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A WASTE FORM/ROCK INTERACTION LEACHING STUDY USING PNL 76-68 GLASS BEADS AND UMTANUM BASALT

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PART I

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ABSTRACT

A 440-day single-pass continuous-flow leaching experiment was conducted at LLNL from September 1980 to December 1981. In this report, we present the data obtained for only one-third of the experiment. The laboratory and data analysis of the remaining portion is still in progress at this time and a second report will follow at the end of FY83.

This report concerns itself with the study of PNL 76-68 glass beads interacting with crushed uranium flow basalt and a simulated basalt groundwater under controlled conditions of temperature (25°C and 75°C) and flow rate (1, 10, and 300 ml/day). The main purpose of the experiment was to determine the absorption on basalt of Pu, Np, and some of the stable elements such as B, Mo, U, and Cs, as they were leached from the glass beads.

Results are presented, as incremental and cumulative leach rates and sorption rates have been calculated for Pu, Np, B, Mo and U. Also sorption profiles as a function of temperature and flow rate are graphically shown for Pu, Np, and U.

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I. INTRODUCTION

Bead Leach II described in this report was a follow-on experiment to Bead Leach I.(1) Both experiments were designed to measure the leaching stability of PNL 76-68, a borosilicate glass doped with a full complement of simulated high level waste components plus Pu and Np. Simulated uranium fuel rods in the form of UO_2 monoliths were also leached in Bead Leach II. Bead Leach I and II shared many resemblances in temperature and flow rate conditions. The main differences between them were the type of leachant solutions and the use of crushed rock in Bead Leach II to test waste form-rock interactions in a continuous flow system.(2) Of no less importance, the Bead Leach II experiment was comprised of 72 channels which provided a large number of leachate samples (more than 1000) during the 443 days of leaching. Following is a listing of the experimental conditions and materials used in Bead Leach II.

Waste Form:	PNL 76-68 glass and UO_2 monoliths
Rock Material:	Umtanum Flow basalt and Nugget sandstone
Leachates:	0.03M $NaHCO_3$, simulated basalt ground water, and simulated brine-sandstone-ground water
Temperature:	25°C and 75°C
Flow Rate:	1 cm^3/day, 10 cm^3/day, and 300 cm^3/day
Matrix Distribution:	8 channels with $NaHCO_3$ (4-glass, 4-UO_2)
	28 channels with basalt ground water (14-glass, 14-UO_2). In each set of 14, 8 channels included rock along with the waste form.
	4 channels with basalt rock only, run as "blanks" for the basalt ground water leachant

28 channels with sandstone ground water (14-glass, 14-UO_2). In each set of 14, 8 channels included rock along with the waste form.

4 channels with sandstone rock only, run as blanks for the sandstone ground water leachant.

Figure 1 is a schematic of the entire design and shows the above conditions in a graphic form.

Because of the complexity of the experiment and the on-going analytical work on the leachate solutions, we have decided to divide the Bead Leach II report in two parts. This report is part I and will contain only data pertaining to the "basalt" channels with the PNL 76-68 glass. The analytical work on the PNL 76-68 sandstone and uranium channels will be completed in FY83 and a final report on this portion will follow by September 1983. Also included in this latter report will be a section containing data from the $NaHCO_3$ leachates for four PNL 76-68 glass samples. These channels were designed to tie together the two experiments, Bead Leach I and II.

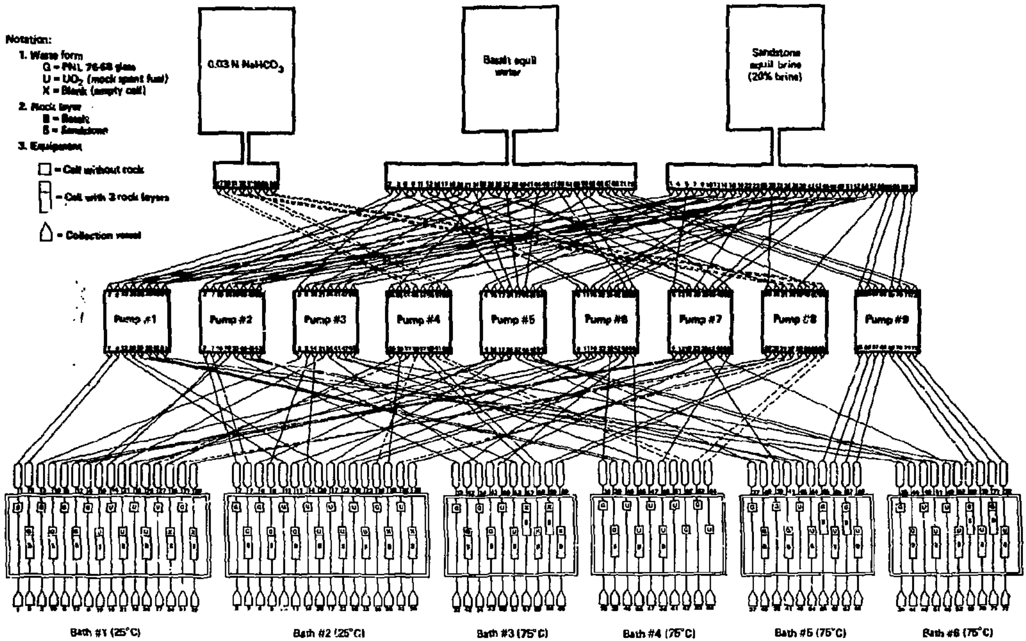

Fig. 1: Schematic of the Bead Leach II experiment.

II. MATERIALS AND METHODS

The Bead Leach II experiment was conceived as a waste form-rock interaction study involving two waste forms, PNL 76-68 glass beads and depleted UO_2 pellets, and two types of rock, basalt and sandstone. The basalt experiments were intended to study the behavior of the two waste forms in a basalt repository. The sandstone experiments were intended to study the behavior of the two waste forms in a salt repository where the brine leachant enters a nearby sandstone aquifer. The glass beads were of the same type and composition as those used in the Bead Leach I experiment[1], are described in PNL 3152[3], and whose composition is shown in Table 1. The UO_2 pellets were prepared and characterized at PNL.[4] The final array of leaching cells consisted of 72 cells to permit the various permutations of the two waste-forms, the two types of rock, and the experimental conditions of flow rate, temperature, and leachant solutions. Forty (40) of the 72 cells were assigned to the glass leaching portion of the experiment and eighteen (18) of these forty cells were used with the basalt ground water and are herein referred to as the "basalt" channels. The experimental matrix for these "basalt" channels as a function of temperature, flow-rate, and glass-rock configuration is given in Table 2. All information on materials, description of procedures, and discussion of results in this report pertain strictly to PNL 76-68 glass beads leached with the basalt ground-water.

A. Preparation of the Glass, Rock, and Leachant

The glass beads were prepared, and characterized at PNL. The basalt was from the Umtanum Flow and was also obtained from PNL. At LLNL the bulk rock was crushed with a chipmunk crusher and ground with a mill

Table 1. Composition of PNL 76-68 Simulated High Level Waste Glass

Glass Composition (wt %)

SiO_2	40.0	La_2O_3	0.53
Na_2O	12.5	Pr_6O_{11}	0.53
Fe_2O_3	9.6	$^{237}NpO_2$	0.46
B_2O_3	9.5	P_2O_5	0.46
ZnO	5.0	Cr_2O_3	0.40
$^{238}UO_2$	4.2	SrO	0.37
TiO_2	3.0	Sm_2O_3	0.32
MoO_3	2.2	TeO_2	0.26
CaO	2.0	Y_2O_3	0.21
ZrO_2	1.7	NiO	0.20
Nd_2O_3	1.65	Rh_2O_3	0.17
CeO_2	1.19	Rb_2O	0.13
RuO_2	1.07	Eu_2O_3	0.070
Cs_2O	1.03	Gd_2O_3	0.050
BaO	0.56	$^{239}PuO_2$	0.046
PdO	0.53	CdO	0.033
		Ag_2O	0.031

Table 2

Bead Leach II

Experimental Matrix
(Glass Beads-Simulated Basalt Groundwater)

Channel (N°)	Temperature (°C)	Flow Rate (ml/d)	Leaching Cell Configuration (Beads)	(Rock)	(Beads-Rock)
2	25	10	X		
3	25	10	X		
6	25	300	X		
9	25	10			X
11	25	300			X
12	25	300			X
26	25	10		X	
30	25	300		X	
35	75	10	X		
37	75	300	X		
38	75	300	X		
40	75	10			X
41	75	10			X
44	75	300			X
58	75	10		X	
60	75	300		X	
67	75	1			X
71	75	1			X

grinder. The crushed material was sieved with various screen-sizes and the grain size fraction selected for this experiment was that passing through an 8-mesh screen (2.4 mm). The chemical composition of the Umtanum basalt is given in Table 3. The analysis of the minor components (Zn, Rb, Sr, Y, Zr, Nb, Cs, U, and Ba) was performed at LLNL using x-ray fluorescence.

Both the beads and the crushed rock were cleaned in an ultrasonic bath by rinsing first with distilled water for two minutes and then with ethanol for another two minutes. Finally, they were allowed to dry overnight at room temperature.

The simulated basalt ground water was prepared in two ways. First, distilled water was equilibrated with finely ground (< 150 μm) rock powder by adding approximately 50 g of fine powder to 200 liters of distilled water, mixing throughly, and allowing the mixture to sit for a period of seven days before adjusting the pH to 7.7-8.2. This method of preparation was discarded after the first forty days of leaching because of algae problems. The second method of preparation which was kept for the remaining of the experiment consisted of the following. The leachant was prepared according to a chemical composition recommended by PNL. This composition is shown in Table 4. Unfortunately, this composition omits SiO_2 which is a necessary component of any ground water obtained from a silicate-rock aquifer. In this procedure, the leachant was prepared in a 50-gallon polyethlene-lined barrel by weighing each reagent individually and dissolving it in a 5-gallon polyethlene container with distilled water. When all the reagents were completely dissolved in this small container, the contents were transferred to the 50-gallon barrel with more water, and made to a total volume of 200 liters. The leachant in the barrel was then thoroughly mixed with a top to bottom tube mixer and a pH of 7.7-8.2 was obtained by sparging with N_2 or

Table 3
Umtanum Flow Basalt Composition

Major Components: *

	Weight Percent
SiO_2	54.90
Al_2O_3	14.34
FeO	13.10
MgO	3.48
CaO	7.30
Na_2O	2.66
K_2O	1.48
TiO_2	2.17
P_2O_5	0.35
MnO	0.22

Minor Components: **

	Micrograms/gram rock
Zn	110
Rb	38
Sr	280
Y	29
Zr	170
Nb	7
Mo	< 1
Cs	< 1
Ba	520
U	< 1

* R. G. Johnston and R. A. Palmer 1981. "Characteristics of Candidate Geologies for Nuclear Waste Isolation: A Review DOE/ET/41900-6, Rockwell *Hanford Operations, Richland, Wash.*

** LLNL XRFA Measurements.

Table 4

Simulated Basalt Ground Water

Chemical Composition *

Reagents	mg/l
$NaHCO_3$	79.8
Na_2SO_4	24.85
$MgSO_4 \cdot 7H_2O$	9.84
$CaSO_4$	4.76
$CaCl_2$	14.42
KCl	14.91
$KF \cdot 2H_2O$	3.76
Na	30
K	9
Ca	6.5
Mg	1.0
HCO_3	58
SO_4	23
Cl	16
F	0.7

* Realyea R. F., Serne R. G., Control Sample Program Publication No. 2. Interlaboratory Comparison of Batch KD Values PNL 2872 June 1979.

CO_2 gases as needed.

B. Leaching Cell Assemblage

Prior to leaching, 14 groups of eight beads were weighed to record their initial weight. They were again weighed at the conclusion of the leaching phase to record any weight losses. These weights are shown in Appendix 1, Table 1. The beads were placed in leaching cells and crushed rock was added to eight of the fourteen cells. The beads to be leached without rock, (channels 2, 3, 6, 35, 37, 38) were placed in a cell having a volume of 2.0 cm^3. A larger cell with a volume of 15 cm^3 was required for the beads-plus-rock configuration (channels 9, 11, 12, 40, 41, 44, 67, 71). This is shown in Fig. 2.

The large cell was also used for channels 26, 30, 58, and 60. These were rock-only channels and were included in the matrix as "blank samples" to obtain corrections for the glass-rock channels. Both types of leaching cells used in this experiment are similar to those used in Bead Leach I. The weight of the crushed rock in each cell was obtained by weighing the cell and beads before and after adding the rock. This weight was compared to the final weight when the rock was removed from the cell at the end of the leaching phase. These weights and percent losses are given in Appendix 1, Table 2. Each cell was given a leak test after being completely loaded and assembled. This test is described in Bead Leach I. One deviation from the Bead Leach I procedure was that no membrane filters were used between the filter grids at both the inlet and outlet ends of the cell (use of these filters in Bead Leach I proved to be unnecessary and a nuisance in maintaining constant flow rate).

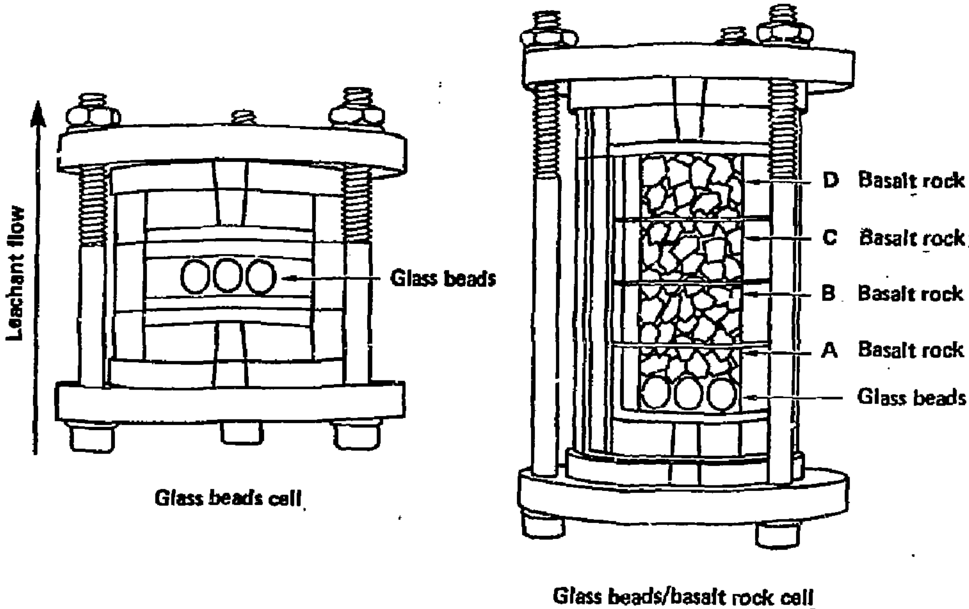

Fig. 2 Leaching cells

C. Starting the Leaching Phase

The continuous flow leaching system in Bead Leach II was assembled following the pattern used in Bead Leach I. The system consisted of the leachant reservoir, the manifold, the peristaltic pumps, the constant temperature baths, and the collection bottles for the leachates. The leachant reservoir was a 25-gallon plastic carboy which was replenished every 5-6 days from the stock solution in the 50-gallon barrel. Lucite manifolds with multiple outlets were placed between the carboy and the peristaltic pumps. Plastic tubing was used to connect the manifolds and the color coded tubing used with the peristaltic pumps. The Gilson Model pumps used in this experiment were found to be very smooth-running and almost maintenance-free throughout the 440 days of leaching. They were properly calibrated with three different size Accurated Pump Tubes and pump motor settings to obtain the desired flow rates of 1, 10, and 300 ml per day.

After the leaching cells were assembled and leak-tested, they were individually connected to the pump via the inlet-end at the bottom of the cell and to the collection bottle via the outlet-end at the top of the cell. Thus, the leachant-flow through the cell was in an upward direction. Simultaneously, as this connection was performed, each cell was carefully immersed in its respective bath and the starting time was noted.

The constant temperature baths were Lab-line Imperial III. Two of them were connected to a water cooler via coils filled with circulating chilled water and the temperature control was set at 25°C. Four other baths were filled with mineral oil and the temperature control was set at 75°C. Constant temperature throughout the experiment was monitored closely with the aid of thermometers immersed in each bath.

With respect to the 75°C channels, it should be pointed out that the temperature of the incoming leachant was room temperature (~25°C). There was approximately 30 to 50 cm of plastic tubing inside the oil baths through which the leachant had to travel before entering the leaching cell. We calculate that it takes about 5 minutes for the leachant to travel this short path for a flow rate of 300 cm^3/day (0.21 cm^3/min). For the other two flow rates of 10 cm^3/day and 1 cm^3/day, the times would be correspondingly longer. Thus, it would appear that even for the fastest flow rate, there is sufficient time for the leachant to equilibrate and reach the required 75°C temperature before coming in contact with the contents of each cell.

The leachate samples were collected in cleaned and pre-weighed polyethylene bottles. The sampling schedule and type of analysis performed are given in Tables 5 and 6. For the 1 ml/day and 10 ml/day samples all leachates collected between the scheduled samplings were saved as historical samples. For the 300 ml/day samples, only a portion (usually 20%) of the leachate collected between scheduled samplings up to day 120 was saved as historical samples because of the large volumes involved on a daily basis; after day 120, all collections between scheduled samplings were discarded.

It should be noted that not all of the scheduled samplings in Tables 5 and 6 represent one day collections. In fact, after the collection on day 70 all subsequent scheduled samplings are longer than one day. Three-day collections were instituted for the 10 ml/day and 300 ml/day channels through day 213. Following this elapsed day, the 10 ml/day collections were lengthened to 30 days but the 300 ml/day collections were kept at three days.

Leachate solutions from the 1 ml/day channels (67 and 71) were collected on an entirely different schedule. The intention was to keep the collection times short during the first part of the experiment in order to establish the

Table 5

Sampling Schedule for the Bead Leach II Experiment

10 ml/day, 300 ml/day

Elapsed Days	Historical Sample	Sample for Analysis	Analysis Performed α-Spec	ICP	XRFA
1		1	X	X	X
2		2	X	X	X
3		3	X	X	X
4-5	X				
6		6	X	X	X
7-10	X				
11		11	X	X	X
12-19	X				
20		20	X	X	X
21-36	X				
37		37	X	X	X
38-69	X				
70		70	X	X	X
71-119	X				
120-123		120	X	X	X
124-150	X				
151-154		151	X	X	
155-182	X				
183-185	X				
186-213	X				
214-216		213	X	X	X
217-245	X				

Table 5 (cont)

Elapsed Days	Historical Sample	Sample for Analysis	Analysis Performed α-Spec	ICP	XRFA
246-249	X				
250-278	X				
279-282		280	X	X	X
283-308	X				
309-312	X				
313-341	X				
342-345		342	X	X	X
346-374	X				
375-377	X				
378-407	X				
408-410	X				
411-440	X				
441-443		435	X	X	X

Table 6

Sampling Schedule for the Bead Leach II Experiment

1 ml/day

Elapsed Days	Historical Sample	Sample for Analysis	Analysis Performed α-Spec	ICP	XRFA
1-10		X	X	X	
11-20		X	X	X	
21-30		X	X	X	
31-50		X	X	X	
51-80		X	X	X	
81-120		X	X	X	
121-150		X	X	X	
151-182	X				
183-213		X	X	X	
214-245	X				
246-280		X	X	X	
281-309	X				
310-342		X	X	X	
343-374	X				
375-407	X				
408-443		X	X	X	

leach rate pattern. Thus the collection times were set at 10 day intervals for the first 30 days to generate enough solution to perform all analyses. Subsequent to day 30, the next collection was for 20 days, and after day 50, the remaining collections were for 30 days until the end of the experiment.

D. Analytical Procedures

The procedure used for collecting leachate solutions in the Bead Leach II experiment was the same as that used in Bead Leach I. The only difference was in the amount of HNO_3 added to the leachates at collection time. In Bead Leach II, we added enough acid to the leachate for a final concentration of 0.5M HNO_3, not 8M as in Bead Leach I. The more dilute acid solution was sufficiently high to allow ICP analysis directly without further dilutions and, at the same time, prevented precipitation in the leachates.

Leachate Analysis

Shortly after collection, analysis of the leachates was begun. Pu and Np were done by alpha-spectrometry, usually on 100 μl aliquots. This volume was carefully evaporated on a Pt disc and then heated with a Meeker burner for several minutes to fix both Pu and Np on the discs as oxides. An alternate method was to use 5-10 ml aliquots to separate Pu and Np radiochemically. This method was used to verify or substitute for data from the 100 μl aliquots that were at or below the limit of detection of the counter. The radiochemical separation of Pu and Np was used more often with the 1 ml/day-type of leachates because of the extremely low concentrations of Pu and Np in solution. The Pu and Np concentrations in dpm/cm^3 are given in Appendix 5.

Aliquots of the leachate solutions were also taken for ICP analysis and x-ray fluorescence analysis (XRFA). The elemental concentrations in μg/cm^3

are given in Appendices 6 and 7 respectively. Standard solutions were run frequently to monitor drifts and background fluctuations. The ICP capability at LLNL is described by Peck, et al.[5]

X-ray fluorescence was used for two reasons. First, it was able to provide data on elements for which ICP was not sensitive enough. Large volumes (100-200 ml) of leachate solution were evaporated to dryness with Avicel (microcrystalline cellulose) and then pressed into a round wafer for counting and analysis with a computerized system.[6] Elemental concentrations were thus enhanced by factors of 100 or more and measurement of U, for instance, was more easily achieved in this manner. The limit of detection for U with ICP is 0.05 $\mu g/cm^3$ and many of the leachates contained less than this amount. The second advantage for using x-ray fluorescence was that it provided additional elemental concentrations for elements such as Cs and Ba for which ICP is not suitable.

Rock Analysis

Since this leaching experiment was primarily a waste form-rock interaction experiment, the rock material was also analyzed at the conclusion of the leaching phase. In order to evaluate the absorption of "radionuclides" on the rock, the crushed rock was analyzed for Pu, Np, Mo, Cs and U using the following procedure. The rock column from each cell was removed in four separate layers of approximately the same size. The layers were labeled A, B, C, and D with the "A" layer be[illegible]arest to the glass beads and the "D" layer farthest away from the bea[illegible] Each rock layer was then "acid washed" by placing the crushed rock in a teflon beaker, adding 30 ml of 2M HNO_3 and 3 drops of conc. HF, and heating on a hot plate for 4 hours with frequent additions of more 2M HNO_3 and water to prevent dryness. The solutions were allowed to cool overnight and then decanted into a 40 ml glass centrifuge tube. After centrifugation, the supernates were transferred into a 100 ml volumetric flask, the rock material in the beaker rinsed twice with 2M HNO_3 and these washes combined in the volumetric flask. Aliquots were then taken for Pu and Np radiochemical analysis and for ICP and x-ray fluorescence analyses. These results are found in Appendix 8, Tables 1-9.

This "acid-washing" procedure was repeated with two rock samples (channels 41B and 44B) to verify that all of the "radionuclides" on the rock were desorbed during the first acid-wash. Channels 41B and 44B were selected for this desorption test because they are high temperature samples and are representative of the remaining rock samples as far as Pu and Np adsorption is concerned. The results of this test are shown in Appendix 8, Table 10, and discussed in Section III.

E. Calculations

As in Bead Leach I, the leaching data from Bead Leach II were stored in a computer data base program. Three types of calculations were carried out using the raw data, dpm/cm^3 for Pu and Np or $\mu g/cm^3$ for elements determined by ICP and x-ray fluorescence.

Leach Rate Calculations

Leach rate data were calculated from the equation:

$$R_i = \frac{(a_i V_i)}{(A_o)(SA)}$$

where:

a_i = dpm/cm^3 leachate or μg $element/cm^3$ leachate

A_o = initial activity (dmp/gram glass) or elemental composition (grams element/gram glass) for the glass beads

V_i = volume leachate collected per day (cm^3/day)
SA = average geometric surface area of beads (cm^2) = 11.128 cm^2 per 8-bead sample

i = channel number

R_i = grams glass leached/cm^2 • day, based on the element or radionuclide analyzed.

Cumulative Fraction Leached Calculations

Cumulative fraction leached, C_{im}, for the i^{th} channel up to an including the m^{th} day, was calculated from the equation

$$C_{im} = \sum_{n \leq m} \frac{(SA)\overline{R}_{in}\ T_n}{W_{oi}}$$

where:

SA = geometric surface area of beads (11.128 cm^2),

W_{oi} = total weight of glass beads in i^{th} cell (grams),

$\overline{R}_{in}$ = average leach rate between n^{th} and (n-1)th days (grams glass/cm^2 day), and

T_n = time (days) between n^{th} and (n-1)th days.

Rock Adsorption Calculations

First, the total amount of radionuclide or element absorbed in each layer of rock was determined by using:

$$N_i = A_i \times V_i$$

where:

A_i = dpm/cm^3 or $\mu g/cm^3$ of "acid wash"

V_i = volume of "acid wash"

N_i = total dpm or μg in each layer

Next, the total amounts were normalized by the weight in grams of each layer. These values are expressed in dpm/g or μg/g of rock (Ni/g).

Finally, the percent amount of radionuclide or element, F_i (fraction in each layer of the total amount in all four layers) was calculated from

$$F_i = \frac{Ni/g}{\sum_{A \to D} Ni/g} \times 100$$

and the percent fraction adsorbed on the entire rock column was calculated simply by dividing the adsorbed amount by the amount of radionuclide or element initially present in the glass beads.

III. RESULTS

The results obtained in Bead Leach II pertaining to the "basalt" channels are presented in the form of appendices. Following is a discussion of each appendix.

Appendix 1:

Appendix 1 contains 3 tables. Table 1 shows the weights of the glass beads before and after leaching. Table 2 shows the weights of the crushed rock, before and after leaching. Table 3 shows the weights of the same crushed rock, before and after the nitric acid "wash" procedure used for removing the adsorbed nuclides.

Based on the change in weight of the beads before and after leaching there appears to be three groups of samples. The samples leached at 25°C, regardless of flow rate, lost the least amount of mass, less than one percent of the original weight. The samples leached at 75°C and low flow rates (1 ml/day or 10 ml/day), lost between 1 and 4 percent of their original weight with the exception of channel 71 which lost 0.3 percent of its original weight. Finally the samples leached at 75°C and 300 ml/day flow rate lost approximately 10 percent of their original weight. We must, however, point out that weight-loss measurements are often misleading when leaching glass. A weight increase is possible because of reprecipitation of leached species or formation of hydrous silica-gels on the surface of the glass beads or a weight loss is often affected by "flaking" of the surface of the glass beads. In either case, we should be cautious in making conclusions about leaching mechanisms based on weight-loss determinations.

This pattern is somewhat repeated with the rock weights listed in

Table 2. Channels 44 and 60 which are the 75^{o}C and 300 ml/day samples show the highest weight loss, 7.3 and 7.1 percent respectively. The remaining ten samples show less than 1 percent weight loss. A similar trend exists when one examines the changes in weights before and after the nitric acid wash treatment. All four fractions of channel 44 and the A fraction of channel 60 which is a 75^{o}C, 300 ml/day rock only sample, show losses on the order of 10 percent. All the remaining samples show losses on the order of 5 percent or less.

One conclusion from all of these weight data is that exposure to 75^{o}C and 300 ml/day flow rate conditions by the glass beads and the rock must alter the surface so that it remains more soluble thereafter. Lower flow rates (10 ml/day and 1 ml/day) both at 75^{o}C and 25^{o}C and high flow rate (300 ml/day) at 25^{o}C, seem to affect the rock surface to the same extent, that is, the weight loss after leaching (less than 1%) and after the "acid-wash" treatment (1-5%) is rather uniform for all samples.

Appendix 2:

Appendix 2 contains two tables. Table 1 contains information pertaining to collection volumes, times, and normalized flow rates (cm^3/day). Table 2 shows the average flow rate for each channel based on thirteen collection volumes.

Appendix 3:

Appendix 3 contains the Np and Pu concentrations in the thirteen collection periods in terms of disintegrations per milliliter (dpm/cm^3) of leachate solution. Underneath each value, standard deviations are given based on counting statistics only. The majority of these results originate from 100 μl aliquots of the leachates; but in some cases where the data were at or near the limit of detection of the alpha counter, then larger aliquots (5-20 ml) were taken for radiochemical separations of Pu. Thus, better data were obtained and these values were incorporated in the tables and identified with the letter C.

Appendix 4:

Appendix 4 contains several tables with ICP (Inductively Coupled Plasma) data showing the concentration in micrograms per milliliter ($\mu g/cm^3$) of solution for many of the elements in the glass. We are presenting data for B, Mo, U, Si, Sr, Ca, and Na. The first three elements are those for which there is no contribution from the rock or the leachant and therefore the measured concentrations represent amounts leached from the glass itself. Furthermore, B is an element representative of the glass matrix whereas Mo and U are representative of the additives. The remaining four element (Si, Sr, Ca, Na) concentrations are partly from the glass and the leachant but mostly from the rock. Initially we expected to be able to make "blank" corrections in order to arrive at the net amounts, that is, the amounts leached from the waste form alone. We now find that these "blank" corrections are too large and thus no further calculations were attempted with these data.

Appendix 5:

Appendix 5 contains Mo, Cs and U x-ray fluorescence data for channels 35, 37, 38, 40, 41 and 44. As can be seen from the ICP data for the same channels in Appendix 4, most of the measurements were at or below the limit of detection of the ICP. X-ray fluorescence, in contrast, yielded absolute values which were useful in calculating leach rates and cumulative fractions. There are gross differences between the ICP and the XRFA uranium analysis and they appear to be caused by the low concentrations of U in solution (<0.05 μg/ml) which fall below the limit of detection of the ICP. The Mo comparison between the two techniques is more favorable; the results agree within 10-20% and the reason may be that the ICP limit of detection for Mo is at least 10 times better than it is for U. In this report and for the channels mentioned above, the calculated leach rates and cumulative fractions for Mo and U are based on XRFA measurements and not on ICP.

