) This model has been used at SITE for calculating evapotranspiration for both OU5 and OU6

26 Section 3 7 The reviewer is correct If either natural or applied tracers could be used and allowed to move through the Rocky Flats Alluvial materials at the two Sites under naturally occurring recharge, then the objectives of quantifying annual, and perhaps seasonal, recharge could be fulfilled

The merit in the Section 3 7 tracer tests is to assess the horizontal and vertical movement of flux in the vadose zone In this case, the tracer would be assumed to act as a contaminant and an assessment of its fate at each Site would be undertaken

27 Section 3 8, Page 53 Potential and actual evapotranspiration will be calculated **not** measured as indicated by the reviewer (see Page 53, line 11) Potential evapotranspiration will be calculated using the Penman FAO method (Doorenbos and Pruitt, 1977) Actual evapotranspiration will be estimated using a water-balance approach with the amount of soil moisture in the root zone limiting the total evapotranspiration An empirical water-balance methodology for this approach has been proposed by Kunkel and Murphy (1983) and is similar to the methodology used in the EPA's HELP model for

assessing the hydrologic performance of landfills (Schroeder and others, 1984a, 1984b)

28 Section 3 81, Page 54 The response to this comment is the same as that to Comment 15, above

29 Section 3 9 Agreed The purpose of the model simulations is to provide an estimate of recharge rate via calibration with field data and to provide insight to the fate of contaminants

30 Section 4 0 - This section will be revised to more clearly address objectives

31 Section 4 2, Page 59 - The reference to the subcontractor will be removed Clarification of the statement will be incorporated into the Work Plan

32 Section 4 3 2, Page 65 - Water temperature was selected for continuous monitoring because it is inexpensive and can sometimes provide useful information on the source of water associated with a spring, i e natural versus anthropogenic It now appears likely that the temporary flume Sites will be replaced by a non-intrusive periodic monitoring program due to the anticipated delays associated with National Environmental Policy Act (NEPA) approval and wetlands mitigation of the flume installation Sites In this case, periodic temperature measurements will be made instead of continuous measurements The Work Plan will be revised to reflect this change

33 Section 5 4 1 1 - Please see response to Specific Comment No 4

34 Section 6 0 - Please see response to Specific Comment No 13

Responses to General Comments/Recommendations of Mike Ruggieri, ER/SAIC

1 Estimation of long-term annual recharge using the soil "bomb" tritium pulse method was actually considered over a year ago, but was shelved because of the observed tritium distribution in groundwater and precipitation at the Site Background tritium levels in Rocky Flats alluvial groundwater typically range from about 20 to 45 tritium units (T U s) compared to that of 9 to 15 T U s in current-day precipitation (see Section 7 0, "Environmental Isotopes in Groundwater at the Rocky Flats Site", in the 1995 Groundwater Geochemistry Report) This distribution implies that the 1960's bomb tritium pulse has probably already passed through the soil column to the saturated zone - a situation that severely limits the applicability of this method In addition the method has been shown to be of limited use in heavy-textured

soils (see Hendry, 1983) due to preferential flow characteristics which can create the effect of multiple peaks at different depths in the soil column It is unlikely that other environmental tracers, such as chlorine-36, offer a viable alternative to tritium since the levels of these tracers in precipitation peaked prior to 1962-1963 thermonuclear tritium peak It might be worthwhile to collect soil cores for enriched tritium and chlorine-36 analysis at sometime in the future to verify our hypothesis about the age of water in the unsaturated zone (younger than 1960's), however, a program to accomplish this objective is not proposed at this time

2 See response to Tim Reeves General Comment No 1c

Responses to Specific Comments/Recommendations of Mike Ruggieri, ER/SAIC

1 Page 17, 1 4 Regional and Plant Site Background Information This sentence will be modified to read "Slopes range from 0 to 3 percent and have a slow infiltration rate " The USCS Soils Report actually says that they have a slow permeability

2 Page 47, 3 4 Artificial Moisture Application Vegetation will be left in the most natural state possible

3 Page 50, 3 7 2 Tracer Application It is intended that steady state conditions would have existed prior to introduction of the tracer to the system

4 Page 57, 4 1 Shallow Well Point Design, Installation, Development and Sampling Due to the cobblely nature of the soils in which well points will be driven, the equipment used to drive well points could not drive the larger rods required to install larger casing This size of casing has been used successfully in other applications (OU5) at the Site

5 Page 45, 3 4 Tensiometer Measurements The use of tensiometers is limited to months of the year when freezing temperatures would not inhibit their use The tensiometers, (see responses to Tim Reeves Comments 17 and 18, above), would only be effective during warmer months and during the periods of artificial moisture application to give an indication of moisture movement through and below the root zone

6 Page 49, 3 7 Field Tracer Tests The surface would have been covered by plastic so that evaporation would be minimized

7 Some additional definition of Data Quality Objectives (DQOs) beyond what is stated will be provided for stream flow measurements

8 Figure 9, Completion diagram for the Proposed Soil-Water Samplers It is not likely that the spacing shown in Figure 9 (which is not to scale) would induce gradients which would impact the overall sampling effort Because the samplers will be vertically separated from each other by at least three feet, little or no impact is expected Horizontal spacing of the samplers also is expected to be at least three feet The final spacing would be determined after preliminary modeling to assess the likely spread of tracer during the artificial moisture application According to Morrison and Lowery (1990), the sampling radius of a porous cup sampler is probably on the order of centimeters This conclusion is based upon laboratory experiments Morrison and Lowery (1990) suggest that in a field application the sampling radius may be significantly less than was measured in their test cell and column experiments, especially if high evacuation tensions (up to 70 centibars) are used

9 Weekly readings of well points, neutron probe measurements, and tensiometers While it is true that weekly readings of well points, neutron probe measurements, and tensiometers would be more informative, previous experience has shown that unless there is a significant precipitation event, there is not enough change in these measurements to warrant weekly monitoring Additionally, as stated in the previous response, it is unlikely that induced gradients will impact the overall sampling effort of the soil-water samplers

REFERENCES (NOT INCLUDED IN THE WORK PLAN BUT USED IN THESE COMMENT RESPONSES)

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