Appendices 6, and 7:

Appendix 6 contains the leach incremental rates and cumulative leach rates for Pu and Np in the leachates from all channels. Appendix 7 contains similar data for the stable elements. Many of these results are expressed as "less than" values; these originate from ICP measurements below the limit of detection. The algorithm to calculate the cumulative leach rates or cumulative fraction leached used the upper limit as a value and identified a cumulative fraction from that point on as "less than". These should be treated with caution in evaluating the total amounts leached at the end of the experiment.

Appendix 8:

Appendix 8 contains data on the radionuclides and elements adsorbed by the rock during 440 days of leaching. These data are presented in Tables 1 to 10 on a channel by channel basis and show a) the amounts adsorbed in each fraction of the rock bed and b) these amounts normalized by the weight of each rock layer. With the exception of B, Mo, Cs, U, Pu, and Np, the remaining elements in each table represent mostly components of the rock itself as evidenced from the chemical composition given in Table 4. During the nitric acid "wash" all glass material adsorbed on the surface of the rock as well as some of the rock components are dissolved and the analysis of this solution is, therefore, a composite of glass and rock. Mo was not detected in any of the rock fractions regardless of temperature or flow rate. B was analyzed only on channels 9, 41, and 67 and was found to be present in very small amounts and to the same extent in each of these three channels. Cs was detectable only in samples from the 75°C-10 ml/day channels (channels 40 and 41) and 75°C-1 ml/day channels (channels 67 and 71). No Cs was detected in the high temperature-high flow rate sample (channel 44).

Appendix 9:

The data for Pu, Np, U, B, and Mo have been summarized in Appendix 9 Table 1. Pu and Np are expressed in dpm/g of rock and U, B, and Mo in μg/g of rock. These data were then converted to percentages of each radionuclide adsorbed in each rock fraction. These amounts are presented in "bar form" for all eight channels and four rock fractions in each channel in Fig. 3, 4, and 5. Of the three actinides, Np and U appear to be adsorbed on the rock at the same rate in all 75°C channels. The distribution of Np and U along the 4 layers of rock is on the order of 30-50% in the A layer, 20-30% in the B and C layers, and 10-30% in the D layer. Neither Np nor U was detected in the rock samples from the lower temperature channels (25°C).

The Pu case is different as one might suspect. About 80% of the total Pu adsorbed on the rock is readily adsorbed on the "A" fraction in the 75°C channels and the adsorption rapidly falls to a few percent on the "C" and "D" fractions. The pattern is similar in the 25°C channels. Here, about 50-60% of the Pu is adsorbed on the "A" fraction and about 5-10% on the "C" and "D" fractions.

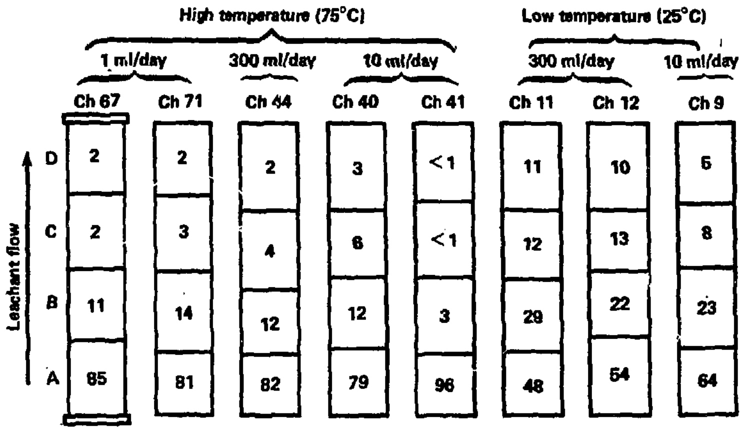

Fig. 3 Plutonium adsorption (%)

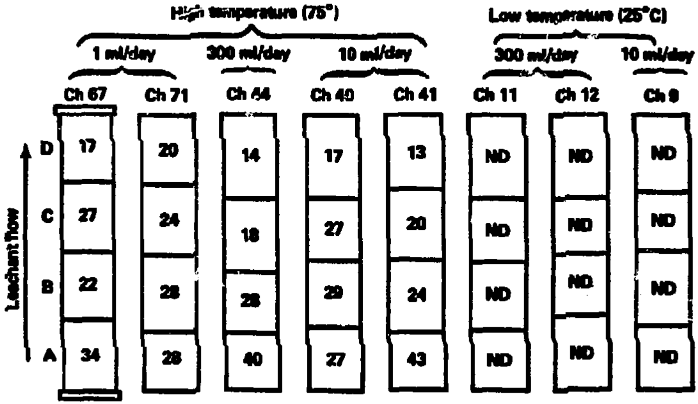

Fig. 4 Neptunium adsorption (%)

ND = Not Detected

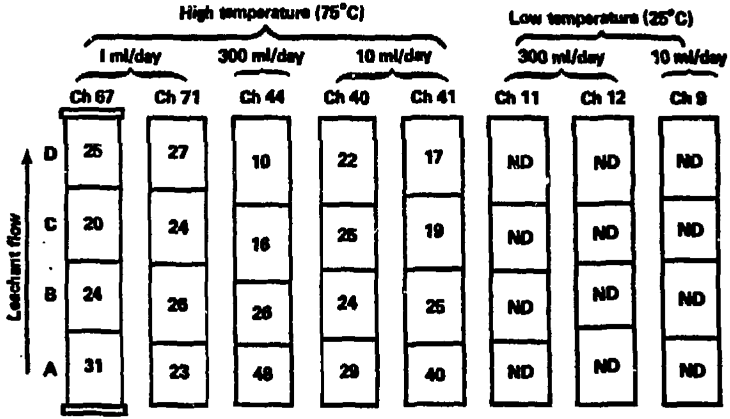

Fig. 5 Uranium adsorption (%)

ND = Not Detected

Appendix 10:

Table 1 shows a comparison of the cumulative fraction at day 440 (expressed in percent) in the leachate solutions for Pu, Np, and U with the cumulative fraction (also expressed in percent) for the same radionuclides adsorbed on the entire rock column. As stated before, only limit of detection values are obtained for Np and U in the low temperature channels (channels 9, 11 and 12). However, for these same channels there is more Pu (as much as 2 to 10 times) adsorbed in the rock than is collected in the leachate. In the high temperature channels, (channels 40, 41, 44, 67, and 71) the amount of Pu adsorbed in the rock escalates to as much as 100-times over the amounts found in the leachates. At 75°C there is slightly more Np on the rock than in the leachate with the exception of channel 44 (75°-300 ml/day) in which the leachate contains more Np. At 75°, there is more U in the leachate fractions (regardless of flowrate).

Table 2 is a summary of the total fraction (expressed in percent) leached for Pu, Np, U, B, and Mo. In those channels where rock was present the values include the amount adsorbed on the rock. These fractions leached are then compared with weight loss of the beads (also expressed in percent). In general the fractions leached are in close agreement with the mass loss of the beads suggesting a congruent dissolution of the glass matrix. One glaring exception is Pu with the apparent fractions leached far below the mass dissolution rate of the beads.

Another observation on the fractions leached shown in Appendix 10, Table 2 concerns a comparison of channels with and without rock. We can make this comparison for four sets of channels. At 25°C and 10 ml/day, the values for Pu and Np for channels 2 and 3 (without rock) agree remarkably well with channel 9 (with rock). The B, Mo, and U data for all these channels are "less than" values. At 25°C and 300 ml/day, the comparison is again quite reasonable for both Pu and Np for channels 6 (without rock) and 11 and 12 (with rock). B, Mo, and U are also "less than" values. At 75°C and 10 ml/day, the only case where all three channels (channel 35, 40, and 41) agree well is for Np. It appears that B, Mo, and U are not totally accounted for in channels 40 and 41 (with rock) or the values for channel 35 (without rock) are abnormally high. In the case of Pu, there is more in the channels with rock than in the single channel without rock. Finally for the last set of channels at 75°C and 300 ml/day the Np, B, Mo, and U in channel 44 (with rock) are slightly higher than their corresponding values in channels 37 and 38 (without rock). Since these results are plus or minus 10 percent, then the agreement between the two (with and without rock) is remarkably good. The Pu comparison in this last set is very poor as expected. There is about 10 times more Pu in channel 44 (with rock) than in channels 37 and 38 (without rock).

Appendix II:

This appendix contains graphs of the incremental leach rate data (g/cm^2.day) as a function of time (days) for Np and Pu. The graphs are semilogarithmic with the leach rate data shown as the ordinate and the time as the abcissa. The flow rates are designated with the letters F for fast (300 ml/day), M for medium (10 ml/day) and S for slow (1 ml/day). These symbols, connected with a broken line, represent the 75°C channels; when connected with a solid line, they represent the 25°C channels. If the lines appear disconnected, it means that the data point causing this apparent anomaly is at or below the limit of detection of the instrument.

This is particularly true of the plutonium data from the "rock" channels. There are separate graphs for data from the "no rock" channels (channels 2, 3, 6, 35, 37, and 38) and for data from the "rock" channels (channels 9, 11, 12, 40, 41, 44, 67, and 71).

Appendix 12:

This appendix contains graphs of the incremental leach rate data (g/cm^2.day) as a function of time (days) for the stable elements. The conventions for plotting and differentiating the data are the same as those used in Appendix 11. However, in addition to the leach rate data, plotted in each graph are three horizontal dotted lines representing the limit of detection of the instrument; the upper horizontal line is the limit of detection for the 300 ml/day leachates, the middle horizontal line is the limit of detection for the 10 ml/day leachates, and the lower horizontal line is the limit of detection for the 1 ml/day leachates.

Appendix 13:

This appendix contains graphs of the cumulative leach rate data as a function of time for Np and Pu. See Appendix 11 for discussion of the symbols used.

Appendix 14:

This appendix contains graphs of the cumulative leach rate data as a function of time for the stable elements.

See Appendix 11 for discussion of the symbols used.

Appendix 15:

This appendix contains graphs of the incremental leach rate data (g/cm^2.day) as a function of time (days). Plots are presented only for

Pu and Np to show a comparison of "rock channels" vs. "no rock channels" for a particular set of experimental conditions. These plots are logarithmic and thus show in greater detail the behavior of Pu and Np in the early stages of leaching. Furthermore each graph depicts only two lines, N for "no rock" and R for "rock" channels. Only one of these symbols in each graph carries an error bar; the data point is the average value of two channels and the error bar represents the standard deviation from the mean.

IV. SUMMARY AND CONCLUSIONS

Based on the data gathered in this report we can make the following observations and conclusions pertaining to the interaction of crushed Umtanum Flow basalt and PNL 76-68 glass beads in a continuous flow leaching system using a simulated basalt ground water under varying experimental conditions of flow rate and temperature.

1. Both the glass beads and the crushed rock appear to be affected by temperature and flow rate as evidenced by their weight loss after 440 days of leaching. High temperature (75°C) and high flow rate (300 ml/day) conditions cause higher weight losses than low temperature (25°C) and low flow rates (10 ml/day and 1 ml/day) conditions, about 10% at 75° and about 1-5% at 25°C.

2. Pu and Np concentrations were obtained in all but a few of the leachates either by using a small volume (100 μl) of the raw solution and α- counting directly or by using larger volumes (> 5ml) and doing radiochemical separations to circumvent the problem of limit of detection. It must be pointed out in the case of the Pu concentrations that the values reported are apparent concentrations in the leachates. As demonstrated in the Bead Leach I experiment, varying amounts of Pu tend to adhere to different parts of the system. No attempt was made in this experiment to repeat the study of Pu retention by the different components of the leaching cell or plastic tubing.

3. Elemental concentrations in the leachates were obtained for B, Mo, U, Cs, Si, Sr, Ca, and Na. Depending on the experimental conditions, these elements were measurable by means of ICP or XRFA. In general, elements in

the low temperature (25°C) leachates, regardless of flow rate, were more difficult to quantify and many results (particularly B, Sr, and Mo) are reported as "less than" values. At the higher temperature, 75°C, all of these elements were more readily detected. In the channels with rock and glass beads, the Si, Sr, Ca, and Na concentrations represent glass, rock, and leachant composition. The fraction of each was difficult to calculate in spite of having "blank" values from rock-only channels or leachant only. The contributions from the rock and or the leachant are too large to make a precise correction.

4. Of the radionuclides and elements adsorbed on the rock (channels 9, 11, 12, 40, 41 44, 67, and 71), we have examined the data for Pu, Np, U, Cs, B, and Mo.

The adsorption of Np, U, Cs and Mo is below limits of detection at 25°C and flow rates of 10 ml/day and 300 ml/day. For these same conditions, the amount of Pu adsorbed on the rock is about 2-10 times larger than the amount found in the leachate. The amount of Pu on the rock appears to be distributed in a decreasing pattern with 50-60% in the A layer (nearest the glass beads) and about 20%, 10%, and 5% in the B, C, and D layers respectively. Only one series of rock samples (channel 9) at 25°C was analyzed for B adsorption. The results indicate a uniform distribution in the four layers of rock of approximately 20-30%. Furthermore, the total amount of B (46 μg) adsorbed is about the same amount found in the leachate (54 μg). We speculate from these results that the other two series of rock samples at this temperature (channels 11 and 12) but higher flow rate (300 ml/day) would exhibit similar behavior.

At 75°C, the adsorption of Pu, Np, U, Cs and B is somewhat different. Mo is still not detectable in any of the samples; thus we conclude that Mo is not adsorbed by the rock regardless of temperature and flow rate conditions.

The adsorption of Pu at the higher temperature follows the pattern at 25°C as far as distribution along the four layers of rock. However, more Pu is adsorbed in the A layer (80-90%) and about 10%, 5%, and less than 5% in the B, C, and D layers respectively. As in the previous case of 25°C, there is no flow rate effect on adsorption at 75°C. The total amount of Pu adsorbed on the four layers of rock, however, is 10-100 times larger than the amount found in the leachates (channels 40, 41, 44, 67 and 71).

Np and U appear to behave similarly on the rock at 75°C. The adsorption regardless of flow rate, is about 30-40% in the A layer, 20-30% in the B and C layers and 10-20% in the D layer. Comparing the total amounts on the rock with the amounts in the leachates, we find that there is about twice as much Np in the rock for the 1 ml/day and the 10 ml/day samples than in the corresponding leachates. For the 300 ml/day samples however, there is about four times more Np in the leachate. We conclude that flow rate certainly effects adsorption at the higher temperature. In the case of U, the total amount adsorbed on the rock is always less than what is found in the leachates regardless of flow rate, from 2 to 6 times less depending on the flow rate.

As in the lower temperature samples, B was selectively analyzed at 75°C. Two series of rock samples, channel 41 (10 ml/day) and channel 67 (1 ml/day) were analyzed. We found that the B adsorption at this temperature is much the same as in the 25°C samples in terms of uniform distribution (20-30%) in each layer. Also the total amounts of B in the rock are about the same but compared to the amounts found in the leachates the rock-boron is about 400 times smaller than the leachate boron (40-50 μg vs 2200 μg). We conclude that B does not readily, if any, adsorb on the rock under any of the experimental conditions.

Cesium was detected in the 75°C rock samples but only at the lower flow rates of 1 ml/day and 10 ml/day. The adsorption of Cs at 1 ml/day is more or less uniform throughout the four layers of rock, on the order of 30% for the A and B layers and 20% for the C and D layers. The total amount of Cs found in all four layers is 310 μg (average value of channels 67 and 71). The total amount of Cs found in the leachates for the entire leaching period (440 days) is 78 μg (average value of channels 67 and 71). Based on these results, we can say that approximately 80% of the leached Cs stays on the rock and only 20% breaks through and appears in the leachate at a flow rate of 1 ml/day and 75°C temperature. At the higher flow rate of 10 ml/day, (channels 40 and 41) the distribution of Cs on the layers of rock is rather uniform, on the order of 25% in each layer. The total amount of Cs adsorbed on the rock is 140 μg compared to 200 μg found in the leachates. Thus, it would appear that about 40% of the total Cs is adsorbed on the rock with the remaining 60% breaking through in the leachate. However, the sum of the two fractions - rock and leachate - does not compare very well with the Cs value found in the "no rock" channel (channel 35). Based on the accumulative fraction leached for channel 35, we calculate 1500 μg of Cs in the leachate; which is about 5 times more than the Cs found in the "rock" channels (channel 40 and 41). We have no explanation for this large discrepancy.

5. Finally, a comparison of the total amounts leached of Np, U, Mo, and B with the mass loss of the glass beads indicates that indeed there may be a correlation between the dissolved "radionuclides" and the weight loss of the beads. For the glass beads-rock channels, the leached amounts in Appendix 10, Table 2 include the fraction adsorbed on the rock. The agree-

ment between the dissolved material and the loss in weight is remarkably good particularly at the higher temperature, thus suggesting congruent dissolution of these species.

Acknowledgments

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1. D. J. Bradley, on the staff of Battelle Pacific Northwest Laboratories and R. W. Mensing of the Computations Department at LLNL. They helped with the design and initial thrust of the experiment.
2. 1. Garrison, S. MacLean, and J. Schweiger of the Nuclear Chemistry Division did much of the laboratory work during the leaching phase and performed some of the analyses afterwards.
3. A. Langhorst of the Biomedical Sciences Division was responsible for all the ICP analyses.
4. R. Buddemeier of the Nuclear Chemistry Division and D. Isherwood of the Earth Sciences Department reviewed this report.
5. Last but not least, R. Achziger of the Nuclear Chemistry Division spent many hours typing and organizing this report.

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APPENDIX 1

Glass beads weights (before and after leaching).

Rock weights (before and after leaching).

Rock weights (before and after acid wash).

Appendix 1: Table 1

Glass Beads Weights (Before and after leaching)

Channel	Temp. (°C)	Flow Rate (cm^3/day)	Original wt. (g)	Final wt. (g)	ΔW	Weight Loss (%)
2	25	10	2.7715	2.7701	-0.0014	0.051
3	25	10	2.8220	2.8199	-0.0021	0.074
6	25	300	2.8209	2.8168	-0.0041	0.15
9	25	10	2.7273	2.7247	-0.0026	0.095
11	25	300	2.8646	2.8496	-0.0150	0.52
12	25	300	2.7895	2.7748	-0.0147	0.53
35	75	10	2.8102	2.7052	-0.1050	3.74
37	75	300	2.8354	2.5917	-0.2437	8.6
38	75	300	2.7936	2.5650	-0.2286	8.2
40	75	10	2.8146	2.7648	-0.0498	1.77
41	75	10	2.7957	2.7459	-0.0498	1.78
44	75	300	2.8553	2.5663	-0.2890	10.1
67	75	1	2.8993	2.8653	-0.0340	1.17
71	75	1	2.8527	2.8435	-0.0092	0.32

Appendix 1: Table 2

Rock Weights (Before and after leaching)

	Layer weight (g)*				Total weight (g)		%loss
Channel	A	B	C	D	Final	Original	
9	3.0992	5.1435	4.3119	5.3717	17.9263	18.00	0.41
11	2.9313	4.6708	4.5437	5.8491	17.9949	18.10	0.58
12	3.9685	4.2595	4.1826	5.8250	18.2356	18.34	0.57
26	4.5929	5.9939	5.0147	5.1143	20.7158	20.82	0.50
30	5.7100	4.8549	5.6273	4.2634	20.4566	20.57	0.56
40	3.1296	4.8055	4.4270	5.8853	18.2474	18.40	0.84
41	2.8966	5.0891	5.2150	5.2123	19.4130	18.36	0.29
44	2.3141	3.9544	4.7182	5.3908	16.3775	17.57	7.3
58	5.5448	4.8727	5.4646	4.9347	20.8165	21.03	1.0
60	4.7829	4.4965	4.2417	5.1491	18.6702	20.00	7.1
67	3.8697	4.7449	5.2822	4.7117	18.6085	18.71	0.55
71	2.9365	5.4033	5.1611	4.9395	18.4404	18.54	0.54

* After leaching

Appendix 1: Table 3

Rock weights (before and after acid wash) and weight percent loss

Channel Layer	Original Wt. (g)	Final Wt. (g)	Weight Loss(g)	Percent Loss
9A	3.0992	2.9718	0.1274	4.1
9B	5.1435	4.9172	0.2263	4.4
9C	4.3119	4.1292	0.1827	4.2
9D	5.3717	5.1645	0.2072	3.9
11A	3.0992	2.9718	0.1274	3.5
11B	4.6708	4.4666	0.2042	4.4
11C	4.5437	4.3415	0.2022	4.5
11D	5.8491	5.6248	0.2243	3.8
12A	3.9685	3.9090	0.0595	1.5
12B	4.2595	4.1828	0.0767	1.8
12C	4.1826	4.0030	0.1796	4.3
12D	5.8250	5.6196	0.2054	3.5
26A	4.5929	4.5077	0.0852	1.9
30A	5.7100	5.5370	0.1730	3.0
40A	3.1296	2.9655	0.1641	5.2
40B	4.8055	4.6193	0.1862	3.9
40C	4.4270	4.2328	0.1942	4.4
40D	5.8853	5.7620	0.1233	2.1
41A	2.8966	2.7160	0.1806	6.2
41B	5.0891	4.7800	0.3091	6.1
41C	5.2150	4.9370	0.2780	5.3
41D	5.2123	4.9492	0.2631	5.1
44A	2.3141	2.0787	0.2354	10.2
44B	3.9544	3.4520	0.5024	12.7
44C	4.7182	4.1942	0.5240	11.1
44D	5.3908	4.8312	0.5596	10.4
58A	5.5448	5.3180	0.2268	4.1
60A	4.7829	4.2938	0.4891	10.2
67A	3.8697	3.7739	0.1958	2.5
67B	4.7449	4.5537	0.1912	4.0
67C	5.2822	5.1038	0.1784	3.4
67D	4.7117	4.4943	0.2174	4.6

Table 3 (cont.)

Rock weights (before and after acid wash) and weight percent loss

Channel Layer	Original Wt. (g)	Final Wt. (g)	Weight Loss(g)	Percent Loss
71A	2.9365	2.8070	0.1295	4.4
71B	5.4033	5.1808	0.2225	4.1
71C	5.1611	4.9375	0.2236	4.3
71D	4.9395	4.7536	0.1859	3.8
41B*	4.7800	4.6780	0.1020	2.1
44B*	3.4520	3.2612	0.1908	5.5

*Samples were recycled through a second acid wash.

APPENDIX 2

Collection volumes, times, and normalized flow rates (cm^3/day). Also average flow rate for each channel based on thirteen collection volumes.

APPENDIX 2: Table 1

Tabulation of Sample Volumes, Sample Time, and Flowrates

CHANNEL/DAY		1	2	3	8	11	20	37	70	120
VOLUME	2	10.41	10.90	10.28	13.68	10.89	11.87	9.84	21.56	20.65
DELT TIME	2	0.99	1.02	0.96	1.22	1.04	1.04	0.97	2.02	3.00
FLOWRATE	2	10.56	10.70	10.74	11.24	10.50	11.37	10.11	10.69	6.89
VOLUME	3	17.07	10.18	9.38	12.30	9.75	9.99	9.30	19.32	37.14
DELT TIME	3	1.00	1.03	0.96	1.22	1.04	1.02	0.96	2.02	2.99
FLOWRATE	3	17.10	9.92	9.77	10.09	9.36	9.76	9.72	9.56	12.43
VOLUME	6	300.80	316.81	288.70	363.83	311.72	316.03	302.32	335.71	901.04
DELT TIME	6	1.00	1.03	0.96	1.20	1.04	1.03	0.99	1.08	2.96
FLOWRATE	6	302.31	307.26	300.10	302.16	298.67	305.64	306.30	312.00	304.30
VOLUME	9	10.57	11.56	10.75	13.30	11.48	11.59	10.76	21.99	29.56
DELT TIME	9	0.99	1.02	[illegible]	1.22	1.04	1.03	0.97	2.02	2.99
FLOWRATE	9	10.63	11.31	11.25	10.88	11.04	11.25	11.09	10.88	9.90
VOLUME	11	297.42	312.46	292.14	361.69	307.96	310.72	297.07	306.21	703.92
DELT TIME	11	0.98	1.01	0.97	1.20	1.04	1.03	0.99	1.13	2.97
FLOWRATE	11	302.87	308.76	301.18	300.66	296.97	301.09	299.47	271.46	237.33
VOLUME	12	308.44	320.03	301.70	388.70	327.73	330.92	313.62	319.49	962.25
DELT TIME	12	1.00	1.02	0.96	1.20	1.04	1.03	0.99	1.08	2.96
FLOWRATE	12	309.37	313.76	313.94	323.11	314.52	320.35	317.11	296.37	325.41
VOLUME	26	10.43	11.23	10.29	13.17	10.32	11.31	10.22	19.04	15.84
DELT TIME	26	0.99	1.01	0.96	1.21	1.01	1.04	0.98	2.02	2.99
FLOWRATE	26	10.57	11.12	10.69	10.88	10.23	10.84	10.46	9.44	5.30
VOLUME	30	308.42	318.28	302.80	371.52	314.09	338.76	301.87	358.26	913.67
DELT TIME	30	0.99	1.00	0.98	1.20	1.01	1.09	0.99	1.13	2.97
FLOWRATE	30	312.48	319.24	310.25	309.09	310.06	309.65	305.54	314.67	307.22
VOLUME	35	130.18	21.89	9.93	32.03	9.75	11.70	10.12	21.29	37.16
DELT TIME	35	0.85	1.19	0.99	3.05	0.99	1.11	0.97	2.01	2.98
FLOWRATE	35	153.33	18.36	10.00	10.50	9.86	10.55	10.48	10.60	12.48
VOLUME	37	444.30	377.68	299.90	297.72	299.69	327.43	285.31	90.72	890.02
DELT TIME	27	0.97	1.08	0.99	0.99	0.99	1.08	0.95	1.13	2.97
FLOWRATE	37	458.04	349.70	303.85	300.73	301.50	302.62	300.01	80.[illegible]	299.77
VOLUME	38	329.83	351.46	301.92	301.18	303.40	332.36	287.34	329.51	902.27
DELT TIME	38	0.97	1.08	0.99	0.99	0.99	1.09	0.95	1.13	2.98
FLOWRATF	38	340.38	325.43	305.90	303.92	305.54	304.64	301.83	292.12	303.18
VOLUME	40	16.04	15.12	15.08	9.42	10.36	10.64	9.82	17.94	6.96
DELT TIME	40	0.97	1.08	1.01	0.99	0.99	1.09	0.96	2.01	2.99
FLOWRATE	40	16.60	13.99	14.87	9.51	10.43	9.76	10.27	8.92	2.33
VOLUME	41	1.26	11.57	11.00	11.14	10.75	11.91	10.50	20.97	28.51
DELT TIME	41	0.96	1.06	0.96	0.99	0.99	1.09	0.96	2.01	2.99
FLOWRATE	41	1.33	10.70	11.19	11.23	10.83	10.96	11.02	10.43	9.53
VOLUME	44	305.13	345.04	302.37	302.04	301.62	336.82	290.28	326.52	869.94
DELT TIME	44	0.96	1.08	0.99	0.99	0.99	1.11	0.96	1.13	2.99
FLOWRATE	44	317.51	319.19	304.20	304.76	304.67	304.81	302.05	289.98	257.64
VOLUME	58	12.29	12.31	11.33	11.55	10.76	11.82	11.90	19.60	20.47
DELT TIME	58	0.95	1.08	1.00	0.99	0.98	1.11	0.96	3.87	3.00
FLOWRATE	58	12.94	11.44	11.35	11.63	10.97	10.69	12.36	5.12	6.84
VOLUME	60	27[illegible] 7[illegible]	322.26	291.12	288.08	288.59	324.61	281.82	317.39	770.89
DELT TIME	60	0.[illegible]4	1.08	1.00	0.99	0.99	1.11	0.97	1.12	2.98
FLOWRATE	60	295.31	298.11	291.41	292.47	2[illegible]2.99	293.95	289.73	283.13	258.43
		1- 10				11- 20	21- 30	31- 50	51- 80	81-120
VOLUME	67	8.39	0.	0.	0.	0.41	11.00	4.13	18.35	31.60
DELT TIME	67	9.92	0.	0.	0.	9.94	10.16	19.76	31.23	38.80
FLOWRATE	67	0.85	0.	0.	0.	0.04	1.08	0.21	0.59	0.81
VOLUME	71	5.28	0.	0.	0.	0.	7.76	18.31	23.39	2.17
DELT TIME	71	9.92	0.	0.	0.	9.96	10.16	19.76	31.23	38.79
FLOWRATE	71	0.63	0.	0.	0.	0.	0.76	0.93	0.75	0.06

APPENDIX 2: Table 1 (cont.)
Tabulation of Sample Volumes, Sample Time, and Flowrates

CHANNEL/DAY		151	213	280	342	435
VOLUME	2	28.89	28.67	295.29	320.40	267.64
DELT TIME	2	2.99	3.00	30.10	32.68	33.00
FLOWRATE	2	9.66	9.54	9.81	9.80	8.11
VOLUME	3	25.35	32.23	325.98	367.20	363.69
DELT TIME	3	3.01	3.00	30.10	32.69	33.00
FLOWRATE	3	8.43	10.75	10.83	11.23	11.02
VOLUME	5	869.83	925.52	970.00	885.40	822.40
DELT TIME	5	3.01	2.95	3.09	2.98	2.94
FLOWRATE	5	288.98	313.84	313.71	296.82	279.92
VOLUME	9	30.62	28.67	300.51	328.50	336.54
DELT TIME	9	3.01	2.99	30.10	32.68	33.92
FLOWRATE	9	10.18	9.58	9.99	10.06	9.92
VOLUME	11	867.04	869.87	959.70	978.90	844.29
DELT TIME	11	2.96	2.97	3.09	2.99	2.92
FLOWRATE	11	292.67	293.21	310.66	327.16	288.75
VOLUME	12	965.07	956.05	947.80	954.90	852.10
DELT TIME	12	2.98	2.96	3.09	2.98	2.93
FLOWRATE	12	323.42	322.98	306.83	319.47	291.02
VOLUME	26	31.34	312.37	369.23	348.50	352.68
DELT TIME	26	2.99	30.90	30.10	32.71	33.92
FLOWRATE	26	10.47	10.11	12.27	10.65	10.40
VOLUME	30	882.77	909.57	899.10	817.40	806.09
DELT TIME	30	2.96	2.97	3.08	2.99	2.94
FLOWRATE	30	298.74	306.56	292.20	273.29	274.21
VOLUME	35	31.25	28.87	308.89	338.40	335.91
DELT TIME	35	2.99	3.01	30.11	32.72	33.00
FLOWRATE	35	10.47	9.59	10.26	10.34	10.18
VOLUME	37	891.49	875.02	929.30	896.60	852.96
DELT TIME	37	2.96	2.97	3.08	3.00	2.94
FLOWRATE	37	301.77	295.02	302.02	299.27	290.52
VOLUME	38	884.82	892.26	589.50	918.70	868.55
DELT TIME	38	2.96	2.98	3.07	2.99	2.94
FLOWRATE	38	299.18	299.62	192.16	306.85	295.15
VOLUME	40	29.94	30.51	304.27	257.10	362.53
DELT TIME	40	2.99	3.02	30.11	32.72	32.98
FLOWRATE	40	10.02	10.11	10.11	7.86	10.99
VOLUME	41	30.52	28.50	299.50	328.90	325.86
DELT TIME	41	2.99	2.98	30.11	32.72	32.98
FLOWRATE	41	10.22	9.55	9.95	10.05	9.88
VOLUME	44	856.35	906.53	981.60	949.20	871.39
DELT TIME	44	2.96	3.01	3.08	3.00	2.92
FLOWRATE	44	289.70	301.74	319.01	316.72	298.01
VOLUME	58	14.35	300.76	335.72	344.00	354.16
DELT TIME	58	2.98	30.91	30.11	32.72	33.92
FLOWRATE	58	4.81	9.73	11.16	10.51	10.44
VOLUME	60	851.17	887.98	907.42	966.20	873.81
DELT TIME	60	2.98	3.01	3.07	3.01	2.93
FLOWRATE	60	286.00	295.11	295.48	321.32	298.23
		121-150	183-213	248-280	310-342	408-435
VOLUME	67	33.35	37.75	37.77	36.40	34.79
DELT TIME	67	31.18	30.79	32.55	32.65	34.90
FLOWRATE	67	1.07	1.23	1.16	1.12	1.00
VOLUME	71	15.08	18.13	19.17	26.40	43.28
DELT TIME	71	31.17	30.60	32.96	32.65	34.90
FLOWRATE	71	0.48	0.59	0.58	0.81	1.24

Appendix 2: Table 2

Average Flow Rate

Channel	Average Flowrate	PCT.SD.
2	9.98	12.2
3	10.71	19.4
6	302.28	3.1
9	10.55	5.7
11	295.17	7.0
12	314.11	3.3
26	10.24	15.2
30	303.08	4.6
35	11.05*	20.8
37	298.95	25.5
38	298.29	11.0
40	10.41	32.3
41	10.43*	5.8
44	305.00	3.2
58	10.00	25.5
60	292.40	4.4
67	0.91	34.2
71	0.68	45.3

*Day 1 excluded

APPENDIX 3

Leachate Np and Pu Concentrations (dpm/cm^3)

Leachate Neptunium and Plutonium activities in disintegrations per minute per cm^3 of solution. The percent uncertainty (one standard deviation) based on counting statistics only is immediately below each concentration value. Blank corrections to the data have been made. A zero denotes no analysis. The letter C denotes a radiochemical separation. The notations on the left hand side of each page correspond to the channel number, the temperature (COLD for 25°C and HOT for 75°C) and the flow rate (SLOW - 1 ml/day, MEDIUM - 10 ml/day, and FAST - 300 ml/day).

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BEADLEACH II

TABLE OF NEPTUNIUM CONCENTRATION (DPM/CM3)

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	70	120	151	213
2	COLD	MED	1.53E+01 1.7E+00	2.83E+01 1.6E+00	1.95E+01 1.5E+00	4.51E+00 3.1E+00	7.22E+00 2.4E+00	6.68E+00 2.9E+00	8.58E-01 6.8E+00	9.87E-02 1.2E+01	2.52E-01 9.0E+00	1.28E-01 1.1E+01	1.13E-01 1.2E+01
3	COLD	MED	1.14E+01 1.9E+00	2.80E+01 1.5E+00	3.03E+01 1.3E+00	8.01E+00 2.3E+00	3.33E+00 3.7E+00	9.01E+00 2.1E+00	1.96E+00 4.6E+00	1.27E-01 1.2E+01	1.57E-01 1.0E+01	3.94E-01 8.5E+00	3.64E-01 1.1E+01
6	COLD	FAST	8.43E-01 6.9E+00	5.51E-01 9.4E+00	4.57E-01 7.7E+00	3.34E-01 9.1E+00	4.19E-01 8.2E+00	1.39E-01 1.2E+01	0. 1.5E+01	3.37E-02 1.4E+01	1.57E-01 1.1E+01	3.18E-01 9.1E+00	2.50E-01 1.1E+01
9	COLD	MED	4.06E+00 3.4E+00	1.33E+01 1.6E+00	1.86E+01 1.6E+00	1.02E+01 2.0E+00	4.54E+00 2.9E+00	3.91E+00 3.2E+00	9.65E-01 6.3E+00	2.20E-01 1.0E+01	4.20E-01 8.4E+00	2.10E-01 1.0E+01	3.31E-01 1.1E+01
11	COLD	FAST	5.50E-01 7.8E+00	5.46E-01 7.6E+00	6.55E-01 6.8E+00	1.93E-01 1.0E+01	3.00E-01 9.4E+00	1.67E-01 1.0E+01	5.17E-02 1.6E+01	9.45E-02 1.2E+01	1.75E-01 1.1E+01	2.17E-01 1.0E+01	5.46E-02 1.5E+01
12	COLD	FAST	5.89E-01 7.9E+00	4.73E-01 8.0E+00	3.56E-01 8.9E+00	2.71E-01 9.4E+00	2.53E-01 8.5E+00	1.01E-01 1.2E+01	0. 1.6E+01	1.16E-01 1.2E+01	1.70E-01 1.1E+01	3.77E-01 8.3E+00	1.43E-01 1.2E+01
26	COLD	MED	0. 0.	0. 0.	0. 0.	0. 0.	0. 0.	0. 0.	0. 0.	4.60E-01 9.3E+00	1.26E-01 1.0E+01	1.16E-01 1.8E+01	0. 0.
30	COLD	FAST	0. 0.	1.48E-01 1.7E+01	1.25E-01 1.9E+01	2.02E-01 1.6E+01	1.63E-01 1.7E+01	1.02E-01 2.2E+01	0. 0.	1.69E-01 1.6E+01	1.33E-01 1.0E+01	2.17E-01 1.3E+01	0. 0.
35	HOT	MED	1.95E+01 1.1E+00	7.07E+01 7.7E-01	1.17E+02 5.7E-01	1.15E+02 6.0E-01	8.42E+01 6.7E-01	5.52E+01 8.1E-01	5.56E+01 8.5E-01	3.53E+01 1.0E+00	7.93E+01 7.3E-01	9.67E+01 6.3E-01	7.20E+01 8.3E-01
37	HOT	FAST	8.81E+00 1.8E+00	1.01E+01 1.9E+00	1.01E+01 2.2E+00	8.58E+00 2.2E+00	8.17E+00 2.3E+00	3.65E+00 3.2E+00	4.50E+00 2.8E+00	1.94E+01 1.4E+00	1.20E+01 1.8E+00	5.09E+00 2.8E+00	1.27E+01 1.9E+00
38	HOT	FAST	1.05E+01 1.6E+00	9.98E+0C 1.9E+00	8.47E+00 2.0E+00	8.23E+00 2.1E+00	6.78E+00 2.3E+00	4.08E+00 3.1E+00	4.39E+00 3.0E+00	6.35E+00 2.9E+00	1.11E+01 1.9E+00	6.93E+00 2.8E+00	1.32E+01 1.9E+00
40	HOT	MED	6.60E+01 6.3E-01	3.61E+01 1.1E+00	1.73E+01 1.5E+00	3.23E+01 1.1E+00	2.47E+01 1.2E+00	4.24E+01 1.0E+00	8.82E+00 2.1E+00	4.60E+01 9.7E-01	0. 0.	2.33E+01 1.4E+00	5.75E+00 2.9E+00
41	HOT	MED	0. 0.	4.03E+01 1.0E+00	2.43E+01 1.2E+00	2.89E+01 1.1E+00	2.56E+01 1.2E+00	4.17E+01 1.0E+00	3.71E+00 3.4E+00	2.02E+00 4.4E+00	2.86E+01 1.3E+00	5.48E+01 9.3E-01	1.45E+01 1.6E+00
44	HOT	FAST	7.81E+00 2.1E+00	1.09E+01 1.8E+00	9.87E+00 3.4E+00	8.93E+00 3.8E+00	8.10E+00 3.9E+00	2.62E+00 6.6E+00	3.98E+00 3.2E+00	7.84E+00 2.2E+00	1.42E+01 1.7E+00	6.89E+00 2.5E+00	1.27E+01 1.6E+00
58	HOT	MED	0. 0.	6.52E-02 2.8E+01	0. 0.	0. 0.	0. 0.	0. 0.	0. 0.	1.50E-01 1.6E+01	1.23E-01 1.0E+01	2.32E-01 1.3E+01	0. 0.
60	HOT	FAST	0. 0.	1.89E-01 1.5E+01	1.19E-01 3.3E+01	8.38E-02 3.8E+01	6.91E-02 4.1E+01	1.28E-01 3.2E+01	0. 0.	1.44E-01 1.6E+01	1.36E-01 9.6E+00	2.17E-01 1.4E+01	0. 0.

			1- 10				11- 20	21- 30	31- 50	51- 80	81-120	121-150	183-213
67	HOT	SLOW	1.21E+02 6.9E-01	0. 0.	0. 0.	0. 0.	0. 0.	7.62E+01 8.6E-01	1.33E+02 5.5E-01	8.22E+01 8.9E-01	2.90E+01 1.1E+00	7.21E+01 7.4E-01	2.12E+02 4.8E-01
71	HOT	SLOW	8.76E+01 6.4E-01	0. 0.	0. 0.	0. 0.	0. 0.	1.77E+02 5.8E-01	8.77E+01 6.6E-01	1.24E+01 2.4E+00	7.18E+01 7.0E-01	1.20E+02 5.9E-01	1.86E+02 5.1E-01

TABLE OF NEPTUNIUM CONCENTRATION (DPM/CM3)

CHAN	TEMP	FLOW	SAMPLING DAYS 280	342	435
2	COLD	MED	0.	5.44E-01	1.01E+00
			0.	1.0E+01	5.6E+00
3	COLD	MED	0.	1.27E+00	1.81E+00
			0.	7.0E+00	4.6E+00
6	COLD	FAST	0.	2.90E-01	1.35E-01
			0.	1.2E+01	1.2E+01
9	COLD	MED	0.	1.20E+00	1.86E+00
			0.	5.2E+00	4.5E+00
11	COLD	FAST	0.	2.38E-01	6.41E-01
			0.	9.1E+00	C 2.1E+00
12	COLD	FAST	0.	3.31E-01	5.68E-01
			0.	9.8E+00	C 2.2E+00
26	COLD	MED	0.	2.20E-01	1.84E-01
			0.	1.4E+01	1.4E+01
30	COLD	FAST	0.	8.10E-02	1.57E-01
			0.	2.3E+01	1.5E+01
35	HOT	MED	0.	1.77E+01	1.51E+01
			0.	1.5E+00	1.6E+00
37	HOT	FAST	0.	1.22E+01	1.09E+01
			0.	2.7E+00	1.8E+00
38	HOT	FAST	0.	1.01E+01	1.35E+01
			0.	2.0E+00	1.7E+00
40	HOT	MED	0.	4.52E+00	2.59E+01
			0.	2.9E+00	C 3.3E-01
41	HOT	MED	0.	1.42E+01	8.51E+00
			0.	1.7E+00	C 8.2E-01
44	HOT	FAST	0.	9.55E+00	1.16E+01
			0.	2.1E+00	1.9E+00
58	HOT	MED	0.	1.80E-01	2.72E-01
			0.	1.2E+01	1.3E+01
60	HOT	FAST	0.	4.78E-02	1.84E-01
			0.	3.2E+01	1.4E+01
			246-280	310-342	408-435
67	HOT	SLOW	0.	1.05E+02	1.15E+02
			0.	5.9E-01	5.3E-01
71	HOT	SLOW	0.	7.91E+01	3.21E+01
			0.	6.8E-01	1.0E+00

BEADLEACH II

TABLE OF PLUTONIUM CONCENTRATION (DPM/CM3)

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	5	11	20	37	70	120	161	213
2	COLD	MED	1.67E+01 1.5E+00	2.66E+01 1.6E+00	6.00E+00 2.8E+00	1.36E+00 5.6E+07	2.23E+00 4.3E+00	1.59E+00 5.8E+00	5.99E-01 8.5E+00	2.34E-02 2.3E+01	1.69E-01 1.2E+01	1.20E-01 1.5E+01	1.07E-01 1.5E+01
3	COLD	MED	1.72E+01 1.6E+00	1.82E+01 1.9E+00	1.55E+01 1.8E+00	1.85E+0J 4.6E+00	1.23E+00 6.2E+00	1.42E+00 5.4E+00	4.14E-01 9.7E+00	7.39E-02 1.8E+01	1.34E-01 1.3E+01	2.56E-01 1.1E+01	3.49E-02 2.8E+01
5	COLD	FAST	6.41E-01 8.3E+00	3.35E-01 1.3E+01	4.09E-01 8.9E+00	2.16E-01 1.2E+01	1.98E-01 1.3E+01	9.49E-02 1.7E+01	1.05E-01 1.5E+01	9.29E-02 1.7E+01	6.21E-02 1.9E+01	2.07E-01 1.2E+01	1.09E-01 1.7E+01
9	COLD	MED	5.99E-01 C 1.5E+00	3.13E-01 C 2.4E+00	2.08E-01 C 5.2E+00	5.60E-02 C 9.6E+00	1.22E-02 C 1.3E+01	1.68E-02 C 8.9E+00	0. 3.5E+01	0. 2.8E+01	8.31E-02 1.7E+01	0. 3.0E+01	0. 5.0E+01
11	COLD	FAST	4.78E-01 9.0E+00	3.12E-01 1.1E+01	3.31E-01 9.9E+00	1.81E-01 1.2E+01	8.20E-02 1.7E+01	1.28E-01 1.4E+01	7.31E-03 3.0E+01	0. 2.8E+01	4.73E-02 2.0E+01	7.22E-02 1.8E+01	1.77E-02 2.6E+01
12	COLD	FAST	2.78E-01 1.2E+01	3.07E-01 1.1E+01	3.36E-01 1.0E+01	1.76E-01 1.3E+01	8.43E-02 1.7E+01	1.35E-01 1.5E+01	0. 3.5E+01	1.99E-02 2.4E+01	1.58E-05 2.8E+01	1.02E-01 1.6E+01	1.97E-02 2.6E+01
26	COLD	MED	0. 0.	0. 0.	0. 0.	0. 0.	0. 0.	0. 0.	0. 0.	3.97E-02 3.2E+01	3.60E-02 2.0E+01	2.54E-02 3.8E+01	0. 0.
30	COLD	FAST	0. 0.	5.34E-02 2.8E+01	6.88E-02 2.5E+01	6.91E-02 2.7E+01	4.31E-02 3.3E+01	1.36E-01 1.9E+01	0. 0.	5.34E-02 2.8E+01	5.68E-02 1.6E+01	3.61E-02 3.2E+01	0. 0.
35	HOT	MED	2.96E+00 C 6.7E-01	3.52E-01 C 3.0E+00	2.55E-01 C 8.3E+00	3.92E-01 C 1.7E+00	1.38E-01 C 3.6E+00	5.07E-02 C 6.2E+00	1.60E-02 2.4E+01	7.42E-03 2.6E+01	9.91E-02 1.7E+01	1.49E-01 1.4E+01	1.50E-02 2.7E+01
37	HOT	FAST	8.25E-01 5.6E+00	1.03E-01 1.6E+01	8.14E-02 1.9E+01	6.09E-02 2.0E+01	5.43E-02 2.0E+01	8.33E-02 1.7E+01	2.51E-02 2.2E+01	1.61E-01 1.4E+01	2.54E-01 1.1E+01	1.76E-01 1.3E+01	4.46E-01 9.9E+00
38	HOT	FAST	1.30E+00 4.6E+00	8.43E-02 1.7E+01	3.44E-02 2.1E+01	1.39E-02 2.4E+01	6.33E-02 1.8E+01	6.43E-02 1.9E+01	2.88E-02 2.2E+01	1.20E-01 1.8E+01	2.04E-01 1.3E+01	2.47E-01 1.3E+01	4.84E-01 9.4E+00
40	HOT	MED	5.73E-01 C 2.7E+00	1.65E-01 C 4.7E+00	6.63E-01 C 1.5E+00	4.91E-01 C 4.8E+00	4.87E-02 C 6.2E+00	3.51E-02 C 6.6E+00	0. 3.3E+01	0. 4.1E+01	0. 0.	0. 3.3E+01	2.72E-01 1.2E+01
41	HOT	MED	0. 0.	7.19E-02 1.8E+01	1.25E-02 2.5E+01	2.57E-02 2.2E+01	1.17E-02 2.5E+01	2.64E-02 2.3E+01	0. 3.0E+01	1.92E-02 2.5E+01	0. 3.3E+01	0. 4.1E+01	1.13E-01 1.5E+01
44	HOT	FAST	1.12E-01 C 2.9E+00	3.71E-03 C 1.4E+01	5.30E-03 C 1.3E+01	3.07E-03 C 1.6E+01	1.29E-03 C 1.9E+01	4.96E-03 C 1.2E+01	0. 3.5E+01	3.14E-02 2.2E+01	8.63E-02 1.8E+01	0. 3.5E+01	3.64E-03 2.5E+01
58	HOT	MED	0. 0.	5.02E-02 3.2E+01	0. 0.	0. 0.	0. 0.	0. 0.	0. 0.	2.62E-02 3.8E+01	3.00E-02 2.1E+01	3.32E-02 3.5E+01	0. 0.
60	HOT	FAST	0. 0.	9.66E-02 2.1E+01	6.58E-02 4.5E+01	9.58E-02 3.5E+01	8.06E-02 3.8E+01	6.42E-02 4.5E+01	0. 0.	3.60E-02 3.2E+01	4.64E-02 1.6E+01	4.02E-02 3.2E+01	0. 0.

			1- 10				11- 20	21- 30	31- 50	51- 80	81-120	121-150	183-213
67	HOT	SLOW	7.38E-02 C 7.8E+00	0. 0.	0. 0.	0. 0.	0. 0.	9.63E-03 3.0E+01	0. 3.0E+01	0. 1.0E+02	4.44E-04 2.6E+01	0. 3.2E+01	5.00E-02 2.2E+01
71	HOT	SLOW	1.63E-01 C 7.7E+00	0. 0.	0. 0.	0. 0.	0. 0.	8.74E-02 2.0E+01	0. 2.9E+01	0. 1.0E+02	0. 2.8E+01	0. 4.1E+01	3.47E-02 2.4E+01

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BEADLEACH II

TABLE OF PLUTONIUM CONCENTRATION (DPM/CM3)

CHAN	TEMP	FLOW	SAMPLING DAYS 280	342	435
2	COLD	MED	0.	3.18E-01	1.07E-01
			0.	1.4E+01	1.5E+01
3	COLD	MED	0.	2.30E-01	2.34E-01
			0.	1.6E+01	1.2E+01
6	COLD	FAST	0.	5.72E-02	3.70E-03
			0.	2.5E+01	2.7E+01
9	COLD	MED	0.	7.32E-03	1.55E-02
			0.	C 1.3E+01	C 7.0E+00
11	COLD	FAST	0.	8.50E-02	1.17E-02
			0.	1.6E+01	C 5.5E+00
12	COLD	FAST	0.	9.18E-03	1.90E-02
			0.	2.8E+01	C 4.3E+00
26	COLD	MED	0.	4.16E-02	1.19E-01
			0.	3.2E+01	1.7E+01
30	COLD	FAST	0.	2.56E-02	3.57E-02
			0.	4.1E+01	3.2E+01
35	HOT	MED	0.	1.85E-02	1.85E-02
			0.	C 8.3E+00	C 9.2E+00
37	HOT	FAST	0.	6.09E-01	3.59E-01
			0.	1.2E+01	9.4E+00
38	HOT	FAST	0.	5.13E-01	6.40E-01
			0.	8.4E+00	7.6E+00
40	HOT	MED	0.	9.21E-01	1.64E-01
			0.	C 9.2E-01	C 1.4E+00
41	HOT	MED	0.	4.00E-03	1.96E-01
			0.	2.7E+01	C 1.3E+00
44	HOT	FAST	0.	2.33E-02	1.32E-03
			0.	C 5.3E+00	C 1.9E+01
58	HOT	MED	0.	1.10E-01	9.96E-02
			0.	1.5E+01	2.1E+01
60	HOT	FAST	0.	3.35E-02	5.42E-02
			0.	3.8E+01	2.6E+01

CHAN	TEMP	FLOW	[illegible]-280	310-342	408-435
67	HOT	SLOW	0.	1.90E-01	6.87E-02
			0.	C 2.8E+00	C 3.3E+00
71	HOT	SLOW	0.	2.61E-01	2.46E-01
			0.	C 2.0E+00	C 2.8E+00

APPENDIX 4

ICP Concentration Data (μg//cm^3)

a. Leachate concentration (micrograms per cm^3) of stable elements as determined by ICP.

The reported detection limit expressed as "less than" is four times the standard deviation of an average of ten blank runs. The blank used is distilled water which has been passed through a Millipore Ion Exchange system. A zero denotes no analysis was performed. Concentrations are reported for B, Mo, U, Na, Si, Ca, and Sr. The last four elements are also rock or leachant components and their concentrations in this appendix include all three sources, the glass beads, the rock, and the leachant.

BEADLEACH II

TABLE OF BORON CONCENTRATION (UG/CM3)

ICP DETECTION LIMIT= 0.010

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	70	120	151	213
2	COLD	MED	4.30E-02	1.30E-01	8.70E-02	0.	2.50E-02	2.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02
3	COLD	MED	5.40E-02	9.20E-02	1.08E-01	0.	<1.00E-02	0.	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02
6	COLD	FAST	<1.00E-02	<1.00E-02	<1.00E-02	0.	<1.00E-02	0.	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02
9	COLD	MED	4.10E-02	9.90E-02	1.31E-01	0.	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02
11	COLD	FAST	<1.00E-02	<1.00E-02	<1.00E-02	0.	<1.00E-02	0.	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02
12	COLD	FAST	<1.00E-02	<1.00E-02	<1.00E-02	0.	<1.00E-02	0.	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02
26	COLD	MED	1.40E-02	0.	<1.00E-02	0.	<1.00E-02	0.	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02
30	COLD	FAST	0.	0.	<1.00E-02	0.	<1.00E-02	0.	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02
35	HOT	MED	1.57E-01	6.32E-01	8.62E-01	0.	6.26E-01	2.47E-01	3.47E-01	4.68E-01	1.01E+00	1.22E+00	1.18E+00
37	HOT	FAST	6.00E-02	6.30E-02	7.10E-02	0.	2.90E-02	0.	1.70E-02	1.28E-01	8.50E-02	1.04E-01	8.30E-02
38	HOT	FAST	6.80E-02	6.40E-02	6.10E-02	0.	3.10E-02	0.	1.60E-02	3.40E-02	7.60E-02	1.04E-01	7.50E-02
40	HOT	MED	6.32E-01	0.	2.16E-01	0.	3.67E-01	6.02E-01	4.32E-01	5.30E-01	1.33E+00	5.72E-01	4.07E-01
41	HOT	MED	0.	5.06E-01	2.68E-01	0.	3.73E-01	0.	3.22E-01	4.93E-01	8.05E-01	7.03E-01	5.21E-01
44	HOT	FAST	8.10E-02	8.20E-02	8.40E-02	0.	3.40E-02	0.	1.80F-02	4.20E-02	1.06E-01	1.15E-01	8.70E-02
58	HOT	MED	1.50E-02	4.29E-01	<1.00E-02	0.	<1.00E-02	0.	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02
60	HOT	FAST	<1.00E-02	<1.00E-02	<1.00E-02	0.	<1.00E-02	0.	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02
			1- 10				11- 20	21- 30	31- 50	51- 80	81-120	121-150	183-213
67	HOT	SLOW	2.55E+00	0.	0.	0.	0.	7.08E+00	7.26E+00	6.30E+00	7.89E+00	5.14E+00	4.47E+00
71	HOT	SLOW	1.84E+00	0.	0.	0.	0.	6.95E+00	4.86E+00	4.65E+00	1.52E+01	1.19E+01	4.58E+00

BEADLEACH II

TABLE OF BORON CONCENTRATION (UG/CM3)

ICP DETECTION LIMIT= 0.010

CHAN	TEMP	FLOW	SAMPLING DAYS 280	342	435
2	COLD	MED	0.	<1.00E 02	<1.00E-02
3	COLD	MED	0.	<1.00E-02	<1.00E-02
6	COLD	FAST	0.	<1.00E-02	<1.00E-02
9	COLD	MED	0.	<1.00E-02	<1.00E-02
11	COLD	FAST	0.	<1.00E-02	<1.00E-02
12	COLD	FAST	0.	<1.00E-02	<1.00E-02
26	COLD	MED	0.	<1.00E-02	<1.00E-02
30	COLD	FAST	0.	0.	<1.00E-02
35	HOT	MED	0.	1.30E+00	1.35E+00
37	HOT	FAST	0.	8.10E-02	7.60E-02
38	HOT	FAST	0.	6.90E-02	7.80E-02
40	HOT	MED	0.	6.26E-01	5.39E-01
41	HOT	MED	0.	4.92E-01	6.43E-01
44	HOT	FAST	0.	9.40E-02	9.20E-02
58	HOT	MED	0.	<1.00E-02	<1.00E-02
60	HOT	FAST	0.	0.	<1.00E-02
			246-280	310-342	408-435
67	HOT	SLOW	4.98E+00	5.14E+00	5.44E+00
71	HOT	SLOW	7.24E+00	8.13E+00	5.01E+00

BEADLEACH II

TABLE OF MOLYBDENUM CONCENTRATION (UG/CM3)

ICP DETECTION LIMIT= 0.005

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	70	120	151	213
2	COLD	MED	5.90E-02	3.00E-02	2.80E-02	0.	<5.00E-03	1.10E-02	<5.00E-03	<5.00E-03	<5.00E-03	5.00E-03	<5.00E-03
3	COLD	MED	6.80E-02	2.50E-02	4.10E-02	0.	1.10E-02	0.	<5.00E-03	<5.00E-03	<5.00E-03	<5.00E-03	<5.00E-03
6	COLD	FAST	<5.00E-03	<5.00E-03	<5.00E-03	0.	<5.00E-03	0.	<5.00E-03	<5.00E-03	<5.00E-03	8.00E-03	<5.00E-03
9	COLD	MED	4.10E-02	5.30E-02	6.00E-02	0.	1.10E-02	<5.00E-03	<5.00E-03	6.00E-03	<5.00E-03	6.00E-03	<5.00E-03
11	COLD	FAST	<5.00E-03	<5.00E-03	<5.00E-03	0.	<5.00E-03	0.	<5.00E-03	<5.00E-03	<5.00E-03	<5.00E-03	<5.00E-03
12	COLD	FAST	6.00E-03	7.00E-03	<5.00E-03	0.	<5.00E-03	0.	<5.00E-03	<5.00E-03	<5.00E-03	<5.00E-03	<5.00E-03
26	COLD	MED	2.60E-02	0.	<5.00E-03	0.	<5.00E-03	0.	<5.00E-03	<5.00E-03	<5.00E-03	<5.00E-03	<5.00E-03
30	COLD	FAST	0.	0.	<5.00E-03	0.	<5.00E-03	0.	<5.00E-03	<5.00E-03	<5.00E-03	<5.00E-03	<5.00E-03
35	HOT	MED	8.40E-02	2.99E-01	3.91E-01	0.	2.90E-01	1.21E-01	1.54E-01	2.17E-01	4.62E-01	5.63E-01	5.89E-01
37	HOT	FAST	3.40E-02	3.40E-02	3.80E-02	0.	1.90E-02	0.	1.20E-02	6.80E-02	<5.00E-03	5.60E-02	4.50E-02
38	HOT	FAST	3.70E-02	3.60E-02	3.40E-02	0.	2.70E-02	0.	1.00E-02	2.60E-02	3.80E-02	5.60E-02	4.40E-02
40	HOT	MED	3.05E-01	0.	1.05E-01	0.	1.77E-01	2.95E-01	1.97E-01	2.42E-01	6.05E-01	2.68E-01	2.02E-01
41	HOT	MED	0.	2.46E-01	1.28E-01	0.	1.74E-01	0.	1.55E-01	2.30E-01	3.73E-01	3.32E-01	2.61E-01
44	HOT	FAST	4.30E-02	4.40E-02	4.60E-02	0.	2.10E-02	0.	7.00E-03	2.80E-02	5.00E-02	6.20E-02	4.70E-02
58	HOT	MED	1.80E-02	2.13E-01	<5.00E-03	0.	<5.00E-03	0.	<5.00E-03	9.00E-03	<5.00E-03	<5.00E-03	<5.00E-03
60	HOT	FAST	<5.00E-03	<5.00E-03	1.10E-02	0.	<5.00E-03	0.	<5.00E-03	8.00E-03	<5.00E-03	<5.00E-03	<5.00E-03
			1- 10				11- 20	21- 30	31- 50	51- 80	81-120	121-150	183-213
67	HOT	SLOW	1.13E+00	0.	0.	0.	0.	3.16E+00	3.32E+00	2.84E+00	3.59E+00	2.40E+00	2.20E+00
71	HOT	SLOW	8.08E-01	0.	0.	0.	0.	3.11E+00	2.17E+00	2.09E+00	6.89E+00	5.53E+00	2.26E+00

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BEADLEACH II

TABLE OF MOLYBDENUM CONCENTRATION (UG/CM3)

ICP DETECTION LIMIT= 0.005

CHAN	TEMP	FLOW	SAMPLING DAYS 280	342	435
2	COLD	MED	0.	<5.00E-03	9.00E-03
3	COLD	MED	0.	6.00E-03	1.00E-02
6	COLD	FAST	0.	<5.00E-03	<5.00E-03
9	COLD	MED	0.	6.00E-03	1.00E-02
11	COLD	FAST	0.	<5.00E-03	<5.00E-03
12	COLD	FAST	0.	<5.00E-03	<5.00E-03
26	COLD	MED	0.	<5.00E-03	<5.00E-03
30	COLD	FAST	0.	0.	6.00E-03
35	HOT	MED	0.	6.33E-01	6.59E-01
37	HOT	FAST	0.	4.40E-02	4.30E-02
38	HOT	FAST	0.	3.60E-02	4.40E-02
40	HOT	MED	0.	3.09E-01	2.62E-01
41	HOT	MED	0.	2.46E-01	3.12E-01
44	HOT	FAST	0.	5.00E-02	5.2[illegible]E-02
58	HOT	MED	0.	<5.00E-03	<5.00E-03
60	HOT	FAST	0.	0.	<5.00E-03
			246-280	310-342	408-435
67	HOT	SLOW	2.40E+00	2.41E+00	2.46E+00
71	HOT	SLOW	3.48E+00	3.86E+00	2.25E+00

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BEADLEACH II

TABLE OF URANIUM CONCENTRATION (UG/CM3)

ICP DETECTION LIMIT= 0.056

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	70	120	151	213
2	COLD	MED	<5.60E-02	<5.60E-02	<5.60E-02	0.	<5.60E-02	<5.60E-02	<5.60E-02	<5.60E-02	<5.60E-02	<5.60E-02	<5.60E-02
3	COLD	MED	<5.60E-02	<5.60E-02	<5.60E-02	0.	<5.60E-02	0.	<5.60E-02	<5.60E-02	<5.60E-02	<5.60E-02	<5.60E-02
6	COLD	FAST	<5.60E-02	<5.60E-02	<5.60E-02	0.	5.60E-02	0.	<5.60E-02	<5.60E-02	<5.60E-02	<5.60E-02	<5.60E-02
9	COLD	MED	<5.60E-02	<5.60E-02	<5.60E-02	0.	<5.60E-02	<5.60E-02	<5.60E-02	<5.60E-02	<5.60E-02	<5.60E-02	<5.60E-02
11	COLD	FAST	<5.60E-02	<5.60E-02	<5.60E-02	0.	<5.60E-02	0.	<5.60E-02	<5.60E-02	<5.60[illegible]	[illegible]E-02	<5.60E-02
12	COLD	FAST	<5.60E-02	<5.60E-02	<5.60E-02	0.	<5.60E-02	0.	<5.60E-02	<5.60E-02	<5.60[illegible]	[illegible]E-02	<5.60E-02
26	COLD	MED	<5.60E-02	0.	<5.60E-02	0.	<5.60E-02	0.	<5.60E-02	<5.60E-02	<5.60E-02	<5.60E-02	<5.60E-02
30	COLD	FAST	0.	0.	<5.60E-02	0.	<5.60E-02	0.	<5.60E-02	<5.60E-02	<5.60E-02	<5.60E-02	<5.60E-02
35	HOT	MED	1.12E-01	6.60E-02	1.33E-01	0.	1.29E-01	<5.60E-02	<5.60E-02	7.90E-02	3.72E-01	5.82E-01	5.06E-01
37	HOT	FAST	9.20E-02	<5.60E-02	<5.60E-02	0.	<5.60E-02	0.	<5.60E-02	<5.60E-02	<5.60E-02	<5.60E-02	<5.60E-02
38	HOT	FAST	<5.60E-02	<5.60E-02	<5.60E-02	0.	<5.60E-02	0.	<5.60E-02	<5.60E-02	<5.60E-02	<5.60E-02	<5.60E-02
40	HOT	MED	5.90E-02	0.	<5.60E-02	0.	<5.60E-02	1.04E-01	9.00E-02	3.14E-01	2.54E-01	1.78E-01	7.80E-02
41	HOT	MED	0.	2.45E-01	<5.60E-02	0.	<5.60E-02	0.	7.90E-02	2.06E-01	2.08E-01	2.24E-01	6.80E-02
44	HOT	FAST	<5.60E-02	<5.60E-02	<5.60E-02	0.	<5.60E-02	0.	<5.60E-02	<5.60E-02	<5.60E-02	<5.60E-02	<5.60E-02
56	HOT	MED	<5.60E-02	<5.60E-02	<5.60E-02	0.	<5.60E-02	0.	<5.60E-02	<5.60E-02	<5.60E-02	<5.60E-02	<5.60E-02
60	HOT	FAST	<5.60E-02	<5.60E-02	<5.60E-02	0.	<5.60E-02	0.	<5.60E-02	<[illegible].60E-02	<5.60E-02	<5.60E-02	<5.60E-02
			1- 10				11- 20	21- 30	31- 50	51- 80	81-120	121-150	183-213
67	HOT	SLOW	6.50E-02	0.	0.	0.	0.	4.22E-01	7.41E+00	7.12E-01	7.96E-01	6.35E-01	9.22E-01
71	HOT	SLOW	<5.60E-02	0.	0.	0.	0.	2.61E-01	4.09E-01	6.06E-01	3.20E+00	1.73E+00	1.11E+00

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BEADLEACH II

TABLE OF URANIUM CONCENTRATION (UG/CM3)

ICP DETECTION LIMIT= 0.056

CHAN	TEMP	FLOW	SAMPLING DAYS		
			280	342	435
2	COLD	MED	0.	<5.60E-02	<5.60E-02
3	COLD	MED	0.	<5.60E-02	<5.60E-02
6	COLD	FAST	0.	<5.60E-02	<5.60E-02
9	COLD	MED	0.	<5.60E-02	<5.60E-02
11	COLD	FAST	0.	<5.60E-02	<5.60E-02
12	COLD	FAST	0.	<5.60E-02	<5.60E-02
26	COLD	MED	0.	<5.60E-02	<5.60E-02
30	COLD	FAST	0.	0.	<5.60E-02
35	HOT	MED	0.	4.08E-01	3.21E-01
37	HOT	FAST	0.	5.70E-02	<5.60E-02
38	HOT	FAST	0.	<5.60E-02	<5.60E-02
40	HOT	MED	0.	7.60E-02	<5.60E-02
41	HOT	MED	0.	6.30E-02	<5.60E-02
44	HOT	FAST	0.	<5.60E-02	<5.60E-02
58	HOT	MED	0.	<5.60E-02	<5.60E-02
60	HOT	FAST	0.	0.	<5.60E-02
			246-280	310-342	408-435
67	HOT	SLOW	7.83E-01	3.53E-01	1.92E-01
71	HOT	SLOW	1.26E+00	7.67E-01	2.82E-01

BEADLEACH II

TABLE OF SODIUM CONCENTRATION (UG/CM3)

ICP DETECTION LIMIT= 0.008

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	70	120	161	213
2	COLD	MED	2.61E+02	2.62E+02	2.00E+02	0.	1.97E+02	2.25E+02	1.90E+02	2.59E+02	1.79E+02	1.03E+02	3.64E+02
3	COLD	MED	2.35E+02	2.36E+02	2.02E+02	0.	1.96E+02	0.	1.91E+02	2.62E+02	1.79E+02	1.03E+02	4.26E+02
6	COLD	FAST	2.10E+02	2.17E+02	1.93E+02	0.	1.89E+02	0.	1.97E+02	[illegible]	1.74E+02	9.91E+01	5.76E+01
9	COLD	MED	2.14E+02	2.03E+02	1.84E+02	0.	1.97E+02	2.19E+02	2.00E+02	2.62E+02	1.85E+02	1.01E+02	3.52E+02
11	COLD	FAST	2.11E+02	2.08E+02	1.97E+02	0.	1.98E+02	0.	2.01E+02	2.61E+02	1.74E+02	1.02E+02	5.79E+01
12	COLD	FAST	2.08E+02	2.07E+02	1.98E+02	0.	2.00E+02	0.	1.96E+02	2.63E+02	1.75E+02	1.02E+02	5.74E+01
26	COLD	MED	8.91E+02	0.	2.29E+02	0.	1.91E+02	0.	1.92E+02	2.66E+02	1.76E+02	1.11E+02	5.26E+02
30	COLD	FAST	0.	0.	1.89E+02	0.	1.87E+02	0.	1.94E+02	2.60E+02	1.76E+02	9.71E+01	5.63E+01
35	HOT	MED	2.10E+02	2.38E+02	2.03E+02	0.	1.98E+02	2.27E+02	1.95E+02	2.74E+02	1.86E+02	1.10E+02	3.79E+02
37	HOT	FAST	2.23E+02	2.15E+02	1.90E+02	0.	1.94E+02	0.	1.92E+02	2.59E+02	1.74E+02	1.01E+02	5.50E+01
38	HOT	FAST	2.25E+02	2.12E+02	2.02E+02	0.	1.98E+02	0.	1.96E+02	2.64E+02	1.76E+02	9.97E+01	5.75E+01
40	HOT	MED	6.84E+02	0.	1.91E+02	0.	1.94E+02	2.35E+02	1.93E+02	2.72E+02	1.84E+02	1.07E+02	4.05E+02
41	HOT	MED	0.	2.92E+02	2.06E+02	0.	1.96E+02	0.	1.93E+02	2.70E+02	1.79E+02	1.17E+02	4.55E+02
44	HOT	FAST	2.45E+02	2.16E+02	1.91E+02	0.	1.94E+02	0.	1.89E+02	2.64E+02	1.72E+02	1.01E+02	5.76E+01
58	HOT	MED	3.38E+02	3.67E+02	1.82E+02	0.	1.98E+02	0.	1.94E+02	2.78E+02	1.79E+02	1.18E+02	5.23E+02
60	HOT	FAST	2.09E+02	2.04E+02	1.77E+02	0.	1.80E+02	0.	1.70E+02	2.60E+02	1.72E+02	9.73E+01	5.86E+01
			1- 10				11- 20	21- 30	31- 60	51- 80	61-120	121-150	163-213
67	HOT	SLOW	3.09E+02	0.	0.	0.	0.	2.41E+02	2.61E+02	2.73E+02	2.56E+02	1.57E+02	1.61E+03
71	HOT	SLOW	3.39E+02	0.	0.	0.	0.	2.57E+02	2.37E+02	2.97E+02	3.86E+02	2.61E+02	2.99E+03

TABLE OF SODIUM CONCENTRATION (UG/CM3)

ICP DETECTION LIMIT= 0.008

CHAN	TEMP	FLOW	SAMPLING DAYS 280	342	435
2	COLD	MED	0.	7.38E+01	3.32E+01
3	COLD	MED	0.	7.15E+01	3.22E+01
6	COLD	FAST	0.	8.63E+01	4.21E+01
9	COLD	MED	0.	8.47E+01	3.50E+01
11	COLD	FAST	0.	8.48E+01	4.12E+01
12	COLD	FAST	0.	8.56E+01	4.36E+01
26	COLD	MED	0.	8.40E+01	3.50E+01
30	COLD	FAST	0.	0.	3.99E+01
35	HOT	MED	0.	8.61E+01	3.76E+01
37	HOT	FAST	0.	8.79E+01	4.14E+01
38	HOT	FAST	0.	8.96E+01	4.27E+01
40	HOT	MED	0.	9.19E+01	4.13E+01
41	HOT	MED	0.	8.82E+01	4.18E+01
44	HOT	FAST	0.	8.99E+01	4.52E+01
58	HOT	MED	0.	9.15E+01	3.92E+01
60	HOT	FAST	0.	0.	4.10E+01
			246-280	310-342	408-435
67	HOT	SLOW	2.60E+02	1.53E+02	1.03E+02
71	HOT	SLOW	4.73E+02	2.00E+02	7.09E+01

BEADLEACH II

TABLE OF SILICON CONCENTRATION (UG/CM3)

ICP DETECTION LIMIT= 0.022

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	70	120	151	21[illegible]
2	COLD	MED	9.17E-01	1.54E+00	4.95E+00	0.	9.92E-01	1.02E+00	9.89E-01	1.12E+00	2.88E-01	2.85E-01	3.49E-01
3	COLD	MED	2.32E+00	1.18E+00	1.28E+00	0.	1.03E+00	0.	1.04E+00	1.16E+00	2.50E-01	3.18E-01	3.33E-01
6	COLD	FAST	6.71E-01	6.90E-01	7.29E-01	0.	8.06E-01	0.	9.78E-01	1.07E+00	2.18E-01	2.26E-01	4.17E-01
9	COLD	MED	5.72E+00	5.69E+00	4.74E+00	0.	2.45E+00	2.45E+00	1.91E+00	1.74E+00	1.12E+00	8.85E-01	6.32E-01
11	COLD	FAST	1.19E+00	9.51E-01	8.98E-01	0.	8.54E-01	0.	1.03E+00	1.06E+00	2.72E-01	3.71E-01	4.46E-01
12	COLD	FAST	1.29E+00	9.29E-01	9.40E-01	0.	8.50E-01	0.	9.77E-01	1.09E+00	2.58E-01	3.39E-01	4.47E-01
26	COLD	MED	4.99E+00	0.	3.98E+00	0.	2.76E+00	0.	1.98E+00	1.78E+00	1.60E+00	1.49E+00	9.28E-01
30	COLD	FAST	0.	0.	9.05E-01	0.	8.15E-01	0.	9.42E-01	1.07E+00	2.57E-01	2.84E-01	4.37E-01
35	HOT	MED	1.66E+00	4.20E+00	5.85E+00	0.	4.38E+00	2.51E+00	3.06E+00	3.73E+00	5.84E+00	[illegible]	[illegible].82E+00
37	HOT	FAST	1.03E+00	1.08E+00	1.15E+00	0.	1.01E+00	0.	1.13E+00	1.81E+00	7.40E-01		[illegible]05E-01
38	HOT	FAST	1.08E+00	1.07E+00	1.14E+00	0.	1.05E+00	0.	1.08E+00	1.33E+00	7.08E-01		[illegible].99E-01
40	HOT	MED	2.25E+01	0.	1.78E+01	0.	1.47E+01	1.32E+01	1.13E+01	1.31E+01	1.57E+01		8.99E+00
41	HOT	MED	0.	1.14E+01	1.87E+01	0.	1.42E+01	0.	1.12E+01	1.16E+01	1 26E+01	[illegible]+01	1.00E+01
44	HOT	FAST	6.04E+00	4.43E+00	3.70E+00	0.	2.15E+00	0.	2.08E+00	2.69E+00	3.[illegible]E+00	6.92E+00	[illegible].93E+00
58	HOT	MED	2.23E+01	2.20E+01	1.88E+01	0.	1.37E+01	0.	1.15E+01	1.46E+01	1.07E+01	9.43E+00	8.61E+00
60	HOT	FAST	6.06E+00	4.20E+00	3.34E+00	0.	2.10E+00	0.	2.11E+00	2.34E+00	2.81E+00	6.58E+00	4.06E+00

			1- 10				11- 20	21- 30	31- 50	51- 80	81-120	121-150	183-213
67	HOT	SLOW	3.72E+01	0.	0.	0.	0.	3.85E+01	4.45E+01	3.58E+01	4.20E+01	3.52E+01	2.60E+01
71	HOT	SLOW	3.66E+01	0.	0.	0.	0.	3.78E+01	3.67E+01	3.57E+01	4.38E+01	4.72E+01	2.71E+01

BEADLEACH II

TABLE OF SILICON CONCENTRATION (UG/CM3)

ICP DETECTION LIMIT= 0.022

CHAN	TEMP	FLOW	SAMPLING DAYS 280	342	435
2	COLD	MED	0.	1.75E-01	1.48E-01
3	COLD	MED	0.	2.01E-01	1.67E-01
6	COLD	FAST	0.	1.65E-01	1.16E-01
9	COLD	MED	0.	7.31E-01	7.23E-01
11	COLD	FAST	0.	1.89E-01	1.44E-01
12	COLD	FAST	0.	2.00E-01	1.40E-01
26	COLD	MED	0.	6.25E-01	6.24E-01
30	COLD	FAST	0.	0.	1.53E-01
35	HOT	MED	0.	7.00E+00	7.09E+00
37	HOT	FAST	0.	6.57E-01	5.55E-01
38	HOT	FAST	0.	5.72E-01	6.35E-01
40	HOT	MED	0.	1.13E+01	9.92E+00
41	HOT	MED	0.	1.04E+01	1.10E+01
44	HOT	FAST	0.	3.64E+00	3.10E+00
58	HOT	MED	0.	9.71E+00	9.72E+00
60	HOT	FAST	0.	0.	2.69E+00
			246-280	310-342	408-435
67	HOT	SLOW	2.82E+01	2.79E+01	2.80E+01
71	HOT	SLOW	3.38E+01	3.42E+01	2.53E+01

BEADLEACH II

TABLE OF CALCIUM CONCENTRATION (UG/CM3)

ICP DETECTION LIMIT= 0.012

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	70	120	151	213
2	COLD	MED	2.56E+00	6.54E+00	2.28E+00	0.	2.90E+00	2.98E+00	4.17E+00	4.02E+00	4.13E+00	2.33E+00	3.28E+00
3	COLD	MED	1.29E+00	1.53E+00	1.86E+00	0.	4.35E+00	0.	2.84E+00	4.29E+00	3.69E+00	2.40E+00	3.12E+00
6	COLD	FAST	2.17E+00	2.30E+00	2.40E+00	0.	2.51E+00	0.	2.86E+00	4.19E+00	3.52E+00	2.19E+00	2.02E+00
9	COLD	MED	1.88E+01	1.90E+01	1.20E+01	0.	6.22E+00	4.80E+00	3.91E+00	4.26E+00	4.48E+00	2.57E+00	1.02E+00
11	COLD	FAST	5.25E+00	2.78E+00	2.68E+00	0.	3.56E+00	0.	3.25E+00	4.36E+00	3.57E+00	2.33E+00	1.93E+00
12	COLD	FAST	6.44E+00	7.57E+00	4.63E+00	0.	6.98E+00	0.	3.75E+00	4.34E+00	3.56E+00	2.35E+00	1.89E+00
26	COLD	MED	4.25E+01	0.	8.92E+00	0.	6.18E+00	0.	3.88E+00	4.52E+00	4.80E+00	3.89E+00	1.93E+00
30	COLD	FAST	0.	0.	3.00E+00	0.	2.69E+00	0.	3.19E+00	7.14E+00	3.62E+00	2.24E+00	1.95E+00
35	HOT	MED	1.97E+00	2.76E+00	2.34E+00	0.	2.72E+00	3.32E+00	2.99E+00	4.89E+00	3.93E+00	2.91E+00	3.35E+00
37	HOT	FAST	3.07E+00	2.93E+00	3.49E+00	0.	3.13E+00	0.	3.69E+00	4.64E+00	3.63E+00	1.77E+00	2.03E+00
38	HOT	FAST	6.83E+00	4.34E+00	4.40E+00	0.	2.87E+00	0.	3.36E+00	4.31E+00	3.64E+00	1.81E+00	2.14E+00
40	HOT	MED	3.67E+01	0.	6.59E+00	0.	4.90E+00	4.65E+00	3.22E+00	4.68E+00	5.59E+00	2.39E+00	9.97E-01
41	HOT	MED	0.	4.43E+00	7.00E+00	0.	4.62E+00	0.	3.13E+00	4.29E+00	4.21E+00	2.39E+00	9.15E-01
44	HOT	FAST	5.48E+00	3.41E+00	2.87E+00	0.	3.18E+00	0.	2.83E+00	4.53E+00	3.72E+00	1.55E+00	2.36E+00
58	HOT	MED	2.63E+01	1.65E+01	9.17E+00	0.	6.09E+00	0.	3.57E+00	6.56E+00	4.32E+00	2.65E+00	2.13E+00
60	HOT	FAST	6.59E+00	4.73E+00	8.29E+00	0.	2.63E+00	0.	2.67E+00	4.70E+00	3.78E+00	1.48E+00	2.35E+00
			1- 10				11- 20	21- 30	31- 50	51- 80	81-120	121-150	183-213
67	HOT	SLOW	3.69E+01	0.	0.	0.	0.	2.32E+01	1.67E+01	1.37E+01	8.84E+00	2.25E+00	<1.20E-02
71	HOT	SLOW	4.42E+01	0.	0.	0.	0.	3.16E+01	1.40E+01	1.27E+01	1.86E+01	7.47E+00	<1.20E-02

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BEADLEACH II

TABLE OF CALCIUM CONCENTRATION (UG/CM3)

ICP DETECTION LIMIT= 0.012

CHAN	TEMP	FLOW	SAMPLING DAYS		
			280	342	435
2	COLD	MED	0.	2.35E+00	9.56E+00
3	COLD	MED	0.	1.75E+00	8.17E+00
6	COLD	FAST	0.	2.17E+00	7.37E+00
9	COLD	MED	0.	7.40E-01	6.73E+00
11	COLD	FAST	0.	2.01E+00	7.20E+00
12	COLD	FAST	0.	2.02E+00	7.52E+00
26	COLD	MED	0.	9.01E-01	6.44E+00
30	COLD	FAST	0.	0.	6.95E+00
35	HOT	MED	0.	3.46E+00	9.19E+00
37	HOT	FAST	0.	2.16E+00	7.10E+00
38	HOT	FAST	0.	2.26E+00	7.33E+00
40	HOT	MED	0.	3.21E-01	5.21E+00
41	HOT	MED	0.	4.38E-01	4.23E+00
44	HOT	FAST	0.	2.42E+00	8.01E+00
56	HOT	MED	0.	1.11E+00	5.07E+00
60	HOT	FAST	0.	0.	7.35E+00
			246-280	310-342	408-435
67	HOT	SLOW	3.76E-01	1.36E-01	2.35E-01
71	HOT	SLOW	1.25E+00	2.09E-01	5.25E-01

BEADLEACH II

TABLE OF STRONTIUM CONCENTRATION (UG/CM3)

ICP DETECTION LIMIT= 0.008

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	70	120	151	213
2	COLD	MED	2.20E-02	1.80E-02	1.80E-02	0.	<8.00E-03	<8.00E-03	<8.00E-03	<8.00E-03	<8.00E-03	<8.00E-03	1.70E-02
3	COLD	MED	1.00E-02	1.90E-02	2.10E-02	0.	<8.00E-03	0.	<8.00E-03	<8.00E-03	<8.00E-03	<8.00E-03	1.90E-02
8	COLD	FAST	<8.00E-03	<8.00E-03	<8.00E-03	0.	<8.00E-03	0.	<8.00E-03	<8.00E-03	<8.00E-03	<8.00E-03	1.20E-02
9	COLD	MED	3.80E-02	4.20E-02	2.10E-02	0.	<8.00E-03	<8.00E-03	<8.00E-03	<8.00E-03	1.00E-02	<8.00E-03	<8.00E-03
11	COLD	FAST	<8.00E-03	<8.00E-03	1.00E-02	0.	<8.00E-03	0.	<8.00E-03	<8.00E-03	<8.00E-03	<8.00E-03	<8.00E-03
12	COLD	FAST	<8.00E-03	1.00E-02	<8.00E-03	0.	<8.00E-03	0.	<8.00E-03	<8.00E-03	<8.00E-03	<8.00E-03	1.00E-02
26	COLD	MED	1.28E-01	0.	1.50E-02	0.	<8.00E-03	0.	<8.00E-03	<8.00E-03	<8.00E-03	<8.00E-03	1.80E-02
30	COLD	FAST	0.	0.	<8.00E-03	0.	<8.00E-03	0.	<8.00E-03	<8.00E-03	<8.00E-03	<8.00E-03	9.00E-03
35	HOT	MED	2.30E-02	5.60E-02	8.60E-02	0.	5.80E-02	2.50E-02	3.30E-01	4.30E-02	9.90E-02	1.25E-01	1.02E-01
37	HOT	FAST	1.90E-02	1.20E-02	<8.00E-03	0.	<8.00E-03	0.	<8.00E-03	<8.00E-03	1.80E-02	9.00E-03	2.00E-02
38	HOT	FAST	1.10E-02	1.20E-02	<8.00E-03	0.	<8.00E-03	0.	<8.00E-03	<8.00E-03	1.40E-02	1.40E-02	1.70E-02
40	HOT	MED	1.46E-01	0.	1.80E-02	0.	<8.00E-03	<8.00E-03	<8.00E-03	<8.00E-03	2.20E-02	1.50E-02	<8.00E-03
41	HOT	MED	0.	1.30E-02	2.00E-02	0.	<8.00E-03	0.	<8.00E-03	<8.00E-03	2.60E-02	<8.00E-03	<8.00E-03
44	HOT	FAST	<8.00E-03	<8.00E-03	<8.00E-03	0.	<8.00E-03	0.	<8.00E-03	<8.00E-03	1.60E-02	<8.00E-03	1.60E-02
58	HOT	MEO	7.60E-02	5.60E-02	2.10E-02	0.	<8.00E-03	0.	<8.00E-03	<8.00E-03	1.10E-02	<8.00E-03	<8.00E-03
60	HOT	FAST	2.00E-02	1.30E-02	<8.00E-03	0.	<8.00E-03	0.	<8.00E-03	<8.00E-03	<8.00E-03	<8.00E-03	<8.00E-03
			1- 10				11- 20	21- 30	31- 50	51- 80	81-120	121-150	183-213
67	HOT	SLOW	1.58E-01	0.	0.	0.	0.	1.07E-01	9.20E-02	8.30E-02	8.00E-02	3.40E-02	<8.00E-03
71	HOT	SLOW	1.59E-01	0.	0.	0.	0.	1.38E-01	6.30E-02	7.60E-02	1.21E-01	7.40E-02	<8.00E-03

BEADLEACH II

TABLE OF STRONTIUM CONCENTRATION (UG/CM3)

ICP DETECTION LIMIT= 0.008

CHAN	TEMP	FLOW	SAMPLING DAYS 280	342	435
2	COLD	MED	0.	1.40E-02	1.80E-02
3	COLD	MED	0.	1.40E-02	1.50E-02
6	COLD	FAST	0.	1.00E-02	1.70E-02
9	COLD	MED	0.	<8.00E-03	1.10E-02
11	COLD	FAST	0.	1.50E-02	1.80E-02
12	COLD	FAST	0.	1.10E-02	1.60E-02
26	COLD	MED	0.	<8.00E-03	1.40E-02
30	COLD	FAST	0.	0.	2.20E-02
35	HOT	MED	0.	1.44E-01	1.66E-01
37	HOT	FAST	0.	2.60E-02	2.10E-02
38	HOT	FAST	0.	1.70E-02	2.30E-02
40	HOT	MED	0.	<8.00E-03	2.00E-02
41	HOT	MED	0.	<8.00E-03	1.50E-02
44	HOT	FAST	0.	2.90E-02	2.60E-02
58	HOT	MED	0.	<8.00E-03	9.00E-03
60	HOT	FAST	0.	0.	1.90E-02
			246-280	310-342	408-435
67	HOT	SLOW	9.00E-03	<8.00E-03	<8.00E-03
71	HOT	SLOW	<8.00E-03	<8.00E-03	<8.00E-03

APPENDIX 5

XRF Concentration Data ($\mu g/cm^3$)

Stable element concentrations in leachate, determined by X-ray fluorescence. Concentrations are reported for Mo, Cs, and U as micrograms of element per cm^3 of solution. A zero denotes no analyzis was perfromed.

TABLE OF MOLYBDENUM CONCENTRATION (UG/CM3)

XRFA ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	70	120	151	213
2	COLD	MED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	COLD	MED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
6	COLD	FAST	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
9	COLD	MED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
11	COLD	FAST	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
[illegible]	COLD	FAST	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
26	COLD	MED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
30	COLD	FAST	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
35	HOT	MED	0.	3.00E-01	3.30E-01	2.80E-01	2.00E-01	9.00E-02	0.	2.30E-01	4.30E-01	5.50E-01	0.
37	HOT	FAST	2.70E-02	3.00E-02	3.20E-02	1.90E-02	1.60E-02	5.50E-02	1.00E-02	3.00E-02	0.	0.	3.90E-02
38	HOT	FAST	3.00E-02	2.80E-02	2.70E-02	1.60E-02	1.60E-02	0.	5.90E-02	0.	3.50E-02	0.	0.
40	HOT	MED	0.	0.	2.00E-01	1.60E-01	2.30E-01	2.00E-01	0.	2.40E-01	0.	2.70E-01	0.
41	HOT	MED	0.	0.	1.70E-01	1.00E-01	2.00E-01	1.90E-01	0.	2.00E-01	3.50E-01	3.30E-01	0.
44	HOT	FAST	3.60E-02	3.90E-02	4.10E-02	2.20E-02	1.70E-02	4.40E-02	1.10E-02	2.30E-02	4.70E-02	0.	4.00E-02
58	HOT	MED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
60	HOT	FAST	<5.00E-03	<5.00E-03	<5.00E-03	<5.00E-03	<5.00E-03	<5.00E-03	<5.00E-03	<5.00E-03	<5.00E-03	<5.00E-03	<5.00E-(
			1- 10				11- 20	21- 30	31- 50	51- 80	81-120	121-150	183-213
67	HOT	SLOW	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
71	HOT	SLOW	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

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BEADLEACH II

TABLE OF MOLYBDENUM CONCENTRATION (UG/CM3)

XRFA ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS		
			280	342	435
2	COLD	MED	0.	0.	0.
3	COLD	MED	0.	0.	0.
6	COLD	FAST	0.	0.	0.
9	COLD	MED	0.	0.	0.
11	COLD	FAST	0.	0.	0.
12	COLD	FAST	0.	0.	0.
26	COLD	MED	0.	0.	0.
30	COLD	FAST	0.	0.	0.
35	HOT	MED	6.30E-01	6.20E-01	6.00E-01
37	HOT	FAST	6.00E-02	3.90E-02	3.60E-02
38	HOT	FAST	3.00E-02	2.90E-02	3.90E-02
40	HOT	MED	1.50E-01	2.90E-01	2.60E-01
41	HOT	MED	2.60E-01	2.30E-01	2.90E-01
44	HOT	FAST	6.70E-02	4.40E-02	4.70E-02
56	HOT	MED	0.	0.	0.
60	HOT	FAST	<5.00E-03	<5.00E-03	<5.00E-03
			246-280	310-342	408-435
67	HOT	SLOW	0.	0.	0.
71	HOT	SLOW	0.	0.	0.

BEADLEACH II

TABLE OF CESIUM CONCENTRATION (UG/CM3)

XRFA ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	70	120	151	213
2	COLD	MED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	COLD	MED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
6	COLD	FAST	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
9	COLD	MED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0
11	COLD	FAST	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
12	COLD	FAST	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
26	COLD	MED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
30	COLD	FAST	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
35	HOT	MED	0.	1.30E-01	2.90E-01	1.90E-01	1.50E-01	6.00E-02	0.	1.50E-01	3.00E-01	4.20E-01	3.20E-01
37	HOT	FAST	1.90E-02	2.40E-02	2.20E-02	1.30E-02	1.00E-02	4.00E-03	7.00E-03	2.00E-02	2.40E-02	0.	2.50E-02
38	HOT	FAST	1.90E-02	1.80E-02	1.30E-02	1.50E-02	1.30E-02	0.	5.00E-03	0.	2.00E-02	0.	0.
40	HOT	MED	0.	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	1.10E-02	0.	4.50E-02	0.	6.40E-02	1.40E-02
41	HOT	MED	0.	0.	0.	0.	0.	0.	0.	2.60E-02	6.50E-02	0.	0.
44	HOT	FAST	3.00E-03	1.00E-02	1.60E-02	1.40E-02	1.10E-02	6.00E-03	7.00E-03	1.30E-02	3.10E-02	0.	2.70E-02
58	HOT	MED	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02	<1.00E-02
60	HOT	FAST	<2.00E-03	<2.00E-03	<2.00E-03	<2.00E-03	<2.00E-03	<2.00E-03	<2.00E-03	<2.00E-03	<2.00E-03	<2.00E-03	<2.00E-03
			1- 10				11- 20	21- 30	31- 50	51- 80	81-120	121-150	183-213
67	HOT	SLOW	0.	0.	0.	0.	0.	<5.00E-02	0.	1.00E-01	0.	1.30E-01	6.90E-01
71	HOT	SLOW	0.	0.	0.	0.	0.	0.	5.00E-02	8.00E-02	0.	1.60E-01	1.07E+00

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BEADLEACH II

TABLE OF CESIUM CONCENTRATION (UG/CM3)
XRFA ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS 280	342	435
2	COLD	MED	0.	0.	0.
3	COLD	MED	0.	0.	0.
6	COLD	FAST	0.	0.	0.
9	COLD	MED	0.	0.	0.
11	COLD	FAST	0.	0.	0.
12	COLD	FAST	0.	0.	0.
25	COLD	MED	0.	0.	0.
30	COLD	FAST	0.	0.	0.
35	HOT	MED	3.60E-01	4.10E-01	4.40E-01
37	HOT	FAST	2.60E-02	2.50E-02	2.50E-02
38	HOT	FAST	2.10E-02	2.10E-02	2.70E-02
40	HOT	MED	1.10E-02	3.90E-02	9.60E-02
41	HOT	MED	0.	5.10E-02	3.70E-02
44	HOT	FAST	3.10E-02	3.00E-02	3.00E-02
56	HOT	MED	<1.00E-02	<1.00E-02	<1.00E-02
60	HOT	FAST	<2.00E-03	<2.00E-03	<2.00E-03
			246-280	310-342	408-435
67	HOT	SLOW	9.00E-02	9.00E-02	1.00E-01
71	HOT	SLOW	1.40E-01	9.00E-02	8.00E-02

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BEADLEACH II

TABLE OF URANIUM CONCENTRATION (UG/CM3)

XRFA ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	70	120	151	213
2	COLD	MED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	COLD	MED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
6	COLD	FAST	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
9	COLD	MED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
11	COLD	FAST	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
12	COLD	FAST	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
26	COLD	MED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
30	COLD	FAST	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
35	HOT	MED	0.	1.80E-01	2.90E-01	2.80E-01	1.80E-01	1.30E-01	0.	2.60E-01	5.10E-01	7.30E-01	6.90E-01
37	HOT	FAST	5.00E-02	5.80E-02	5.10E-02	3.50E-02	2.80E-02	1.40E-02	1.90E-02	4.90E-02	6.50E-02	0.	6.10E-02
38	HOT	FAST	5.10E-02	5.10E-02	4.70E-02	3.30E-02	2.40E-02	0.	1.60E-02	0.	5.50E-02	0.	0.
40	HOT	MED	0.	1.00E-01	0.	1.20E-01	2.10E-01	2.50E-01	0.	3.80E-01	2.50E-01	2.40E-01	1.50E-01
41	HOT	MED	0.	2.40E-01	0.	1.80E-01	2.10E-01	2.20E-01	0.	3.50E-01	2.60E-01	3.10E-01	1.30E-01
44	HOT	FAST	4.70E-02	6.30E-02	6.20E-02	4.00E-02	2.90E-02	1.70E-02	1.60E-02	5.50E-02	6.80E-02	0.	6.10E-02
58	HOT	MED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
60	HOT	FAST	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
			1- 10				11- 20	21- 30	31- 50	51- 80	81-120	121-150	183-213
67	HOT	SLOW	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
71	HOT	SLOW	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

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BEADLEACH II

TABLE OF URANIUM CONCENTRATION (UG/CM3)
XRFA ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS		
			280	342	435
2	COLD	MED	0.	0.	0.
3	COLD	MED	0.	0.	0.
6	COLD	FAST	0.	0.	0.
9	COLD	MED	0.	0.	0.
11	COLD	FAST	0.	0.	0.
12	COLD	FAST	0.	0.	0.
26	COLD	MED	0.	0.	0.
30	COLD	FAST	0.	0.	0.
35	HOT	MED	6.20E-01	4.40E-01	3.20E-01
37	HOT	FAST	6.60E-02	5.80E-02	2.80E-02
38	HOT	FAST	5.70E-02	4.00E-02	3.60E-02
40	HOT	MED	1.50E-01	1.10E-01	7.80E-02
41	HOT	MED	1.40E-01	8.60E-02	5.60E-02
44	HOT	FAST	5.30E-02	3.80E-02	3.40E-02
58	HOT	MED	0.	0.	0.
60	HOT	FAST	0.	0.	0.
			246-280	310-342	408-435
67	HOT	SLOW	0.	0.	0.
71	HOT	SLOW	0.	0.	0.

APPENDIX 6

Incremental and Cumulative Leach Results for ^{237}Np and ^{239}Pu

Incremental leach rates (R, in grams glass leached per cm^2-day) and cumulative fractions leached (CFL) for Np and Pu. See text for equations and calculation method. A zero in the rate table signifies "not analyzed"; the CFL calculation method replaces this zero value with the average of the adjacent data points for the purposes of cumulation. The letter C in the ^{239}Pu Table indicates a radiochemical separation of plutonium.

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BEADLEACH II

NEPTUNIUM LEACH RATE (G/CM2.DAY)

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	70	120	151	213
2	COLD	MED	2.26E-06 1.7E+00	4.24E-06 1.6E+00	2.94E-06 1.5E+00	7.11E-07 3.1E+00	1.06E-06 2.4E+00	1.07E-06 2.9E+00	1.22E-07 6.8E+00	1.48E-08 1.2E+01	2.44E-08 9.0E+00	1.73E-08 1.1E+01	1.51E-08 1.2E+01
3	COLD	MED	2.74E-06 1.9E+00	3.90E-06 1.5E+00	4.15E-06 1.3E+00	1.13E-06 2.3E+00	4.37E-07 3.7E+00	1.24E-06 2.1E+00	2.67E-07 4.6E+00	1.70E-08 1.2E+01	2.73E-08 1.0E+01	4.66E-08 8.5E+00	5.80E-08 1.1E+01
6	COLD	FAST	3.58E-06 6.9E+00	2.37E-06 9.4E+00	1.97E-06 7.7E+00	1.42E-06 9.1E+00	1.76E-06 8.2E+00	5.98E-07 1.2E+01	0. 0.	1.48E-07 1.4E+01	6.72E-07 1.1E+01	1.29E-06 9.1E+00	1.10E-06 1.1E+01
9	COLD	MED	6.05E-07 3.4E+00	2.11E-06 1.6E+00	2.94E-06 1.6E+00	1.53E-06 2.0E+00	7.04E-07 2.9E+00	6.17E-07 3.2E+00	1.50E-07 6.3E+00	3.36E-08 1.0E+01	5.83E-08 8.4E+00	2.99E-08 1.0E+01	4.44E-08 1.1E+01
11	COLD	FAST	2.34E-06 7.8E+00	2.37E-06 7.6E+00	2.77E-06 6.8E+00	8.13E-07 1.0E+01	1.25E-06 9.4E+00	7.04E-07 1.0E+01	2.17E-07 1.6E+01	3.60E-07 1.2E+01	5.81E-07 1.1E+01	6.90E-07 1.0E+01	2.24E-07 1.5E+01
12	COLD	FAST	2.56E-06 7.9E+00	2.08E-06 8.0E+00	1.57E-06 8.9E+00	1.23E-06 9.4E+00	1.12E-06 9.5E+00	4.54E-07 1.2E+01	0. 0.	4.81E-07 1.2E+01	7.77E-07 1.1E+01	1.71E-06 8.3E+00	6.47E-07 1.2E+01
36	HOT	MED	4.20E-05 1.1E+00	1.82E-05 7.7E-01	1.65E-05 5.7E-01	1.70E-05 6.0E-01	1.17E-05 6.7E-01	6.17E-06 8.1E-01	8.17E-06 8.5E-01	5.24E-06 1.0E+00	1.39E-05 7.3E-01	1.42E-05 6.3E-01	9.68E-06 8.3E-01
37	HOT	FAST	5.66E-05 1.8E+00	4.97E-05 1.9E+00	4.30E-05 2.2E+00	3.62E-05 2.2E+00	1.45E-05 2.3E+00	1.55E-05 3.2E+00	1.90E-05 2.8E+00	2.19E-05 1.4E+00	5.03E-05 1.8E+00	2.16E-05 2.8E+00	5.24E-05 1.9E+00
38	HOT	FAST	5.00E-05 1.6E+00	4.56E-05 1.9E+00	3.64E-05 2.0E+00	3.51E-05 2.1E+00	2.91E-05 2.3E+00	1.74E-05 3.1E+00	1.36E-05 3.0E+00	2.60E-05 2.9E+00	4.72E-05 1.9E+00	2.91E-05 2.8E+00	5.57E-05 1.9E+00
40	HOT	MED	1.54E-05 6.3E-01	7.09E-06 1.1E+00	3.62E-06 1.5E+00	4.31E-06 1.1E+00	3.62E-06 1.2E+00	5.62E-06 1.0E+00	1.27E-06 2.1E+00	5.75E-06 9.7E-01	0. 0.	3.27E-06 1.4E+00	8.15E-07 2.9E+00
41	HOT	MED	0. 0.	6.06E-06 1.0E+00	3.82E-06 1.2E+00	4.56E-06 1.1E+00	3.89E-06 1.2E+00	6.41E-06 1.0E+00	5.74E-07 3.4E+00	2.96E-07 4.4E+00	3.83E-06 1.3E+00	7.85E-06 9.3E-01	1.95E-06 1.6E+00
44	HOT	FAST	3.48E-05 2.1E+00	4.87E-05 1.8E+00	4.21E-05 3.4E+00	3.82E-05 3.8E+00	3.46E-05 3.9E+00	1.21E-05 6.6E+00	1.69E-05 3.2E+00	3.19E-05 2.2E+00	5.91E-05 1.7E+00	2.80E-05 2.5E+00	5.37E-05 1.6E+00
			1- 10				11- 20	21- 30	31- 50	51- 80	81-120	121-150	183-213
67	HOT	SLOW	1.43E-08 6.9E-01	0. 0.	0. 0.	0. 0.	0. 0.	1.16E-06 8.6E-01	3.91E-07 5.5E-01	6.78E-07 8.9E-01	3.31E-07 1.1E+00	1.08E-06 7.4E-01	3.64E-06 4.8E-01
71	HOT	SLOW	7.75E-07 6.4E-01	0. 0.	0. 0.	0. 0.	0. 0.	1.90E-06 5.8E-01	1.14E-06 6.6E-01	1.30E-07 2.4E+00	5.64E-08 7.0E-01	8.17E-07 5.9E-01	1.54E-06 5.1E-01

BEADLEACH II

NEPTUNIUM LEACH RATE (G/CM2.DAY)

CHAN	TEMP	FLOW	SAMPLING DAYS 280	342	435
2	COLD	MED	0. 0.	7.48E-08 1.0E+01	1.15E-07 5.6E+00
3	COLD	MED	0. 0.	2.01E-07 7.0E+00	2.80E-07 4.6E+00
6	COLD	FAST	0. 0.	1.21E-06 1.2E+01	5.29E-07 1.2E+01
9	COLD	MED	0. 0.	1.69E-07 5.2E+00	2.59E-07 4.5E+00
11	COLD	FAST	0. 0.	1.09E-06 8.1E+00	2.60E-06 C 2.1E+00
12	COLD	FAST	0. 0.	1.48E-06 9.8E+00	2.32E-06 C 2.2E+00
35	HOT	MED	0. 0.	2.56E-06 1.5E+00	2.16E-06 1.6E+00
37	HOT	FAST	0. 0.	5.13E-05 2.7E+00	4.43E-05 1.8E+00
38	HOT	FAST	0. 0.	4.33E-05 2.0E+00	5.61E-05 1.7E+00
40	HOT	MED	0. 0.	4.98E-07 2.9E+00	4.00E-06 C 3.3E-01
41	HOT	MED	0. 0.	2.00E-06 1.7E+00	1.18E-06 C 8.2E-01
44	HOT	FAST	0. 0.	4.24E-05 2.1E+00	4.85E-05 1.9E+00
			246-280	310-342	408-435
67	HOT	SLOW	0. 0.	1.64E-06 5.9E-01	1.61E-06 5.3E-01
71	HOT	SLOW	0. 0.	8.97E-07 6.8E-01	5.57E-07 1.0E+00

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BEADLEACH II

PLUTONIUM LEACH RATE (G/CM2.DAY)

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	70	120	151	213
2	COLD	MED	3.17E-07 1.5E+00	4.56E-07 1.5E+00	1.04E-07 2.8E+00	2.49E-08 5.6E+00	3.77E-08 4.3E+00	2.91E-08 5.8E+00	9.73E-09 8.5E+00	4.03E-10 2.3E+01	1.87E-09 1.2E+01	1.87E-09 1.5E+01	1.63E-09 1.5E+01
3	COLD	MED	4.74E-07 1.6E+00	2.90E-07 1.9E+00	2.43E-07 1.8E+00	2.99E-08 4.8E+00	1.84E-08 6.2E+00	2.23E-08 5.4E+00	6.46E-09 9.7E+00	1.13E-09 1.8E+01	2.68E-09 1.3E+01	3.46E-09 1.1E+01	6.03E-10 2.8E+01
6	COLD	FAST	3.11E-07 8.3E+00	1.65E-07 1.3E+01	1.97E-07 8.9E+00	1.06E-07 1.2E+01	9.50E-08 1.3E+01	4.66E-08 1.7E+01	5.17E-08 1.5E+01	4.66E-08 1.7E+01	3.03E-08 1.9E+01	9.60E-08 1.2E+01	5.51E-08 1.7E+01
9	COLD	MED	1.02E-08 C 1.5E+00	5.68E-09 C 2.4E+00	3.76E-09 C 5.2E+00	9.58E-10 C 9.8E+00	2.16E-10 C 1.3E+01	3.03E-10 C 8.9E+00	0. 3.5E+01	0. 2.8E+01	1.32E-09 1.7E+01	0. 3.0E+01	0. 5.0E+01
11	COLD	FAST	2.33E-07 9.0E+00	1.55E-07 1.1E+01	1.60E-07 9.9E+00	8.72E-08 1.2E+01	3.91E-08 1.7E+01	6.18E-08 1.4E+01	3.52E-09 3.0E+01	0. 2.8E+01	1.80E-08 2.0E+01	3.40E-08 1.8E+01	8.34E-09 2.6E+01
12	COLD	FAST	1.38E-07 1.2E+01	1.55E-07 1.1E+01	1.70E-07 1.0E+01	9.13E-08 1.3E+01	4.26E-08 1.7E+01	6.95E-08 1.5E+01	0. 3.5E+01	9.46E-09 2.4E+01	8.26E-12 2.8E+01	5.32E-08 1.6E+01	1.02E-08 2.6E+01
35	HOT	MED	7.30E-07 C 6.7E-01	1.04E-08 C 3.0E+00	4.10E-09 C 8.3E+00	8.61E-09 C 1.7E+00	2.19E-09 C 3.6E+00	8.60E-10 C 6.2E+00	2.70E-10 2.4E+01	1.26E-10 2.6E+01	1.99E-09 1.7E+01	2.51E-09 1.4E+01	2.31E-10 2.7E+01
37	HOT	FAST	6.07E-07 5.6E+00	5.78E-08 1.6E+01	3.97E-08 1.9E+01	2.94E-08 2.0E+01	2.63E-08 2.0E+01	4.05E-08 1.7E+01	1.21E-08 2.2E+01	2.09E-08 1.4E+01	1.22E-07 1.1E+01	8.55E-08 1.3E+01	2.11E-07 9.9E+00
38	HOT	FAST	7.09E-07 4.6E+00	4.41E-08 1.7E+01	1.69E-08 2.1E+01	6.78E-09 2.4E+01	3.11E-08 1.8E+01	3.15E-08 1.9E+01	1.40E-08 2.2E+01	5.61E-08 1.8E+01	9.95E-08 1.3E+01	1.19E-07 1.3E+01	2.33E-07 9.4E+00
40	HOT	MED	1.53E-09 C 2.7E+00	3.47E-09 C 4.7E+00	1.58E-08 C 1.5E+00	7.50E-09 C 4.8E+00	8.15E-10 C 6.2E+00	5.52E-10 C 6.6E+00	0. 3.3E+01	0. 4.1E+01	0. 0.	0. 3.3E+01	4.42E-09 1.2E+01
41	HOT	MED	0. 0.	1.24E-09 1.8E+01	2.25E-10 2.5E+01	4.64E-10 2.2E+01	2.04E-10 2.5E+01	4.65E-10 2.3E+01	0. 3.0E+01	3.21E-10 2.5E+01	0. 3.3E+01	0. 4.1E+01	1.74E-09 1.5E+01
44	HOT	FAST	5.72E-08 C 2.9E+00	1.90E-09 C 1.4E+01	2.59E-09 C 1.3E+01	1.50E-09 C 1.8E+01	6.29E-10 C 1.9E+01	2.43E-09 C 1.2E+01	0. 3.5E+01	1.46E-08 2.2E+01	4.12E-08 1.8E+01	0. 3.5E+01	1.76E-09 2.5E+01
			1- 10				11- 20	21- 30	31- 50	51- 80	81-120	121-150	183-213
67	HOT	SLOW	1.00E-10 C 7.8E+00	0. 0.	0. [illegible]	0. 0.	0. 0.	1.67E-11 3.0E+01	0. 3.0E+01	0. 1.0E+02	5.81E-13 2.6E+01	0. 3.2E+01	9.85E-11 2.2E+01
71	HOT	SLOW	1.55E-10 C 7.7E+00	0. 0.	0. 0.	0. 0.	0. 0.	1.07E-10 2.0E+01	0. 2.9E+01	0. 1.0E+02	0. 2.8E+01	0. 4.1E+01	3.28E-11 2.4E+01

BEADLEACH II

PLUTONIUM LEACH RATE (G/CM2.DAY)

CHAN	TEMP	FLOW	SAMPLING DAYS 280	342	435
2	COLD	MED	0. 0.	5.00E-09 1.4E+01	1.39E-09 1.5E+01
3	COLD	MED	0. 0.	4.15E-09 1.6E+01	4.13E-09 1.2E+01
6	COLD	FAST	0. 0.	2.73E-08 2.5E+01	1.66E-09 2.7E+01
9	COLD	MED	0. 0.	1.18E-10 C 1.3E+01	2.46E-10 C 7.0E+00
11	COLD	FAST	0. 0.	4.47E-08 1.6E+01	5.42E-09 C 5.5E+00
12	COLD	FAST	0. 0.	4.71E-09 2.8E+01	8.88E-09 C 4.3E+00
35	HOT	MED	0. 0.	3.07E-10 C 8.3E+00	3.04E-10 C 9.2E+00
37	HOT	FAST	0. 0.	2.93E-07 1.2E+01	1.67E-07 9.4E+00
38	HOT	FAST	0. 0.	2.53E-07 8.4E+00	3.03E-07 7.6E+00
40	HOT	MED	0. 0.	1.16E-08 C 9.2E-01	2.90E-09 C 1.4E+00
41	HOT	MED	0. 0.	6.46E-11 2.7E+01	3.11E-09 C 1.3E+00
44	HOT	FAST	0. 0.	1.18E-08 C 5.3E+00	6.32E-10 C 1.9E+01
			246-280	310-342	408-435
67	HOT	SLOW	0. 0.	3.40E-10 C 2.8E+00	1.10E-10 C 3.3E+00
71	HOT	SLOW	0. 0.	3.39E-10 C 2.0E+00	4.89E-10 C 2.8E+00

BEADLEACH II

NEPTUNIUM CUMULATED FRACTIONAL LEACH(CFL)

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	70	120	151	213
2	COLD	MED	6.96E-06	2.63E-05	3.76E-05	5.55E-05	7.35E-05	1.12E-04	1.51E-04	1.60E-04	1.64E-04	1.66E-04	1.70E-04
3	COLD	MED	1.02E-05	2.65E-05	4.23E-05	6.85E-05	8.20E-05	1.13E-04	1.62E-04	1.80E-04	1.85E-04	1.89E-04	2.02E-04
6	COLD	FAST	1.40E-05	2.37E-05	3.12E-05	5.11E-05	8.20E-05	1.21E-04	0.	1.94E-04	2.83E-04	4.06E-04	7.02E-04
9	COLD	MED	2.45E-06	1.13E-05	2.27E-05	4.85E-05	6.87E-05	9.26E-05	1.18E-04	1.31E-04	1.41E-04	1.46E-04	1.56E-04
11	COLD	FAST	8.91E-06	1.82E-05	2.86E-05	4.62E-05	6.64E-05	9.93E-05	1.29E-04	1.66E-04	2.64E-04	3.54E-04	4.87E-04
12	COLD	FAST	1.02E-05	1.86E-05	2.46E-05	4.16E-05	6.39E-05	9.07E-05	0.	1.84E-04	3.18E-04	4.78E-04	7.87E-04
35	HOT	MED	1.41E-04	2.27E-04	2.92E-04	4.97E-04	7.64E-04	1.11E-03	1.66E-03	2.55E-03	4.57E-03	6.29E-03	9.24E-03
37	HOT	FAST	2.15E-04	4.26E-04	5.93E-04	1.05E-03	1.73E-03	2.57E-03	3.72E-03	6.40E-03	1.40E-02	1.82E-02	2.76E-02
38	HOT	FAST	1.93E-04	3.89E-04	5.32E-04	9.64E-04	1.58E-03	2.38E-03	3.60E-03	6.57E-03	1.44E-02	1.90E-02	2.98E-02
40	HOT	MED	5.87E-05	8.90E-05	1.03E-04	1.52E-04	2.28E-04	3.99E-04	6.29E-04	1.12E-03	0.	2.58E-03	3.08E-03
41	HOT	MED	0.	2.61E-05	4.10E-05	9.35E-05	1.75E-04	3.63E-04	5.88E-04	6.46E-04	1.09E-03	1.84E-03	3.03E-03
44	HOT	FAST	1.30E-04	3.35E-04	4.98E-04	9.68E-04	1.66E-03	2.42E-03	3.39E-03	6.58E-03	1.61E-02	2.12E-02	3.13E-02
			1- 10				11- 20	21- 30	31- 50	51- 80	81-120	121-150	183-213
67	HOT	SLOW	5.46E-05				0.	1.49E-04	1.79E-04	2.60E-04	3.09E-04	4.39E-04	1.16E-03
71	HOT	SLOW	3.00E-05				0.	1.57E-04	2.45E-04	2.61E-04	2.69E-04	3.69E-04	7.00E-04

BEADLEACH II

NEPTUNIUM CUMULATED FRACTIONAL LEACH(CFL)

CHAN	TEMP	FLOW	SAMPLING DAYS		
			280	342	435
2	COLD	MED	0.	1.97E-04	2.37E-04
3	COLD	MED	0.	2.75E-04	3.75E-04
6	COLD	FAST	0.	1.29E-03	1.62E-03
9	COLD	MED	0.	2.18E-04	3.12E-04
11	COLD	FAST	0.	8.19E-04	1.54E-03
12	COLD	FAST	0.	1.32E-03	2.07E-03
35	HOT	MED	0.	1.18E-02	1.27E-02
37	HOT	FAST	0.	5.35E-02	7.21E-02
38	HOT	FAST	0.	5.49E-02	7.46E-02
40	HOT	MED	0.	3.39E-03	4.49E-03
41	HOT	MED	0.	4.02E-03	4.59E-03
44	HOT	FAST	0.	5.52E-02	7.28E-02
			246-280	310-342	408-435
67	HOT	SLOW	0.	2.33E-03	2.96E-03
71	HOT	SLOW	0.	1.27E-03	1.53E-03

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BEADLEACH II

PLUTONIUM CUMULATED FRACTIONAL LEACH(CFL)

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	5	11	20	37	70	120	151	213
2	COLD	MED	1.26E-06	3.12E-06	3.52E-06	4.15E-06	4.78E-06	5.97E-06	7.26E-06	7.91E-06	8.16E-06	8.39E-06	8.83E-06
3	COLD	MED	1.86E-06	3.04E-06	3.96E-06	5.17E-06	5.61E-06	6.34E-06	7.27E-06	7.76E-06	8.16E-06	8.54E-06	9.03E-06
6	COLD	FAST	1.22E-06	1.89E-06	2.64E-06	4.33E-06	6.22E-06	8.63E-06	1.19E-05	1.84E-05	2.63E-05	3.44E-05	5.29E-05
9	COLD	MED	4.15E-08	6.53E-08	7.99E-08	1.04E-07	1.14E-07	1.23E-07	0.	0.	4.71E-07	0.	0.
11	COLD	FAST	8.87E-07	1.50E-06	2.10E-06	3.45E-06	4.54E-06	6.35E-06	8.40E-06	0.	1.21E-05	1.53E-05	2.03E-05
12	COLD	FAST	5.49E-07	1.18E-06	1.83E-06	3.30E-06	4.43E-06	6.55E-06	0.	1.43E-05	1.53E-05	1.89E-05	2.66E-05
35	HOT	MED	2.45E-06	2.50E-06	2.52E-06	2.60E-06	2.67E-06	2.73E-06	2.76E-06	2.79E-06	3.02E-06	3.30E-06	3.62E-06
37	HOT	FAST	2.31E-06	2.56E-06	2.71E-06	3.10E-06	3.63E-06	4.84E-06	6.69E-06	8.70E-06	2.41E-05	5.05E-05	7.40E-05
38	HOT	FAST	2.74E-06	2.93E-06	2.99E-06	3.12E-06	3.54E-06	4.65E-06	8.15E-06	1.09E-05	2.75E-05	4.11E-05	8.59E-05
40	HOT	MED	5.84E-08	7.33E-08	1.37E-07	2.60E-07	3.27E-07	3.51E-07	0.	0.	0.	0.	2.31E-06
41	HOT	MED	0.	5.32E-09	6.20E-09	1.09E-08	1.69E-08	2.93E-08	0.	1.09E-07	0.	0.	7.15E-07
44	HOT	FAST	2.14E-07	2.22E-07	2.32E-07	2.55E-07	2.73E-07	3.31E-07	0.	2.02E-06	7.91E-06	0.	1.56E-05
			1- 10				11- 20	21- 30	31- 50	51- 80	81-120	121-150	183-213
67	HOT	SLOW	3.82E-09				0.	6.70E-09	0.	0.	8.49E-09	0.	3.21E-08
71	HOT	SLOW	6.00E-09				0.	1.53E-08	0.	0.	0.	0.	6.10E-08

BEADLEACH II

PLUTONIUM CUMULATED FRACTIONAL LEACH(CFL)

CHAN TEMP FLOW	SAMPLING DAYS		
	280	342	435
2 COLD MED	0.	1.07E-05	1.18E-05
3 COLD MED	0.	1.04E-05	1.20E-05
6 COLD FAST	0.	7.35E-05	7.90E-05
9 COLD MED	0.	1.03E-06	1.12E-06
11 COLD FAST	0.	3.37E-05	4.31E-05
12 COLD FAST	0.	3.04E-05	3.31E-05
35 HOT MED	0.	3.76E-06	3.88E-06
37 HOT FAST	0.	2.01E-04	2.90E-04
38 HOT FAST	0.	2.10E-04	3.20E-04
40 HOT MED	0.	6.73E-06	9.01E-06
41 HOT MED	0.	1.05E-06	1.88E-06
44 HOT FAST	0.	1.90E-05	2.14E-05
	246-280	310-342	408-435
67 HOT SLOW	0.	1.55E-07	2.27E-07
71 HOT SLOW	0.	1.73E-07	3.47E-07

APPENDIX 7

a. Incremental and Cumulative Leach Rates for Stable Elements (ICP)

Incremental leach rates (R, in grams glass leached per cm^2-day) and cumulative fractions leached (CFL) for stable elements determined by ICP. See text for equations and calculation method. A zero in the rate table signifies "not analyzed", and the CFL calculation replaces it with the average of the adjacent R values. A "less than" rate value is derived from the detection limit for those samples where the net concentration (Appendix 4) was below detection limits. In the CFL calculation, the detection limit value is used when present and all CFL values incorporating any "less than" rate data are identified as "less than". Results are reported for B, Mo, U, Si, Ca, and Sr. For the last three elements, we report results only from the "no rock" channels (channels 2, 3, 6, 35 37, and 38). Refer to the text for explanations about not reporting data from the "rock" channels.

b. Mean Incremental and Cumulative Leach Rates for Stable Elements (XRFA)

Results are reported only for Mo, Cs, and U from the high temperature channels. A zero value denotes that no analysis was performed and the CFL calculation replaces it with the average of the adjacent R values.

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BEADLEACH II

BORON LEACH RATE (G/CM2.DAY)

ICP ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	70	120	151	213
2	COLD	MED	1.38E-06	4.25E-06	2.85E-06	0.	8.02E-07	6.94E-07	<3.09E-07	<3.27E-07	<2.10E-07	<2.95E-07	<2.91E-07
3	COLD	MED	2.62E-06	2.79E-06	3.22E-06	0.	<2.86E-07	0.	<2.97E-07	<2.92E-07	<3.80E-07	<2.57E-07	<3.28E-07
6	COLD	FAST	<9.23E-06	<9.38E-06	<9.16E-06	0.	<9.13E-06	0.	<9.35E-06	<9.53E-06	<9.29E-06	<8.82E-06	<9.58E-06
9	COLD	MED	1.33E-06	3.42E-06	4.50E-06	0.	<3.37E-07	<3.44E-07	<3.39E-07	<3.32E-07	<3.02E-07	<3.11E-07	<2.93E-07
11	COLD	FAST	<9.25E-06	<9.43E-06	<9.20E-06	0.	<9.07E-06	0.	<9.15E-06	<8.29E-06	<7.25E-06	<8.94E-06	<8.95E-06
12	COLD	FAST	<9.45E-06	<9.58E-06	<9.59E-06	0.	<9.60E-06	0.	<9.68E-06	<9.05E-06	<9.94E-06	<9.88E-06	<9.86E-06
35	HOT	MED	7.35E-05	3.54E-05	2.63E-05	0.	1.88E-05	7.96E-06	1.11E-05	1.51E-05	3.85E-05	3.90E-05	3.46E-05
37	HOT	FAST	8.39E-05	6.73E-05	6.59E-05	0.	2.67E-05	0.	1.56E-05	3.15E-05	7.73E-05	9.58E-05	7.48E-05
38	HOT	FAST	7.07E-05	6.36E-05	5.70E-05	0.	2.89E-05	0.	1.47E-05	3.03E-05	7.04E-05	9.50E-05	6.87E-05
40	HOT	MED	3.20E-05	0.	9.81E-06	0.	1.17E-05	1.80E-05	1.36E-05	1.44E-05	9.44E-06	1.75E-05	1.26E-05
41	HOT	MED	0.	1.65E-05	9.16E-06	0.	1.23E-05	0.	1.08E-05	1.57E-05	2.34E-05	2.19E-05	1.52E-05
44	HOT	FAST	7.85E-05	7.99E-05	7.80E-05	0.	3.16E-05	0.	1.66E-05	3.72E-05	9.63E-05	1.02E-04	8.02E-05
			1- 10				11- 20	21- 30	31 - 50	51- 80	81-120	121-150	183-213
67	HOT	SLOW	6.59E-06	0.	0.	0.	0.	2.34E-05	4.63E-06	1.13E-05	1.96E-05	1.68E-05	1.67E-05
71	HOT	SLOW	3.55E-06	0.	0.	0.	0.	1.62E-05	1.38E-05	1.06E-05	2.60E-06	1.76E-05	8.23E-05

BEADLEACH II

BORON LEACH RATE (G/CM2.DAY)

ICP ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS 280	342	435
2	COLD	MED	0.	<2.99E-07	<2.48E-07
3	COLD	MED	0.	<3.43E-07	<3.37E-07
6	COLD	FAST	0.	<9.06E-06	<8.55E-06
9	COLD	MED	0.	<3.07E-07	<3.03E-07
11	COLD	FAST	0.	<9.99E-06	<6.82E-06
12	COLD	FAST	0.	<9.76E-06	<6 89E-06
35	HOT	MED	0.	4.11E-05	4.20E-05
37	HOT	FAST	0.	7.40E-05	6.74E-05
38	HOT	FAST	0.	6.47E-05	7.03E-05
40	HOT	MED	0.	1.50E-05	1.81E-05
41	HOT	MED	0.	1.61E-05	1.94E-05
44	HOT	FAST	0.	9.09E-05	8.37E-05
			246-280	310-342	408-435
67	HOT	SLOW	1.71E-05	1.75E-05	1.66E-05
71	HOT	SLOW	1.42E-05	2.01E-05	1.90E-05

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BEADLEACH II

BORON CUMULATED FRACTIONAL LEACH(CFL)

ICP ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	70	120	151	213
2	COLD	MED	5.49E-06	2.29E-05	3.38E-05	0.	8.83E-05	1.15E-04	<1.49E-04	<1.92E-04	<2.47E-04	<2.79E-04	<3.53E-04
3	COLD	MED	1.11E-05	2.24E-05	3.46E-05	0.	<8.40E-05	0.	<1.14E-04	<1.53E-04	<2.23E-04	<2.61E-04	<3.34E-04
6	COLD	FAST	<3.62E-05	<7.44E-05	<1.09E-04	0.	<3.98E-04	0.	<1.35E-03	<2.58E-03	<4.54E-03	<5.65E-03	<7.93E-03
9	COLD	MED	5.40E-06	1.97E-05	3.72E-05	0.	<1.08E-04	<1.20E-04	<1.44E-04	<1.90E-04	<2.57E-04	<2.96E-04	<3.74E-04
11	COLD	FAST	<3.53E-05	<7.23E-05	<1.07E-04	0.	<3.91E-04	<0.	<1.31E-03	<2.43E-03	<4.02E-03	<5.00E-03	<7.19E-03
12	COLD	FAST	<3.76E-05	<7.65E-05	<1.13E-04	0.	<4.20E-04	<0.	<1.42E-03	<2.66E-03	<4.66E-03	<5.89E-03	<8.37E-03
35	HOT	MED	2.47E-04	4.14E-04	5.18E-04	0.	1.21E-03	1.67E-03	2.31E-03	4.10E-03	9.74E-03	1.45E-02	2.36E-02
37	HOT	FAST	3.19E-04	6.05E-04	8.60E-04	0.	2.23E-03	0.	4.36E-03	7.46E-03	1.90E-02	2.97E-02	5.07E-02
38	HOT	FAST	2.73E-04	5.46E-04	7.70E-04	0.	2.08E-03	0.	4.30E-03	7.32E-03	1.81E-02	2.85E-02	4.89E-02
40	HOT	MED	1.22E-04	0.	2.51E-04	0.	5.92E-04	1.13E-03	2.18E-03	4.07E-03	6.49E-03	8.19E-03	1.19E-02
41	HOT	MED	0.	7.12E-05	1.07E-04	0.	4.54E-04	0.	1.65E-03	3.47E-03	7.56E-03	1.03E-02	1.50E-02
44	HOT	FAST	2.94E-04	6.31E-04	9.33E-04	0.	2.54E-03	0.	4.95E-03	8.48E-03	2.25E-02	3.45E-02	5.67E-02
			1- 10				11- 20	21- 30	31- 50	51- 80	81-120	121-150	183-213
67	HOT	SLOW	2.51E-04	0.	0.	0.	0.	1.74E-03	2.09E-03	3.44E-03	6.36E-03	8.37E-03	1.24E-02
71	HOT	SLOW	1.37E-04	0.	0.	0.	0.	1.16E-03	2.22E-03	3.52E-03	3.91E-03	6.05E-03	8.65E-03

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BEADLEACH II

BORON CUMULATED FRACTIONAL LEACH(CFL)

ICP ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS		
			280	342	435
2	COLD	MED	4.28E-04	<5.02E-04	<6.08E-04
3	COLD	MED	4.17E-04	<5.00E-04	<6.33E-04
6	COLD	FAST	1.03E-02	<1.26E-02	<1.61E-02
9	COLD	MED	4.50E-04	<5.27E-04	<6.52E-04
11	COLD	FAST	9.54E-03	<1.19E-02	<1.55E-02
12	COLD	FAST	1.09E-02	<1.34E-02	<1.71E-02
35	HOT	MED	3.32E-02	4.27E-02	5.91E-02
37	HOT	FAST	6.93E-02	8.80E-02	1.15E-01
38	HOT	FAST	6.58E-02	8.28E-02	1.09E-01
40	HOT	MED	1.54E-02	1.89E-02	2.56E-02
41	HOT	MED	1.87E-02	2.25E-02	2.96E-02
44	HOT	FAST	7.80E-02	9.94E-02	1.33E-01
			246-280	310-342	408-435
67	HOT	SLOW	1.67E-02	2.09E-02	2.74E-02
71	HOT	SLOW	1.19E-02	1.64E-02	2.41E-02

BEADLEACH II

MOLYBDENUM LEACH RATE (G/CM2.DAY)

ICP ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	70	120	151	213
2	COLD	MED	3.68E-06	1.90E-06	1.78E-06	0.	<3.10E-07	7.40E-07	<2.99E-07	<3.16E-07	<2.04E-07	3.43E-07	<2.82E-07
3	COLD	MED	6.88E-06	1.47E-06	2.37E-06	0.	6.09E-07	0.	<2.87E-07	<2.83E-07	<3.67E-07	<2.49E-07	<3.18E-07
6	COLD	FAST	<8.94E-06	<9.09E-06	<8.87E-06	0.	<8.84E-06	0.	<9.06E-06	<9.22E-06	<9.00E-06	1.37E-05	<9.28E-06
9	COLD	MED	2.58E-06	3.54E-06	3.99E-06	0.	7.18E-07	<3.33E-07	<3.28E-07	3.86E-07	<2.93E-07	3.61E-07	<2.83E-07
11	COLD	FAST	<8.95E-06	<9.13E-06	<8.90E-06	0.	<8.78E-06	0.	<8.85E-06	<8.03E-06	<7.02E-06	<8.65E-06	<8.67E-06
12	COLD	FAST	1.10E-05	1.30E-05	<9.28E-06	0.	<9.30E-06	0.	<9.38E-06	<8.76E-06	<9.62E-06	<9.56E-06	<9.55E-06
35	HOT	MED	7.62E-05	3.25E-05	2.31E-05	0.	1.69E-05	7.55E-06	9.54E-06	1.36E-05	3.41E-05	3.48E-05	3.34E-05
37	HOT	FAST	9.21E-05	7.03E-05	6.83E-05	0.	3.39E-05	0.	2.13E-05	3.24E-05	<8.86E-06	9.99E-05	7.85E-05
38	HOT	FAST	7.45E-05	6.93E-05	6.15E-05	0.	4.88E-05	0.	1.78E-05	4.49E-05	6.81E-05	9.91E-05	7.80E-05
40	HOT	MED	2.99E-05	0.	9.23E-06	0.	1.09E-05	1.71E-05	1.20E-05	1.28E-05	8.32E-06	1.59E-05	1.21E-05
41	HOT	MED	0.	1.56E-05	8.47E-06	0.	1.11E-05	0.	1.01E-05	1.42E-05	2.10E-05	2.01E-05	1.47E-05
44	HOT	FAST	8.07E-05	8.30E-05	6.27E-05	0.	3.78E-05	0.	1.25E-05	4.60E-05	8.80E-05	1.06E-04	6.39E-05
			1- 10				11- 20	21- 30	31- 50	51- 80	81-120	121-150	183-213
67	HOT	SLOW	5.65E-06	0.	0.	0.	0.	2.02E-05	4.10E-06	9.87E-06	1.73E-05	1.52E-05	1.59E-05
71	HOT	SLOW	3.02E-06	0.	0.	0.	0.	1.40E-05	1.19E-05	9.26E-06	2.28E-06	1.58E-05	7.87E-05

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BEADLEACH II

MOLYBDENUM LEACH RATE (G/CM2.DAY)

ICP ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS		
			280	342	435
2	COLD	MED	0.	<2.90E-07	4.32E-07
3	COLD	MED	0.	3.99E-07	6.52E-07
6	COLD	FAST	0.	<8.78E-06	<8.28E-06
9	COLD	MED	0.	3.56E-07	5.87E-07
11	COLD	FAST	0.	<9.67E-06	<8.54E-06
12	COLD	FAST	0.	<9.45E-06	<8.60E-06
35	HOT	MED	0.	3.87E-05	3.97E-05
37	HOT	FAST	0.	7.79E-05	7.39E-05
38	HOT	FAST	0.	6.53E-05	7.68E-05
40	HOT	MED	0.	1.44E-05	1.70E-05
41	HOT	MED	0.	1.46E-05	1.62E-05
44	HOT	FAST	0.	9.36E-05	9.16E-05
			248-280	310-342	408-435
67	HOT	SLOW	1.59E-05	1.59E-05	1.45E-05
71	HOT	SLOW	1.32E-05	1.65E-05	1.65E-05

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BEADLEACH II

MOLYBDENUM CUMULATED FRACTIONAL LEACH(CFL)

ICP ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	70	120	151	213
2	COLD	MED	1.46E-05	2.23E-05	2.92E-05	0.	<5.97E-05	<7.96E-05	<1.14E-04	<1.56E-04	<2.10E-04	<2.45E-04	<3.23E-04
3	COLD	MED	2.71E-05	3.30E-05	4.20E-05	0.	8.54E-05	0.	<1.31E-04	<1.69E-04	<2.36E-04	<2.73E-04	<3.44E-04
6	COLD	FAST	<3.51E-05	<7.20E-05	<1.06E-04	0.	<3.86E-04	0.	<1.30E-03	<2.50E-03	<4.40E-03	<5.81E-03	<8.63E-03
9	COLD	MED	1.05E-05	2.53E-05	4.08E-05	0.	1.11E-04	<1.29E-04	<1.52E-04	<2.02E-04	<2.73E-04	<3.15E-04	<3.98E-04
11	COLD	FAST	<3.42E-05	<7.00E-05	<1.04E-04	0.	<3.78E-04	<0.	<1.27E-03	<2.36E-03	<3.89E-03	<4.84E-03	<6.96E-03
12	COLD	FAST	4.37E-05	9.65E-05	<1.32E-04	0.	<4.29E-04	<0.	<1.40E-03	<2.60E-03	<4.54E-03	<5.72E-03	<8.12E-03
35	HOT	MED	2.56E-04	4.09E-04	5.00E-04	0.	1.12E-03	1.53E-03	2.11E-03	3.69E-03	8.70E-03	1.29E-02	2.14E-02
37	HOT	FAST	3.51E-04	6.49E-04	9.13E-04	0.	2.44E-03	0.	5.22E-03	8.75E-03	<1.29E-02	<2.00E-02	<4.20E-02
38	HOT	FAST	2.87E-04	5.85E-04	8.27E-04	0.	2.55E-03	0.	5.93E-03	1.01E-02	2.22E-02	3.26E-02	5.47E-02
40	HOT	MED	1.14E-04	0.	2.35E-04	0.	5.54E-04	1.06E-03	2.03E-03	3.70E-03	5.83E-03	7.36E-03	1.08E-02
41	HOT	MED	0.	6.70E-05	1.00E-04	0.	4.16E-04	0.	1.51E-03	3.17E-03	6.85E-03	9.37E-03	1.37E-02
44	HOT	FAST	3.02E-04	6.52E-04	9.73E-04	0.	2.75E-03	0.	5.25E-03	9.25E-03	2.34E-02	3.53E-02	5.85E-02
			1- 10				11- 20	21- 30	31- 50	51- 80	81-120	121-150	183-213
67	HOT	SLOW	2.15E-04	0.	0.	0.	0.	1.50E-03	1.81E-03	2.99E-03	5.57E-03	7.38E-03	1.12E-02
71	HOT	SLOW	1.17E-04	0.	0.	0.	0.	1.00E-03	1.92E-03	3.05E-03	3.39E-03	5.32E-03	7.74E-03

BEADLEACH II

MOLYBDENUM CUMULATED FRACTIONAL LEACH(CFL)

ICP ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS 280	342	435
2	COLD	MED	3.95E-04	<4.67E-04	<6.20E-04
3	COLD	MED	4.34E-04	<5.25E-04	<7.47E-04
6	COLD	FAST	1.09E-02	<1.32E-02	<1.65E-02
9	COLD	MED	4.81E-04	<5.65E-04	<7.74E-04
11	COLD	FAST	9.24E-03	<1.15E-02	<1.50E-02
12	COLD	FAST	1.05E-02	<1.30E-02	<1.65E-02
35	HOT	MED	3.05E-02	3.96E-02	5.51E-02
37	HOT	FAST	6.16E-02	<8.12E-02	<1.11E-01
38	HOT	FAST	7.30E-02	9.12E-02	1.19E-01
40	HOT	MED	1.41E-02	1.75E-02	2.38E-02
41	HOT	MED	1.73E-02	2.10E-02	2.77E-02
44	HOT	FAST	8.06E-02	1.03E-01	1.39E-01
			246-280	310-342	408-435
67	HOT	SLOW	1.52E-02	1.90E-02	2.48E-02
71	HOT	SLOW	1.07E-02	1.50E-02	2.17E-02

BEADLEACH II

URANIUM LEACH RATE (G/CM2.DAY)

ICP ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	70	120	151	213
2	COLD	MED	<1.43E-06	<1.45E-06	<1.45E-06	0.	<1.42E-06	<1.54E-06	<1.37E-06	<1.45E-06	<9.32E-07	<1.31E-06	<1.29E-06
3	COLD	MED	<2.31E-06	<1.34E-06	<1.32E-06	0.	<1.27E-06	0.	<1.31E-06	<1.29E-06	<1.68E-06	<1.14E-06	<1.45E-06
6	COLD	FAST	<4.09E-05	<4.16E-05	<4.06E-05	0.	<4.04E-05	0.	<4.14E-05	<4.22E-05	<4.12E-05	<3.91E-05	<4.25E-05
9	COLD	MED	<1.44E-06	<1.53E-06	<1.52E-06	0.	<1.49E-06	<1.52F-06	<1.50E-06	<1.47E-06	<1.34E-06	<1.38E-06	<1.30E-06
11	COLD	FAST	<4.10E-05	<4.18E-05	<4.07E-05	0.	<4.02E-05	0.	<4.05E-05	<3.67E-05	<3.21E-05	<3.96E-05	<3.97E-05
12	COLD	FAST	<4.19E-05	<4.24E-05	<4.25E-05	0.	<4.25E-05	0.	<4.29E-05	<4.01E-05	<4.40E-05	<4.38E-05	<4.37E-05
35	HOT	MED	4.15E-05	2.88E-06	3.21E-06	0.	3.07E-06	<1.43E-06	<1.42E-06	2.02E-06	1.12E-05	1.47E-05	1.17E-05
37	HOT	FAST	1.02E-04	<4.73E-05	<4.11E-05	0.	<4.08E-05	0.	<4.06E-05	<1.09E-05	<4.06E-05	<4.08E-05	<3.99E-05
38	HOT	FAST	<4.60E-05	<4.40E-05	<4.14E-05	0.	<4.13E-05	0.	<4.08E-05	<3.95E-05	<4.10E-05	<4.05E-05	<4.06E-05
40	HOT	MED	2.37E-06	0.	<2.01E-06	0.	<1.41E-06	2.46E-06	2.23E-06	6.77E-06	1.43E-06	4.31E-06	1.90E-06
41	HOT	MED	0.	6.33E-06	<1.51E-06	0.	<1.46E-06	0.	2.10E-06	5.19E-06	4.79E-06	5.53E-08	1.57E-06
44	HOT	FAST	<4.30E-05	<4.32E-05	<4.12E-05	0.	<4.12E-05	0.	<4.09E-05	<3.92E-05	<4.03E-05	<3.92E-05	<4.08E-05

			1- 10				11- 20	21- 30	31- 50	51- 80	81-120	121-150	183-213
7	HOT	SLOW	1.33E-07	0.	0.	0.	0.	1.10E-06	3.74E-06	1.01E-06	1.57E-06	1.64E-06	2.73E-06
1	HOT	SLOW	<8.54E-08	0.	0.	0.	0.	4.81E-07	9.15E-07	1.10E-06	4.32E-07	2.02E-06	1.58E-06

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BEADLEACH II

URANIUM LEACH RATE (G/CM2.DAY)

ICP ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS 280	342	435
2	COLD	MED	0.	<1.33E-06	<1.10E-06
3	COLD	MED	0.	<1.52E-06	<1.49E-06
8	COLD	FAST	0.	<4.02E-05	<3.79E-05
9	COLD	MED	0.	<1.36E-06	<1.34E-06
11	COLD	FAST	0.	<4.43E-05	<3.91E-05
12	COLD	FAST	0.	<4.32E-05	<3.94E-05
35	HOT	MED	0.	1.02E-05	7.89E-06
37	HOT	FAST	0.	4.12E-05	<3.93E-05
38	HOT	FAST	0.	<4.15E-05	<3.99E-05
40	HOT	MED	0.	1.44E-06	<1.49E-06
41	HOT	MED	0.	1.53E-06	<1.34E-06
44	HOT	FAST	0.	<4.28E-05	<4.03E-05
			246-280	310-342	408-435
67	HOT	SLOW	1.64E-06	9.51E-07	4.62E-07
71	HOT	SLOW	1.54E-06	1.50E-06	8.44E-07

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BEADLEACH II

URANIUM CUMULATED FRACTIONAL LEACH(CFL)

ICP ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	70	120	151	213
2	COLD	MED	<5.65E-06	<1.16E-05	<1.72E-05	0.	<6.33E-05	<1.17E-04	<2.16E-04	<4.09E-04	<6.53E-04	<7.35E-04	<1.12E-03
3	COLD	MED	<9.11E-06	<1.45E-05	<1.95E-05	0.	<6.03E-05	<0.	<1.93E-04	<3.68E-04	<6.74E-04	<8.44E-04	<1.17E-03
6	COLD	FAST	<1.61E-04	<3.30E-04	<4.84E-04	0.	<1.76E-03	<0.	<5.97E-03	<1.14E-02	<2.01E-02	<2.50E-02	<3.52E-02
9	COLD	MED	<5.83E-06	<1.22E-05	<1.82E-05	0.	<6.74E-05	<1.23E-04	<2.28E-04	<4.35E-04	<7.31E-04	<9.03E-04	<1.25E-03
11	COLD	FAST	<1.56E-04	<3.21E-04	<4.74E-04	0.	<1.73E-03	<0.	<5.81E-03	<1.08E-02	<1.78E-02	<2.22E-02	<3.19E-02
12	COLD	FAST	<1.66E-04	<3.39E-04	<5.02E-04	0.	<1.86E-03	<0.	<6.30E-03	<1.18E-02	<2.07E-02	<2.61E-02	<3.71E-02
35	HOT	MED	1.39E-04	1.53E-04	1.66E-04	0.	2.64E-04	<3.41E-04	<4.36E-04	<6.71E-04	<2.08E-03	<3.70E-03	<6.97E-03
37	HOT	FAST	0.00C 04	<5.66E-04	<7.47E-04	0.	<2.03E-03	<0.	<6.16E-03	<9.46E-03	<1.49E-02	<1.99E-02	<2.99E-02
38	HOT	FAST	<1.78E-04	<3.67E-04	<5.30E-04	0.	<1.84E-03	<0.	<6.08E-03	<1.14E-02	<1.99E-02	<2.49E-02	<3.51E-02
40	HOT	MED	9.04E-06	0.	<2.65E-05	0.	<7.89E-05	<1.50E-04	<3.07E-04	<9.32E-04	<1.74E-03	<2.11E-03	<2.87E-03
41	HOT	MED	0.	2.73E-05	<3.32E-05	0.	<8.02E-05	<0.	<2.66E-04	<7.73E-04	<1.80E-03	<2.44E-03	<3.31E-03
44	HOT	FAST	<1.61E-04	<3.43E-04	<5.02E-04	0.	<1.78E-03	<0.	<5.93E-03	<1.11E-02	<1.93E-02	<2.41E-02	<3.39E-02
			1- 10				11- 20	21- 30	31- 50	51- 80	81-120	121-150	183-213
67	HOT	SLOW	5.06E-06	0.	0.	0.	0.	7.17E-05	3.55E-04	4.77E-04	7.10E-04	9.06E-04	1.50E-03
71	HOT	SLOW	<3.30E-06	0.	0.	0.	0.	<3.34E-05	<1.04E-04	<2.38E-04	<3.03E-04	<5.49E-04	<9.63E-04

BEADLEACH II

URANIUM CUMULATED FRACTIONAL LEACH(CFL)

ICP ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS 280	342	435
2	COLD	MED	1.45E-03	<1.78E-03	<2.25E-03
3	COLD	MED	1.54E-03	<1.90E-03	<2.49E-03
6	COLD	FAST	4.56E-02	<5.60E-02	<7.12E-02
9	COLD	MED	1.59E-03	<1.93E-03	<2.48E-03
11	COLD	FAST	4.23E-02	<5.27E-02	<6.87E-02
12	COLD	FAST	4.81E-02	<5.92E-02	<7.55E-02
35	HOT	MED	9.63E-03	<1.23E-02	<1.57E-02
37	HOT	FAST	4.00E-02	<5.02E-02	<6.59E-02
38	HOT	FAST	4.55E-02	<5.59E-02	<7.20E-02
40	HOT	MED	3.27E-03	<3.66E-03	<4.24E-03
41	HOT	MED	3.69E-03	<4.07E-03	<4.63E-03
44	HOT	FAST	4.42E-02	<5.47E-02	<7.08E-02
			246-280	310-342	408-435
67	HOT	SLOW	2.01E-03	2.29E-03	2.53E-03
71	HOT	SLOW	<1.36E-03	<1.73E-03	<2.14E-03

BEADLEACH II

SILICON LEACH RATE (G/CM2.DAY)

ICP ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	70	120	151	213
2	COLD	MED	4.67E-06	7.95E-06	2.57E-05	0.	5.03E-06	5.60E-06	4.83E-06	5.78E-06	9.58E-07	1.33E-06	1.61E-06
3	COLD	MED	1.92E-05	5.65E-06	6.04E-06	0.	4.65E-06	0.	4.88E-06	5.35E-06	1.50E-06	1.29E-06	1.73E-06
6	COLD	FAST	9.80E-05	1.02E-04	1.06E-04	0.	1.16E-04	0.	1.45E-04	1.61E-04	3.20E-05	3.15E-05	6.32E-05
35	HOT	MED	1.23E-04	3.72E-05	2.82E-05	0.	2.09E-05	1.28E-05	1.55E-05	1.91E-05	3.52E-05	3.70E-05	3.16E-05
37	HOT	FAST	2.28E-04	1.82E-04	1.69E-04	0.	1.47E-04	0.	1.64E-04	7.04E-05	1.07E-04	1.15E-04	1.29E-04
38	HOT	FAST	1.78E-04	1.68E-04	1.68E-04	0.	1.55E-04	0.	1.57E-04	1.88E-04	1.04E-04	1.18E-04	1.30E-04

BEADLEACH II

SILICON LEACH RATE (G/CM2.DAY)

ICP ANALYSIS

CHAN TEMP FLOW SAMPLING DAYS

CHAN	TEMP	FLOW	280	342	435
2	COLD	MED	0.	8.28E-07	5.80E-07
3	COLD	MED	0.	1.09E-06	8.89E-07
6	COLD	FAST	0.	2.36E-05	1.57E-05
35	HOT	MED	0.	3.50E-05	3.49E-0[illegible]
37	HOT	FAST	0.	9.49E-05	7.79E-05
38	HOT	FAST	0.	8.48E-05	9.06E-05

BEADLEACH II

SILICON CUMULATED FRACTIONAL LEACH(CFL)

ICP ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	70	120	151	213
2	COLD	MED	1.85E-05	5.11E-05	1.50E-04	0.	6.00E-04	7.93E-04	1.15E-03	1.88E-03	2.55E-03	2.70E-03	3.07E-03
3	COLD	MED	7.54E-05	9.83E-05	1.21E-04	0.	2.87E-04	0.	7.77E-04	1.47E-03	2.14E-03	2.31E-03	2.69E-03
6	COLD	FAST	3.84E-04	9.01E-04	1.20E-03	0.	4.73E-03	0.	1.82E-02	3.82E-02	5.76E-02	6.15E-02	7.34E-02
35	HOT	MED	4.13E-04	5.89E-04	7.00E-04	0.	1.46E-03	2.04E-03	2.99E-03	5.34E-03	1.10E-02	1.55E-02	2.40E-02
37	HOT	FAST	8.67E-04	1.64E-03	2.29E-03	0.	7.18E-03	0.	2.30E-02	3.81E-02	5.66E-02	7.02E-02	1.00E-01
38	HOT	FAST	6.85E-04	1.41E-03	2.07E-03	0.	7.17E-03	0.	2.33E-02	4.62E-02	7.63E-02	9.01E-02	1.21E-01

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BEADLEACH II

SILICON CUMULATED FRACTIONAL LEACH(CFL)
ICP ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS 280	342	435
2	COLD	MED	3.35E-03	3.63E-03	3.89E-03
3	COLD	MED	3.02E-03	3.35E-[illegible]	3.72E-03
6	COLD	FAST	8.43E-02	9.52E-02	1.03E-01
35	HOT	MED	3.23E-02	4.06E-02	5.43E-02
37	HOT	FAST	1.28E-01	1.56E-01	1.90E-01
38	[illegible]	FAST	1.49E-01	1.76E-01	2.10E-01

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BEADLEACH II

CALCIUM LEACH RATE (G/CM2.DAY)

ICP ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	70	120	151	213
2	COLD	MED	1.70E-04	4.40E-04	1.54E-04	0.	1.91E-04	2.13E-04	2.65E-04	2.70E-04	1.79E-04	1.41E-04	1.97E-04
3	COLD	MED	1.39E-04	9.54E-05	1.14E-04	0.	2.56E-04	0.	1.73E-04	2.58E-04	2.88E-04	1.27E-04	2.11E-04
6	COLD	FAST	4.12E-03	4.44E-03	4.52E-03	0.	4.71E-03	0.	5.51E-03	8.22E-03	6.73E-03	3.97E-03	3.98E-03
35	HOT	MED	1.90E-03	3.19E-04	1.47E-04	0.	1.69E-04	2.20E-04	1.97E-04	3.26E-04	3.08E-04	1.91E-04	2.02E-04
37	HOT	FAST	8.84E-03	6.44E-03	6.66E-03	0.	5.93E-03	0.	6.96E-03	2.35E-03	6.84E-03	3.36E-03	3.76E-03
38	HOT	FAST	1.46E-02	8.88E-03	8.46E-03	0.	5.51E-03	0.	6.37E-03	7.91E-03	6.94E-03	3.40E-03	4.03E-03

BEADLEACH II

CALCIUM LEACH RATE (G/CM2.DAY)

ICP ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS 280	342	435
2	COLD	MED	0.	1.46E-04	4.87E-04
3	COLD	MED	0.	1.24E-04	5.66E-04
6	COLD	FAST	0.	4.05E-03	1.30E-02
35	HOT	MED	0.	2.25E-04	5.88E-04
37	HOT	FAST	0.	4.06E-03	1.30E-02
38	HOT	FAST	0.	4.36E-03	1.36E-02

BEADLEACH II

CALCIUM CUMULATED FRACTIONAL LEACH(CFL)

ICP ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	70	120	151	213
2	COLD	MED	6.72E-04	2.47E-03	3.06E-03	0.	8.69E-03	1.60E-02	3.25E-02	6.92E-02	1.15E-01	1.35E-01	1.78E-01
3	COLD	MED	5.46E-04	9.32E-04	1.36E-03	0.	7.51E-03	0.	2.94E-02	5.87E-02	1.15E-01	1.39E-01	1.82E-01
6	COLD	FAST	1.62E-02	3.42E-02	5.14E-02	0.	1.98E-01	0.	7.24E-01	1.63E+00	3.17E+00	3.81E+00	4.80E+00
35	HOT	MED	6.38E-03	7.89E-03	8.46E-03	0.	1.35E-02	2.05E-02	3.45E-02	7.02E-02	1.35E-01	1.65E-01	2.14E-01
37	HOT	FAST	3.36E-02	6.09E-02	8.67E-02	0.	2.82E-01	0.	9.39E-01	1.54E+00	2.51E+00	3.11E+00	3.99E+00
38	HOT	FAST	5.64E-02	9.46E-02	1.28E-01	0.	3.43E-01	0.	9.59E-01	1.91E+00	3.46E+00	4.08E+00	5.01E+00

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BEADLEACH II

CALCIUM CUMULATED FRACTIONAL LEACH(CFL)

ICP ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS 280	342	435
2	COLD	MED	2.19E-01	2.60E-01	4.09E-01
3	COLD	MED	2.20E-01	2.58E-01	4.22E-01
6	COLD	FAST	5.81E+00	6.82E+00	1.02E+01
35	HOT	MED	2.63E-01	3.21E-01	5.05E-01
37	HOT	FAST	4.98E+00	5.96E+00	9.32E+00
36	HOT	FAST	6.08E+00	7.15E+00	1.08E+01

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BEADLEACH II

STRONTIUM LEACH RATE (G/CM2.DAY)

ICP ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	70	120	151	213
2	COLD	MED	6.49E-06	5.39E-06	5.41E-06	0.	<2.35E-06	<2.54E-06	<2.26E-06	<2.39E-06	<1.54E-06	<2.16E-06	4.54E-06
3	COLD	MED	4.78E-06	5.27E-06	5.74E-06	0.	<2.09E-06	0.	<2.17E-06	<2.14E-06	<2.78E-06	<1.89E-06	5.71E-06
6	COLD	FAST	<6.76E-05	<6.88E-05	<6.71E-05	0.	<6.69E-05	D.	<6.85E-05	<6.98E-05	<6.81E-05	<6.46E-05	1.05E-04
35	HOT	MED	9.86E-05	2.88E-05	2.41E-05	0.	1.60E-05	7.38E-06	9.67E-05	1.27E-05	3.46E-05	3.66E-05	2.74E-05
37	HOT	FAST	2.43E-04	1.17E-04	<6.80E-05	C.	<6.75E-05	0.	<6.71E-05	<1.80E-05	1.51E-04	7.60E-05	1.65E-04
38	HOT	FAST	1.05E-04	1.09E-04	<6.84E-05	0.	<6.84E-05	0.	<6.75E-05	<6.54E-05	1.19E-04	1.17E-04	1.43E-04

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BEADLEACH II

STRONTIUM LEACH RATE (G/CM2.DAY)

ICP ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS 280	342	435
2	COLD	MED	0.	3.84E-06	4.08E-06
3	COLD	MED	0.	4.40E-06	4.62E-05
6	COLD	FAST	0.	8.30E-05	1.33E-04
36	HOT	MED	0.	4.17E-05	4.73E-05
37	HOT	FAST	0.	2.18E-04	1.71E-04
38	HOT	FAST	0.	1.46E-04	1.90E-04

BEADLEACH II

STRONTIUM CUMULATED FRACTIONAL LEACH(CFL)

ICP ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	70	120	151	213
2	COLD	MED	2.57E-05	4.78E-05	6.85E-05	0.	<1.87E-04	<2.76E-04	<4.39E-04	<7.59E-04	<1.16E-03	<1.40E-03	<2.26E-03
3	COLD	MED	1.88E-05	4.02E-05	6.19E-05	0.	<1.78E-04	<0.	<3.97E-04	<6.87E-04	<1.19E-03	<1.47E-03	<2.44E-03
6	COLD	FAST	<2.66E-04	<5.45E-04	<8.00E-04	0.	<2.92E-03	<0.	<9.87E-03	<1.89E-02	<3.33E-02	<4.14E-02	<6.27E-02
35	HOT	MED	3.32E-04	4.67E-04	5.62E-04	0.	1.18E-03	1.57E-03	5.24E-03	1.23E-02	1.73E-02	2.17E-02	2.96E-02
37	HOT	FAST	9.27E-04	1.42E-03	<1.69E-03	0.	<3.80E-03	0.	<1.06E-02	<1.61E-02	<3.43E-02	<4.77E-02	<7.80E-02
38	HOT	FAST	4.04E-04	8.74E-04	<1.14E-03	0.	<3.31E-03	0.	<1.03E-02	<1.91E-02	<3.88E-02	<5.33E-02	<8.60E-02

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BEADLEACH II

STRONTIUM CUMULATED FRACTIONAL LEACH(CFL)

ICP ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS 280	342	435
2	COLD	MED	3.28E-03	<4.31E-03	<5.91E-03
3	COLD	MED	3.64E-03	<4.85E-03	<5.63E-03
6	COLD	FAST	8.64E-02	<1.10E-01	<1.53E-01
35	HOT	MED	3.85E-02	4.75E-02	6.34E-02
37	HOT	FAST	1.26E-01	<1.74E-01	<2.49E-01
38	HOT	FAST	1.23E-01	<1.59E-01	<2.26E-01

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BEADLEACH II

MOLYBDENUM LEACH RATE (G/CM2.DAY)

XRFA ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	70	120	151	213
2	COLD	MED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	COLD	MED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
8	COLD	FAST	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
9	COLD	MED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
11	COLD	FAST	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
12	COLD	FAST	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
35	HOT	MED	0.	3.26E-05	1.95E-05	1.74E-05	1.17E-05	5.61E-06	0.	1.44E-05	3.17E-05	3.40E-05	0.
37	HOT	FAST	7.31E-05	6.[illegible]E-05	5.75E-05	3.38E-05	2.85E-05	9.84E-05	1.77E-05	1.43E-05	0.	0.	6.80E-05
38	HOT	FAST	6.04E-05	5.39E-05	4.88E-05	2.88E-05	2.89E-05	0.	1.23E-04	0.	6.27E-05	0.	0.
40	HOT	MED	0.	0.	1.76E-05	8.99E-06	1.42E-05	1.16E-05	0.	1.27E-05	0.	1.60E-05	0.
41	HOT	MED	0.	0.	1.12E-05	6.64E-06	1.28E-05	1.23E-05	0.	1.23E-05	1.97E-05	1.99E-05	0.
44	HOT	FAST	6.76E-05	7.36E-05	7.37E-05	3.96E-05	3.06E-05	7.93E-05	1.96E-05	3.94E-05	8.27E-05	0.	7.14E-05
			1- 10				11- 20	21- 30	31- 50	51- 80	81-120	121-150	183-213
67	HOT	SLOW	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
71	HOT	SLOW	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

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BEADLEACH II

MOLYBDENUM LEACH RATE (G/CM2.DAY)

XRFA ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS 280	342	435
2	COLD	MED	0.	0.	0.
3	COLD	MED	0.	0.	0.
6	COLD	FAST	0.	0.	0.
9	COLD	MED	0.	0.	0.
11	COLD	FAST	0.	0.	0.
12	COLD	FAST	0.	0.	0.
35	HOT	MED	3.82E-05	3.79E-05	3.61E-05
37	HOT	FAST	1.07E-04	8.90E-05	6.18E-05
38	HOT	FAST	3.41E-05	5.26E-05	6.81E-05
40	HOT	MED	8.96E-06	1.35E-05	1.69E-05
41	HOT	MED	1.53E-05	1.37E-05	1.69E-05
44	HOT	FAST	1.26E-04	8.24E-05	8.28E-05
			246-280	310-342	408-435
67	HOT	SLOW	0.	0.	0.
71	HOT	SLOW	0.	0.	0.

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BEADLEACH II

MOLYBDENUM CUMULATED FRACTIONAL LEACH(CFL)

XRFA ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	70	120	151	213
2	COLD	MED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	COLD	MED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
6	COLD	FAST	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
9	COLD	MED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
11	COLD	FAST	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
12	COLD	FAST	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
35	HOT	MED	0.	1.54E-04	2.31E-04	4.41E-04	7.11E-04	1.00E-03	0.	3.06E-03	7.90E-03	1.20E-02	0.
37	HOT	FAST	2.78E-04	5.41E-04	7.64E-04	1.27E-03	1.85E-03	4.23E-03	7.95E-03	1.00E-02	0.	0.	3.40E-02
38	HOT	FAST	2.33E-04	4.65E-04	6.57E-04	1.09E-03	1.65E-03	0.	9.68E-03	0.	4.11E-02	0.	0.
40	HOT	MED	0.	0.	7.05E-05	2.13E-04	4.47E-04	8.97E-04	0.	3.35E-03	0.	8.06E-03	0.
41	HOT	MED	0.	0.	4.40E-05	1.44E-04	3.46E-04	7.92E-04	0.	3.30E-03	6.65E-03	9.10E-03	0.
44	HOT	FAST	2.53E-04	5.63E-04	8.49E-04	1.46E-03	2.11E-03	4.14E-03	7.30E-03	1.12E-02	2.40E-02	0.	5.21E-02
			1- 10				11- 20	21- 30	31- 50	51- 80	81-120	121-150	183-213
67	HOT	SLOW	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
71	HOT	SLOW	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

BEADLEACH 11

MOLYBDENUM CUMULATED FRACTIONAL LEACH(CFL)

XRFA ANALYSIS

			SAMPLING DAYS 280	342	435
2	COLD	MED	0.	0.	0.
3	COLD	MED	0.	0.	[illegible]
5	COLD	FAST	0.	0.	0.
9	COLD	MED	0.	0.	0.
11	COLD	FAST	0.	0.	0.
12	COLD	FAST	0.	0.	0.
35	HOT	MED	3.01E-02	3.95E-02	5.40E-02
37	HOT	FAST	5.87E-02	7.81E-02	1.04E-01
38	HOT	FAST	7.17E-02	8.26E-02	1.07E-01
40	HOT	MED	1.38E-02	1.59E-02	2.31E-02
41	HOT	MED	1.76E-02	2.11E-02	2.74E-02
44	HOT	FAST	7.76E-02	1.03E-01	1.35E-01
			246-280	310-342	[illegible]08-435
	HOT	SLOW	0.	0.	0.
	HOT	SLOW	0.	0.	0.

BEADLEACH II

CESIUM LEACH RATE (G/CM2.DAY)

XRFA ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	70	120	151	213
2	COLD	MED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	COLD	MED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
6	COLD	FAST	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
9	COLD	MED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
11	COLD	FAST	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
12	COLD	FAST	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
35	HOT	MED	0.	2.21E-05	2.68E-05	1.85E-05	1.37E-05	7.81E-06	0.	1.47E-05	3.46E-05	4.07E-05	2.84E-05
37	HOT	FAST	8.05E-05	7.76E-05	6.18E-05	3.62E-05	2.79E-05	1.12E-05	1.94E-05	1.49E-05	6.65E-05	0.	6.82E-05
36	HOT	FAST	5.98E-05	5.42E-05	3.68E-05	4.22E-05	3.67E-05	0.	1.40E-05	0.	5.61E-05	0.	0.
40	HOT	MED	0.	<1.29E-06	<1.38E-06	<8.79E-07	<9.65E-07	9.95E-07	0.	3.71E-06	0.	5.93E-06	1.31E-06
41	HOT	MED	0.	0.	0.	0.	0.	0.	0.	2.51E-06	5.73E-06	0.	0.
44	HOT	FAST	8.81E-06	2.95E-05	4.50E-05	3.95E-05	3.10E-05	1.69E-05	1.96E-05	3.49E-05	8.53E-05	0.	7.54E-05
			1- 10				11- 20	21- 30	31- 50	51- 80	81-120	121-150	183-213
67	HOT	SLOW	0.	0.	0.	0.	0.	<5.01E-07	0.	5.43E-07	0.	1.29E-06	7.82E-06
71	HOT	SLOW	0.	0.	0.	0.	0.	0.	4.29E-07	5.54E-07	0.	7.16E-07	5.83E-06

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BEADLEACH II

CESIUM LEACH RATE (G/CM2.DAY)

XRFA ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS 280	342	435
2	COLD	MED	0.	0.	0.
3	COLD	MED	0.	0.	0.
6	COLD	FAST	0.	0.	0.
9	COLD	MED	0.	0.	0.
11	COLD	FAST	0.	0.	0.
12	COLD	FAST	0.	0.	0.
35	HOT	MED	3.42E-05	3.92E-05	4.14E-05
37	HOT	FAST	7.26E-05	6.92E-05	6.72E-05
38	HOT	FAST	3.73E-05	5.96E-05	7.37E-05
40	HOT	MED	1.03E-06	2.83E-06	9.76E-06
41	HOT	MED	0.	4.74E-06	7.95E-06
44	HOT	FAST	9.15E-05	8.79E-05	8.27E-05
			246-280	310-342	408-435
67	HOT	SLOW	9.57E-07	9.28E-07	9.22E-07
71	HOT	SLOW	7.53E-07	8.73E-07	9.17E-07

BEADLEACH II

CESIUM CUMULATED FRACTIONAL LEACH(CFL)

XRFA ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	70	120	151	213
2	COLD	MED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	COLD	MED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
6	COLD	FAST	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
9	COLD	MED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
11	COLD	FAST	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
12	COLD	FAST	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
35	HOT	MED	0.	1.04E-04	2.10E-04	4.33E-04	7.35E-04	1.10E-03	0.	3.41E-03	8.59E-03	1.32E-02	2.18E-02
37	HOT	FAST	3.06E-04	6.36E-04	8.75E-04	1.41E-03	2.01E-03	2.66E-03	3.70E-03	5.93E-03	1.47E-02	0.	3.95E-02
38	HOT	FAST	2.31E-04	4.64E-04	6.09E-04	1.10E-03	1.86E-03	0.	4.43E-03	0.	1.67E-02	0.	0.
40	HOT	MED	0.	<5.53E-06	<1.10E-05	<2.36E-05	<4.16E-05	<7.63E-05	<0.	<5.63E-04	<0.	<2.16E-03	<3.03E-03
41	HOT	MED	0.	0.	0.	0.	0.	0.	0.	2.01E-05	8.89E-04	0.	0.
44	HOT	FAST	3.30E-05	1.57E-04	3.32E-04	8.22E-04	1.48E-03	2.29E-03	3.50E-03	7.06E-03	1.97E-02	0.	4.91E-02
			1- 10				11- 20	21- 30	31- 50	51- 80	81-120	121-150	183-213
67	HOT	SLOW	0.	0.	0.	0.	0.	<1.95E-05	<0.	<1.24E-04	<0.	<4.14E-04	<1.90E-03
71	HOT	SLOW	0.	0.	0.	0.	0.	0.	3.30E-05	1.01E-04	0.	2.84E-04	1.39E-0[illegible]

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BEADLEACH II

CESIUM CUMULATED FRACTIONAL LEACH(CFL)
XRFA ANALYSIS

			SAMPLING DAYS 280	342	435
2	COLD	MED	0.	0.	0.
3	COLD	MED	0.	0.	0.
6	COLD	FAST	0.	0.	0.
9	COLD	MED	0.	0.	0.
11	COLD	FAST	0.	0.	0.
12	COLD	FAST	0.	0.	0.
35	HOT	MED	2.98E-02	3.93E-02	5.53E-02
37	HOT	FAST	5.76E-02	7.50E-02	1.02E-01
38	HOT	FAST	4.62E-02	5.84E-02	8.48E-02
40	HOT	MED	<3.30E-03	<3.89E-03	<6.82E-03
41	HOT	MED	0.	5.38E-03	8.10E-03
44	HOT	FAST	7.04E-02	9.22E-02	1.25E-01
			246-280	310-342	408-435
67	HOT	SLOW	<2.56E-03	<2.79E-03	<3.15E-03
71	HOT	SLOW	1.90E-03	2.07E-03	2.40E-03

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BEADLEACH II

URANIUM LEACH RATE (G/CM2.DAY)

XRFA ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	70	120	151	213
2	COLD	MED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	COLD	MED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
6	COLD	FAST	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
9	COLD	MED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
11	COLD	FAST	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
12	COLD	FAST	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
35	HOT	MED	0.	7.99E-06	7.01E-06	7.10E-06	4.29E-06	3.31E-06	0.	6.66E-06	1.54E-05	1.85E-05	1.60E-05
37	HOT	FAST	5.53E-05	4.90E-05	3.74E-05	2.54E-05	2.04E-05	1.02E-05	1.38E-05	9.53E-06	4.71E-05	0.	4.35E-05
38	HOT	FAST	4.19E-05	4.01E-05	3.47E-05	2.42E-05	1.77E-05	0.	1.17E-05	0.	4.03E-05	0.	0.
40	HOT	MED	0.	3.38E-06	0.	2.76E-06	5.29E-06	5.91E-06	0.	8.19E-06	1.40E-06	5.81E-06	3.86E-06
41	HOT	MED	0.	6.21E-06	0.	4.88E-06	5.49E-06	5.82E-06	0.	8.82E-06	5.98E-06	7.65E-06	3.00E-06
44	HOT	FAST	3.61E-05	4.86E-05	4.56E-05	2.95E-05	2.13E-05	1.25E-05	1.17E-05	3.85E-05	4.39E-05	0.	4.45E-05
			1- 10				11- 20	21- 30	31- 50	51- 80	81-120	121-150	183-213
67	HOT	SLOW	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
71	HOT	SLOW	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

BEADLEACH II

URANIUM LEACH RATE (G/CM2.DAY)

XRFA ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS		
			280	342	435
2	COLD	MED	0.	0.	0.
3	COLD	MED	0.	0.	0.
6	COLD	FAST	0.	0.	0.
9	COLD	MED	0.	0.	0.
11	COLD	FAST	0.	0.	0.
12	COLD	FAST	0.	0.	0.
35	HOT	MED	1.54E-05	1.10E-05	7.87E-06
37	HOT	FAST	4.82E-05	4.19E-05	1.97E-05
38	HOT	FAST	2.65E-05	2.97E-05	2.57E-05
40	HOT	MED	3.66E-06	2.09E-06	2.07E-06
41	HOT	MED	3.36E-06	2.09E-06	1.34E-06
44	HOT	FAST	4.08E-05	2.91E-05	2.45E-05
			246-280	310-342	406-435
67	HOT	SLOW	0.	0.	0.
71	HOT	SLOW	0.	0.	0.

BEADLEACH II

URANIUM CUMULATED FRACTIONAL LEACH(CFL)

XRFA ANALYSIS

CHAN	TEMP	FLOW	SAMPLING DAYS 1	2	3	6	11	20	37	70	120	151	213
2	COLD	MED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	COLD	MED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
6	COLD	FAST	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
9	COLD	MED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
11	COLD	FAST	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
12	COLD	FAST	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
35	HOT	MED	0.	3.77E-05	6.52E-05	1.51E-04	2.56E-04	3.89E-04	0.	1.41E-03	3.72E-03	5.82E-03	1.01E-02
37	HOT	FAST	2.11E-04	4.16E-04	5.63E-04	9.17E-04	1.35E-03	1.86E-03	2.67E-03	4.18E-03	1.03E-02	0.	2.69E-02
38	HOT	FAST	1.62E-04	3.34E-04	4.71E-04	8.09E-04	1.21E-03	0.	2.71E-03	0.	1.18E-02	0.	0.
40	HOT	MED	0.	1.44E-05	0.	6.22E-05	1.45E-04	3.45E-04	0.	1.78E-03	2.72E-03	3.19E-03	4.35E-03
41	HOT	MED	0.	2.67E-05	0.	1.13E-04	2.16E-04	4.18E-04	0.	1.92E-03	3.43E-03	4.28E-03	5.59E-03
44	HOT	FAST	1.35E-04	3.40E-04	5.16E-04	9.30E-04	1.40E-03	1.97E-03	2.77E-03	6.08E-03	1.51E-02	0.	3.22E-02
			1- 10				11- 20	21- 30	31- 50	51- 80	81-120	121-150	183-213
67	HOT	SLOW	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
71	HOT	SLOW	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

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BEADLEACH II

URANIUM CUMULATED FRACTIONAL LEACH(CFL)

XRFA ANALYSIS

			SAMPLING DAYS 280	342	435
2	COLD	MED	0.	0.	0.
3	COLD	MED	0.	0.	0.
6	COLD	FAST	0.	0.	0.
9	COLD	MED	0.	0.	0.
11	COLD	FAST	0.	0.	0.
12	COLD	FAST	0.	0.	0.
35	HOT	MED	1.39E-02	1.6[illegible]E-02	2.04E-02
37	HOT	FAST	3.87E-02	4.97E-02	6.18E-02
36	HOT	FAST	3.28E-02	3.99E-02	5.08E-02
40	HOT	MED	5.25E-03	5.86E-03	6.68E-03
41	HOT	MED	6.40E-03	6.99E-03	7.82E-03
44	HOT	FAST	4.30E-02	5.15E-02	6.18E-02
			246-280	310-342	408-435
67	HOT	SLOW	0.	0.	0.
71	HOT	SLOW	0.	0.	0.

APPENDIX 8.

Radionuclide and Elemental Adsorption on Crushed Basalt

Total concentration (dpm for Pu and Np and micrograms for the stable elements) and normalized concentration (dpm/gram of rock and micrograms/gram of rock) are shown in Tables 1-10. For each channel, there are four rock fractions labeled A, B, C, and D. The leachant flow is from A to D.

With the exception of B, Mo, Cs, U, Pu and Np, the remaining elements in each table are also components of the rock itself. The concentrations shown include both sources - the rock and the glass beads.

Appendix 8: Table 1

Rock Adsorption Data

Element	Total Concentration 9A	9B	9C	9D	Normalized Concentration 9A	9B	9C	9D
	Micrograms x 1000				Micrograms x 1000/gram rock			
Ca	14	27	19	23	4.5	5.2	4.4	4.3
Ti	3.8	8.8	6.3	7.7	1.2	1.7	1.5	1.4
Mn	0.7	1.1	0.8	1.0	0.2	0.2	0.2	0.2
Fe	32	66	48	59	10	13	11	11
	Micrograms				Micrograms/gram rock			
Zn	81	98	71	90	26	19	16	17
Rb	ND	ND	5.5	ND	ND	ND	1	ND
Sr	73	78	66	75	24	15	15	14
Y	19	32	26	32	6	6	6	6
Zr	38	54	42	54	12	10	10	10
Mo	ND	ND	ND	ND	ND	ND	ND	ND
Cs	ND	ND	ND	ND	ND	ND	ND	ND
Ba	84	82	82	98	27	16	19	18
U	ND	ND	ND	ND	ND	ND	ND	ND
B	7.5	15	11	12	2.4	2.9	2.6	2.2
	dpm				dpm/gram rock			
Pu	890	528	125	160	287	103	29	30
Np	<80	<250	<250	<580	<25	<50	<50	<108

ND = non detectable

Appendix 8: Table 2

Rock Adsorption Data

Element	Total Concentration 11A	11B	11C	11D	Normalized Concentration 11A	11B	11C	11D
	Micrograms x 1000				Micrograms x 1000/gram rock			
Ca	14	27	24	30	4.9	5.7	5.3	5.1
Ti	3.9	8.4	7.8	8.6	1.3	1.8	1.7	1.5
Mn	0.5	1.0	0.9	1.1	0.2	0.2	0.2	0.2
Fe	32	66	60	71	11	14	13	12
	Micrograms				Micrograms/gram rock			
Zn	85	146	101	110	29	31	22	19
Rb	ND	ND	ND	ND	ND	ND	ND	ND
Sr	67	74	78	86	23	16	17	15
Y	19	30	29	35	6.6	6.4	6.4	6.0
Zr	30	53	64	57	10	11	14	10
Mo	ND	ND	ND	ND	ND	ND	ND	ND
Cs	ND	ND	ND	ND	ND	ND	ND	ND
Ba	76	89	93	106	26	19	20	18
U	ND	ND	ND	ND	ND	ND	ND	ND
	dpm				dpm/gram rock			
Pu	3980	3847	1509	1735	1358	824	332	297
Np	<330	<250	<90	<290	<110	<50	<20	<50

ND = non detectable

Appendix 8: Table 3

Rock Adsorption Data

Element	Total Concentration 12A	12B	12C	12D	Normalized Concentration 12A	12B	12C	12D
	Micrograms x 1000				Micrograms x 1000/gram rock			
Ca	22	21	20	26	5.5	5.0	4.9	4.5
Ti	6.1	6.7	6.7	9.3	1.5	1.6	1.6	1.6
Mn	0.8	0.8	0.8	1.1	0.2	0.2	0.2	0.2
Fe	48	48	50	66	12	11	12	11
	Micrograms				Micrograms/gram rock			
Zn	129	107	115	122	32	25	28	21
Rb	ND	ND	ND	ND	ND	ND	ND	ND
Sr	75	78	72	82	19	18	17	14
Y	26	28	32	36	6.6	6.6	7.6	6.2
Zr	46	52	58	68	12	12	14	12
Mo	ND	ND	ND	ND	ND	ND	ND	ND
Cs	ND	ND	ND	ND	ND	ND	ND	ND
Ba	98	88	92	99	25	21	22	17
U	ND	ND	ND	ND	ND	ND	ND	ND
	dpm				dpm/gram rock			
Pu	7980	3554	2084	2233	2010	834	498	383
Np	<400	<250	<210	<90	<100	<60	<50	<20

ND = non detectable

Appendix 8: Table 4

Rock Adsorption Data

Element	Total Concentration 26A	30A	58A	60A	Normalized Concentration 26A	30A	58A	60A
	Micrograms x 1000				Micrograms x 1000/gram rock			
Ca	14	35	53	120	4.9	6.2	9.6	25
Ti	3.8	9.8	15	41	1.3	1.7	2.7	8.5
Mn	0.7	1.4	2.1	4.4	0.2	0.2	0.4	0.9
Fe	32	78	120	248	10	14	22	52
	Micrograms				Micrograms/gram rock			
Zn	81	161	128	328	16	28	23	71
Rb	ND	ND	6	ND	ND	ND	1	ND
Sr	73	86	115	269	17	15	21	56
Y	19	43	48	69	6	8	9	14
Zr	38	79	97	267	9	14	18	56
Mo	ND	ND	ND	ND	ND	ND	ND	ND
Cs	ND	ND	ND	ND	ND	ND	ND	ND
Ba	84	105	145	447	20	19	26	94
U	ND	ND	ND	ND	ND	ND	ND	ND
	dpm				dpm/gram rock			
Pu	<70	<11	<50	<90	<15	<2	<10	<20
Np	<20	<270	<20	<20	<5	<50	<5	<5

ND = non detectable

Appendix 8: Table 5

Rock Adsorption Data

Element	Total Concentration 40A	40B	40C	40D	Normalized Concentration 40A	40B	40C	40D
	Micrograms x 1000				Micrograms x 1000/gram rock			
Ca	20	35	32	41	6.4	7.3	7.2	7.0
Ti	5.7	8.8	8.8	11	1.8	1.8	2.0	1.9
Mn	0.8	1.3	1.2	1.9	0.3	0.3	0.3	0.3
Fe	46	69	65	93	15	14	15	16
	Micrograms				Micrograms/gram rock			
Zn	230	116	82	103	73	[illegible]	18	18
Rb	6	7	7	12	2	2	2	2
Sr	90	124	125	149	29	26	28	25
Y	19	29	29	42	6	6	7	7
Zr	56	77	80	89	18	16	18	15
Mo	ND	ND	ND	ND	ND	ND	ND	ND
Cs	25	33	28	52	7.9	6.9	6.3	8.8
Ba	170	202	173	214	54	42	39	36
U	28	34	33	40	8.9	7.1	7.4	6.8
	dpm				dpm/gram rock			
Pu	7540	1820	780	530	2440	380	176	80
Np	2.8×10^4	4.7×10^4	3.9×10^4	3.4×10^4	9.1×10^3	9.9×10^3	8.8×10^3	5.7×10^3

ND = non detectable

Appendix 8: Table 6

Rock Adsorption Data

Element	Total Concentration 41A	41B	41C	41D	Normalized Concentration 41A	41B	41C	41D
	Micrograms x 1000				Micrograms x 1000/gram rock			
Ca	21	32	25	25	7.2	6.3	4.8	4.8
Ti	6.0	9.7	6.9	7.3	2.1	1.9	1.3	1.4
Mn	0.8	1.3	1.0	1.0	0.3	0.3	0.2	0.2
Fe	49	72	56	59	17	14	11	11
	Micrograms				Micrograms/gram rock			
Zn	304	95	65	61	105	19	12	12
Rb	7	[illegible]	8	7	2	2	2	1
Sr	99	118	100	92	34	23	19	18
Y	22	35	29	33	8	7	6	6
Zr	46	83	63	60	16	16	12	11
Mo	ND	ND	ND	ND	ND	ND	ND	ND
Cs	39	35	32	36	14	6.9	6.1	6.9
Ba	196	190	136	129	68	37	26	25
U	33	36	28	25	11.4	7.1	5.4	4.8
B	13	17	14	12	4.5	3.3	2.7	2.3
	dpm				dpm/gram rock			
Pu	22,500	1140	300	380	7768	224	58	73
Np	3.1×10^4	3.1×10^4	2.7×10^4	1.7×10^4	1.1×10^4	6.1×10^3	5.2×10^3	3.2×10^3

ND = non detectable

Appendix 8: Table 7

Rock Adsorption Data

Element	Total Concentration 44A	44B	44C	44D	Normalized Concentration 44A	44B	44C	44D
	Micrograms x 1000				Micrograms x 1000/gram rock			
Ca	60	84	88	100	26	21	19	19
Ti	19	31	36	37	8.1	7.0	7.6	6.9
Mn	2.1	3.0	3.6	4.3	0.9	0.8	0.8	0.8
Fe	114	168	198	226	49	42	42	42
	Micrograms				Micrograms/gram rock			
Zn	925	589	366	312	400	149	78	58
Rb	26	15	11	15	11	4	2	3
Sr	149	194	185	218	64	49	39	40
Y	38	59	71	62	17	15	15	12
Zr	211	293	286	308	91	74	61	57
Mo	ND	ND	ND	ND	ND	ND	ND	ND
Cs	ND	ND	ND	ND	ND	ND	ND	ND
Ba	325	423	398	488	140	107	84	90
U	322	302	219	159	139	76	46	30
	dpm				dpm/gram rock			
Pu	$3.1x10^5$	$8.1x10^4$	$4.0x10^4$	$1.9x10^4$	$1.3x10^5$	$2.1x10^4$	$8.5x10^3$	$3.5x10^3$
Np	$8.0x10^4$	$9.6x10^4$	$7.0x10^4$	$6.7x10^4$	$3.4x10^4$	$2.4x10^4$	$1.5x10^4$	$1.2x10^4$

ND = non detectable

Appendix 8: Table 8

Rock Adsorption Data

Element	Total Concentration 67A	67B	67C	67D	Normalized Concentration 67A	67B	67C	67D
	Micrograms x 1000				Micrograms x 1000/gram rock			
Ca	19	21	19	24	4.9	4.5	3.7	5.0
Ti	4.8	6.8	6.3	6.4	1.2	1.4	1.2	1.4
Mn	0.8	0.9	0.8	0.9	0.2	0.2	0.2	0.2
Fe	42	53	52	53	11	11	10	11
	Micrograms				Micrograms/gram rock			
Zn	271	117	78	76	70	25	15	16
Rb	14	16	16	18	4	4	3	4
Sr	102	96	94	116	26	20	18	25
Y	22	30	28	28	6	6	5	6
Zr	32	63	48	40	8	13	9	9
Mo	ND	ND	ND	ND	ND	ND	ND	ND
Cs	73	97	85	74	19	20	15	16
Ba	127	133	121	143	33	28	23	30
U	38	36	35	38	9.8	7.6	6.6	8.1
P	13	11	11	16	3.3	2.3	2.1	3.4
	dpm				dpm/gram rock			
Pu	1895	301	73	56	490	63	14	12
Np	2.6×10^4	2.0×10^4	2.9×10^4	1.7×10^4	6.7×10^3	4.3×10^3	5.4×10^3	3.5×10^3

ND = non detectable

Appendix 8: Table 9

Rock Adsorption Data

Element	Total Concentration 71A	71B	71C	71D	Normalized Concentration 71A	71B	71C	71D
	Micrograms x 1000				Micrograms x 1000/gram rock			
Ca	15	24	25	19	5.2	4.6	4.8	3.8
Ti	3.8	7.7	8.3	6.2	1.3	1.5	1.6	1.2
Mn	0.6	1.0	1.0	0.8	0.2	0.2	0.2	0.2
Fe	32	59	61	47	11	11	12	10
	Micrograms				Micrograms/gram rock			
Zn	229	124	94	64	78	22	18	13
Rb	10	18	17	13	3	3	3	3
Sr	93	94	107	84	32	19	21	17
Y	16	28	34	31	6	6	7	6
Zr	25	62	68	53	9	11	13	11
Mo	ND	ND	ND	ND	ND	ND	ND	ND
Cs	62	93	78	65	21	17	15	13
Ba	122	126	129	99	42	24	25	20
U	21	45	40	42	7.3	8.2	7.8	8.6
	dpm				dpm/gram rock			
Pu	1045	320	78	51	356	59	15	10
Np	$1.2x10^4$	$2.3x10^4$	$1.9x10^4$	$1.5x10^4$	$4.1x10^3$	$4.2x10^3$	$3.6x10^3$	$3.0x10^3$

' = non detectable

Appendix 8: Table 10

Rock Adsorption Data

Element	Concentration 41B*	Concentration 44B*	Normalized Concentration 41B*	Normalized Concentration 44B*
	Micrograms x 1000		Micrograms x 1000/gram rock	
Ca	6.3	21	1.3	6.1
Ti	1.5	3.5	0.3	1.0
Mn	0.3	0.9	0.06	0.3
Fe	18	42	4.0	12
	Micrograms		Micrograms/gram rock	
Zn	24	40	5	12
Rb	ND	ND	ND	ND
Sr	59	74	13	21
Y	7	8	2	2
Zr	ND	ND	ND	ND
Mo	ND	ND	ND	ND
Cs	ND	ND	ND	ND
Ba	81	61	17	18
U	ND	ND	ND	ND
	dpm		dpm/gram rock	
Pu	176	177	36	52
Np	<132	<18	<26	<5

ND = non detectable

* Samples treated through a second acid wash

APPENDIX 9

Summary of Adsorption Data for Pu, Np, U, B, and Mo.

Appendix 9: Table 1

Summary of Adsorption Data

			dpm/g rock		g/g rock			Percent Adsorbed				
Channel	Temp. (°C)	Flow Rate (ml/d)	Pu	Np	U	B	Mo	Pu	Np	U	B	Mo
9A	25	10	287	<25	<3	2	<3	64	--	--	20	--
9B	25	10	103	<50	<2	3	<2	23	--	--	30	--
9C	25	10	29	<50	<2	3	<2	6	--	--	30	--
9D	25	10	30	<100	<2	2	<2	7	--	--	20	--
11A	25	300	1360	<110	<3	-	<3	48	--	--	-	--
11B	25	300	820	<50	<2	-	<2	29	--	--	-	--
11C	25	300	330	<20	<2	-	<2	12	--	--	-	--
11D	25	300	300	<50	<2	-	<2	11	--	--	-	--
12A	25	300	2010	<100	<3	-	<3	54	--	--	-	--
12B	25	300	830	<60	<2	-	<2	22	--	--	-	--
12C	25	300	500	<50	<2	-	<2	13	--	--	-	--
12D	25	300	380	<20	<2	-	<2	10	--	--	-	--

Appendix 9: Table 1 (cont)

Channel	Temp. (^{o}C)	Flow Rate (ml/d)	dpm/g rock Pu	dpm/g rock Np	g/g rock U	g/g rock B	g/g rock Mo	Percent Adsorbed Pu	Percent Adsorbed Np	Percent Adsorbed U	Percent Adsorbed B	Percent Adsorbed Mo
40A	75	10	2440	$9.1x10^3$	8.9	-	<3	79	27	29	-	--
40B	75	10	380	$9.9x10^3$	7.1	-	<2	12	29	24	-	--
40C	75	10	176	$8.8x10^3$	7.4	-	<2	6	27	25	-	--
40D	75	10	80	$5.7x10^3$	6.8	-	<2	3	17	22	-	--
41A	75	10	7770	$1.1x10^4$	11.4	4.5	<3	96	43	40	35	--
41B	75	10	224	$6.1x10^3$	7.1	3.3	<2	3	24	25	26	--
41C	75	10	58	$5.2x10^3$	5.4	2.7	<2	<1	20	19	21	--
41D	75	10	73	$3.2x10^3$	4.8	2.3	<2	<1	13	17	18	--
44A	75	300	$1.3x10^5$	$3.4x10^4$	139	-	<3	82	40	48	-	--
44B	75	300	$2.1x10^4$	$2.4x10^4$	76	-	<2	12	28	26	-	--
44C	75	300	$8.5x10^3$	$1.5x10^4$	46	-	<2	4	18	16	-	--
44D	75	300	$3.5x10^3$	$1.2x10^4$	30	-	<2	2	14	10	-	--
67A	75	1	190	$6.7x10^3$	9.8	3.3	<3	85	34	31	30	--
67B	75	1	63	$4.3x10^3$	7.6	2.3	<2	11	22	24	21	--
67C	75	1	14	$5.4x10^3$	6.6	2.1	<2	2	27	20	19	--
67D	75	1	12	$3.5x10^3$	8.1	3.4	<2	2	17	25	30	--
71A	75	1	356	$4.1x10^3$	7.3	-	<3	81	28	23	-	--
71B	75	1	59	$4.2x10^3$	8.2	-	<2	14	28	26	-	--
71C	75	1	15	$3.6x10^3$	7.8	-	<2	3	24	24	-	--
71D	75	1	10	$3.0x10^3$	8.6	-	<2	2	20	27	-	--

APPENDIX 10

Comparison of Pu, Np, and U concentrations in the leachate vs. the rock and comparison of the total fraction leached of Pu, Np, B, Mo, and U vs. the weight loss of the glass beads.

Appendix 10: Table 1

Comparison of Leachate vs Rock

	Temp (°C)	Flow Rate (ml/d)	Percent Fraction: Pu Leachate	Pu Rock	Np Leachate	Np Rock	U Leachate	U Rock
2	25	10	1.2×10^{-3}	--	0.024	--	<0.2	--
3	25	10	1.2×10^{-3}	--	0.037	--	<0.2	--
6	25	300	7.9×10^{-3}	--	0.16	--	<7.1	--
9	25	10	1.1×10^{-4}	1.1×10^{-3}	0.031	<0.004	<0.2	<0.1
11	25	300	4.3×10^{-3}	6.8×10^{-3}	0.15	<0.004	<6.9	<0.1
12	25	300	3.3×10^{-3}	9.9×10^{-3}	0.21	<0.004	<7.6	<0.1
35	75	10	3.9×10^{-4}	--	1.3	--	2.0	--
37	75	300	2.9×10^{-2}	--	7.2	--	6.2	--
38	75	300	3.2×10^{-2}	--	7.5	--	5.1	--
40	75	10	9.0×10^{-4}	6.7×10^{-3}	0.45	0.84	0.67	0.1
41	75	10	1.9×10^{-4}	1.5×10^{-2}	0.46	0.60	0.76	0.1
44	75	300	2.1×10^{-3}	2.8×10^{-1}	7.3	1.8	6.2	1.0
67	75	1	2.3×10^{-5}	1.4×10^{-3}	0.30	0.51	0.26	0.1
71	75	1	3.5×10^{-5}	9.4×10^{-4}	0.15	0.38	<0.22	0.1

Appendix 10: Table 2

Comparison of Total Fraction Leached vs Beads Weight Loss

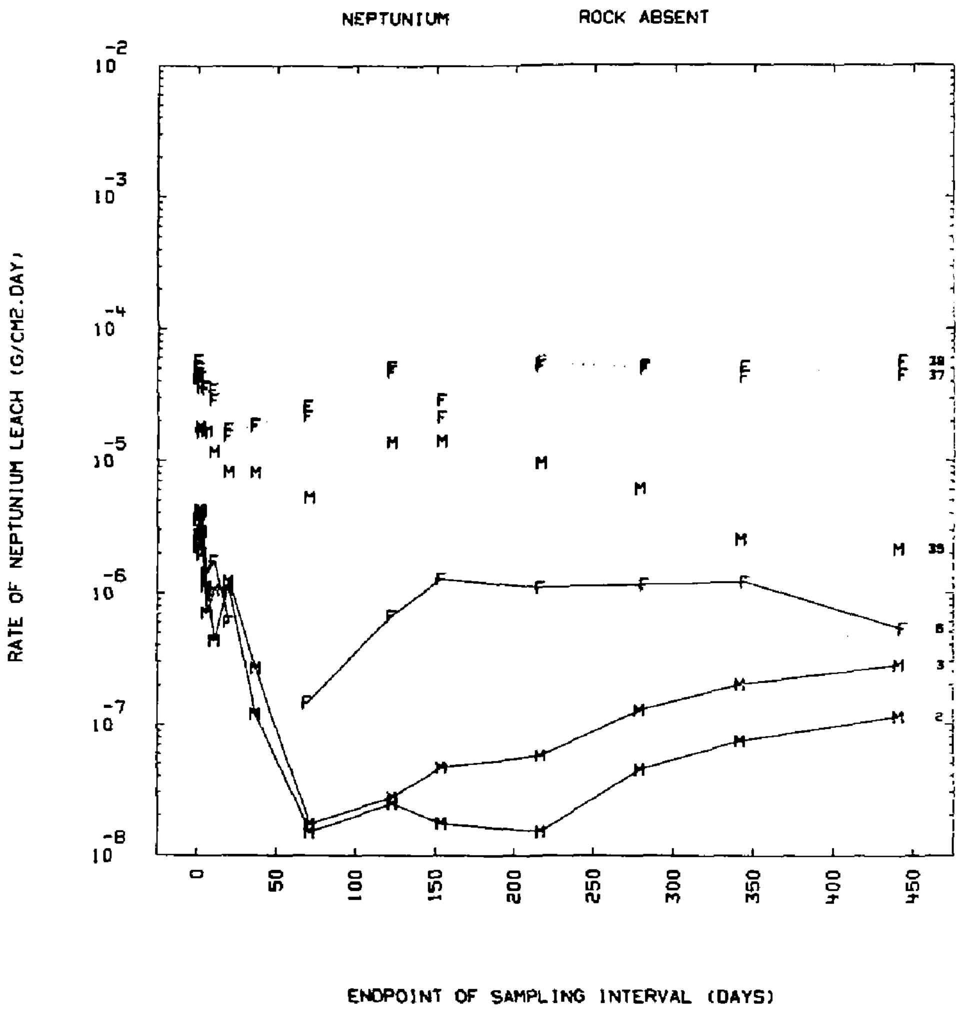
	Temp (°C)	Flow Rate (ml/d)	Beads Weight Loss (%)	Percent Leached				
				Pu	Np	B	Mo	U
2	25	10	0.05	$1.2x10^{-3}$	0.02	<0.06	<0.09	<0.2
3	25	10	0.07	$1.2x10^{-3}$	0.04	<0.06	<0.1	<0.2
6	25	300	0.15	$7.9x10^{-3}$	0.16	<1.6	<1.7	<7.1
9[a]	25	10	0.10	$1.2x10^{-3}$	0.03	<0.07	<0.1	<0.2
11[a]	25	300	0.52	0.011	0.15	<1.6	<1.5	<6.9
12[a]	25	300	0.53	0.013	0.21	<1.7	<1.7	<7.6
35	75	10	3.7	$3.9x10^{-4}$	1.3	5.9	5.5	2.0[b]
37	75	300	8.6	0.029	7.2	11.5	10.4[b]	6.2[b]
38	75	300	8.2	0.032	7.5	10.9	10.7[b]	5.1[b]
40[a]	75	10	1.8	$7.6x10^{-3}$	1.3	2.7	<2.5	0.77[b]
41[a]	75	10	1.8	0.016	1.1	<3.0	2.8	0.86[b]
44[a]	75	300	10.1	0.28	9.1	13.3	13.5[b]	7.2[b]
67[a]	75	1	1.2	$1.4x10^{-3}$	0.8	2.8	2.5	0.36
71[a]	75	1	0.3	$1.0x10^{-3}$	0.5	2.4	2.1	<0.32

a channels with beads and rock
b values obtained by XRFA

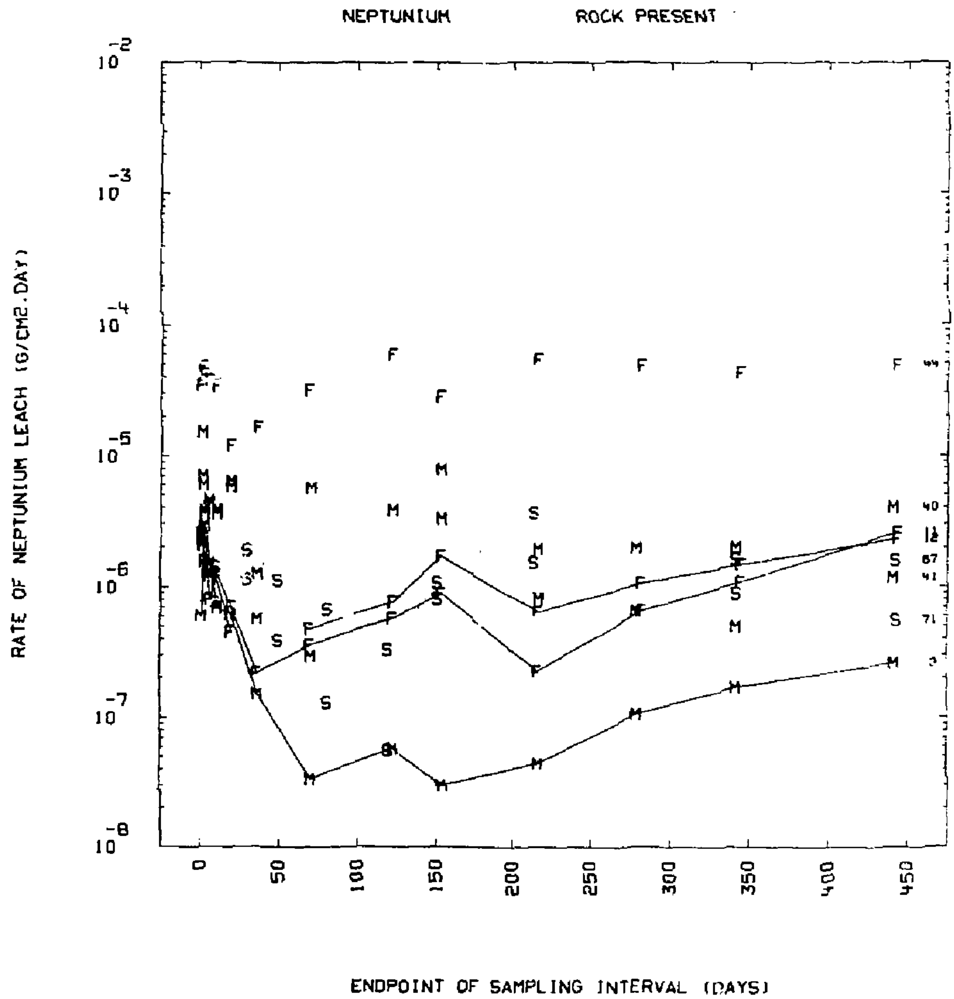
APPENDIX 11

Graphs of Incremental Leach Rate for Np and Pu vs. Time.

Flow rates are designated with the letters F for fast (300 ml/day), M for medium (10 ml/day) and S for slow (1 ml/day). Dotted lines represent the 75°C channels and solid lines represent the 25°C channels. Identification of channels is shown with a number on the right hand side of each graph. There are separate graphs for "no rock" channels (channels 2, 3, 6, 35, 37 and 38) and for "rock" channels (channels 9, 11, 12, 40, 41, 67 and 71).



NEPTUNIUM ROCK ABSENT
RATE OF NEPTUNIUM LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)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ROCK PRESENT
RATE OF NEPTUNIUM LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)
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10^{-8}
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300
350
400
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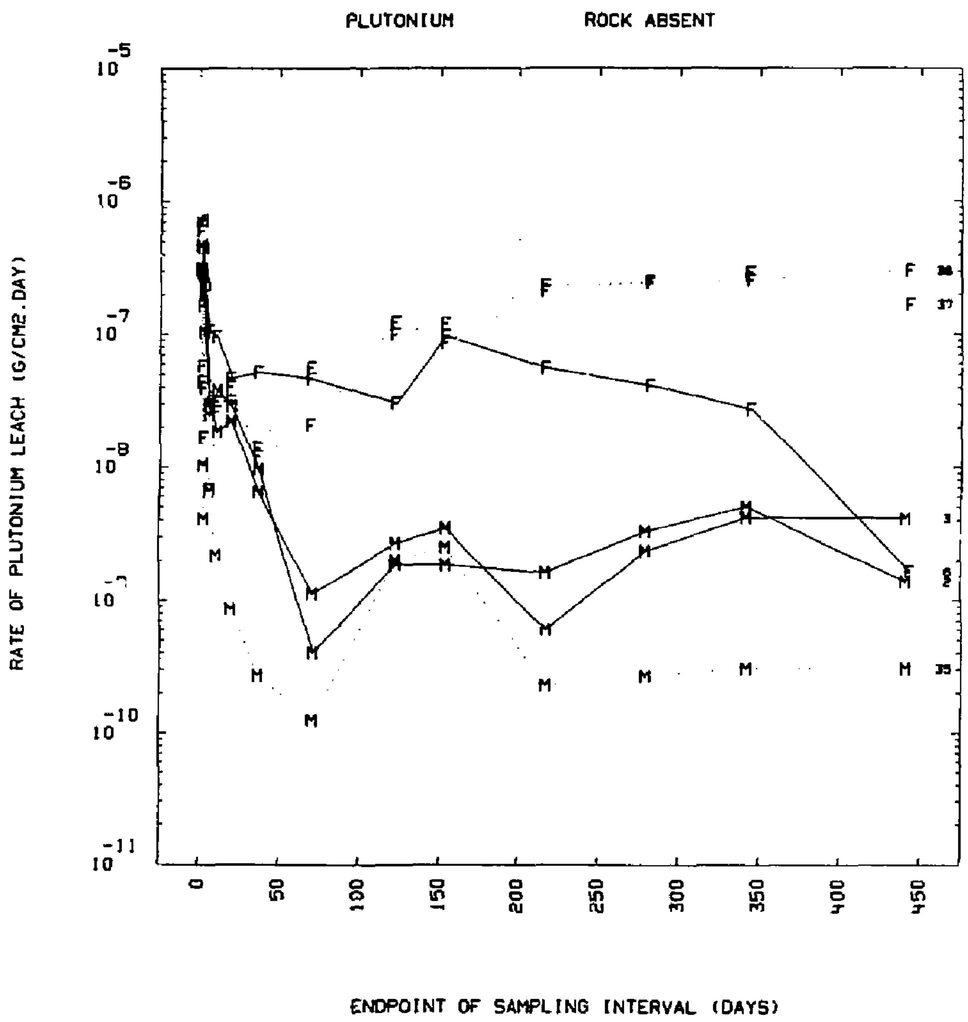
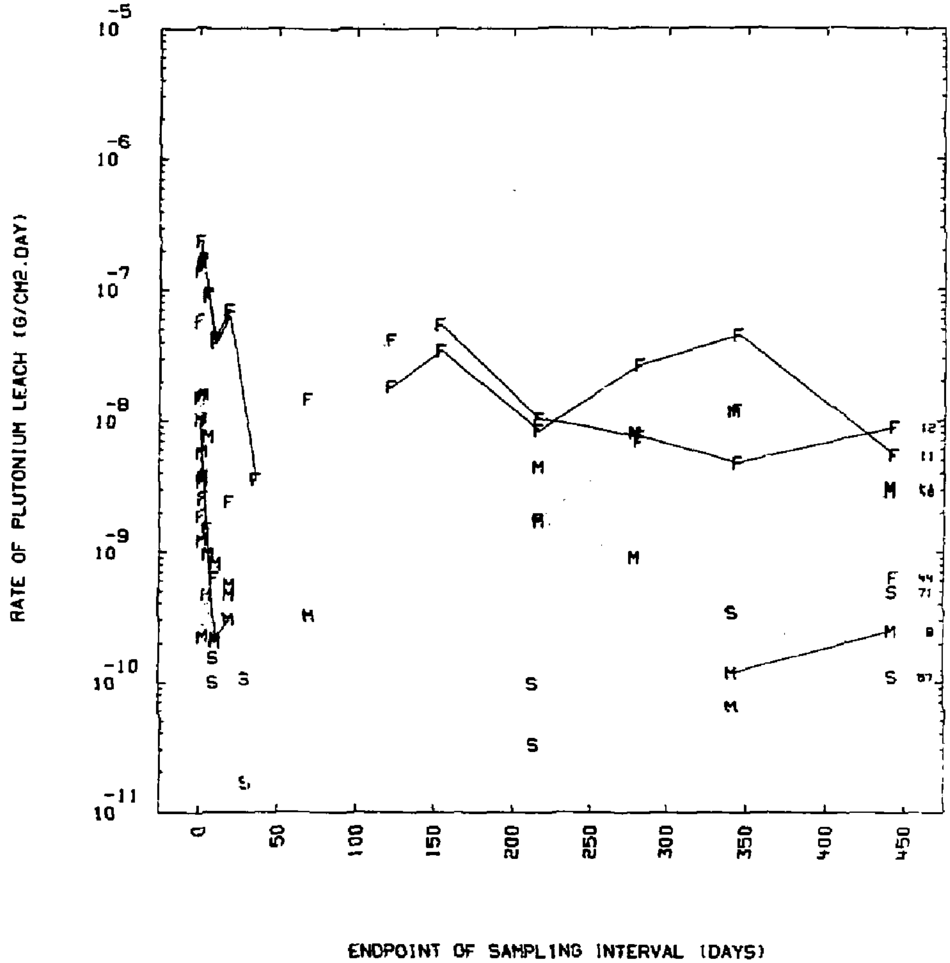


PLUTONIUM
ROCK ABSENT
RATE OF PLUTONIUM LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

PLUTONIUM ROCK PRESENT

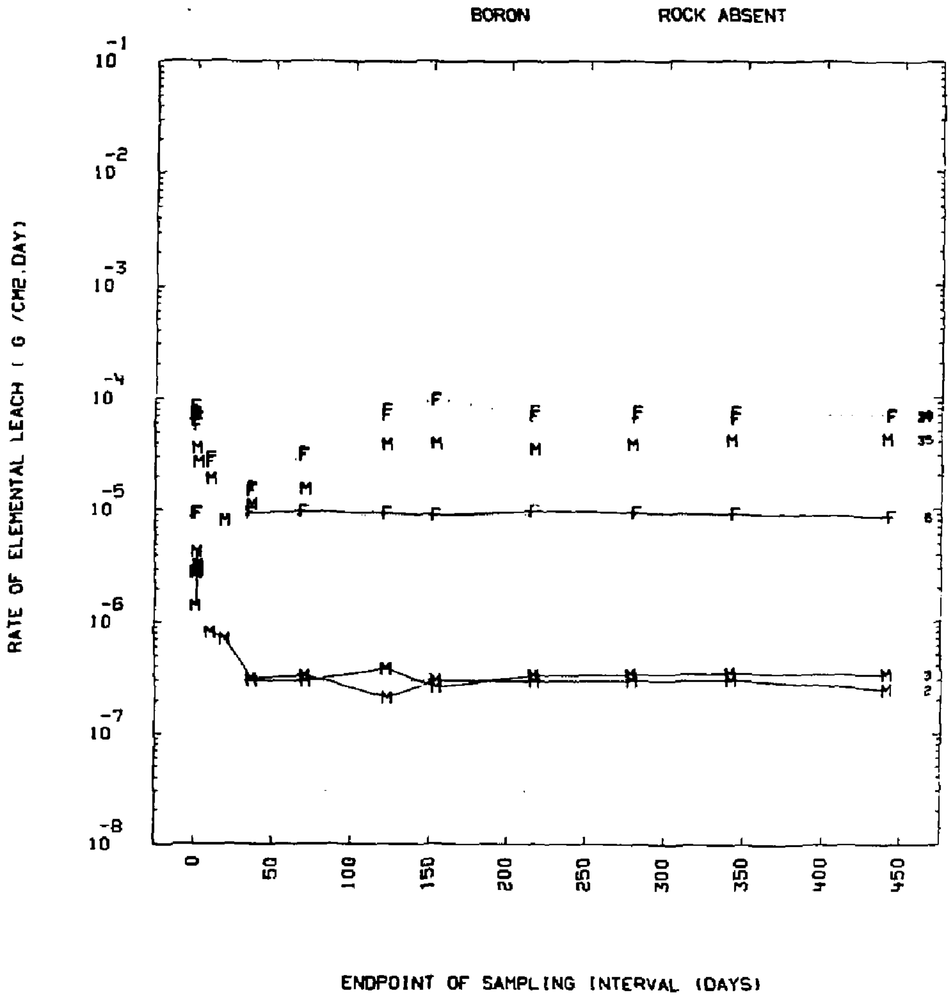


APPENDIX 12

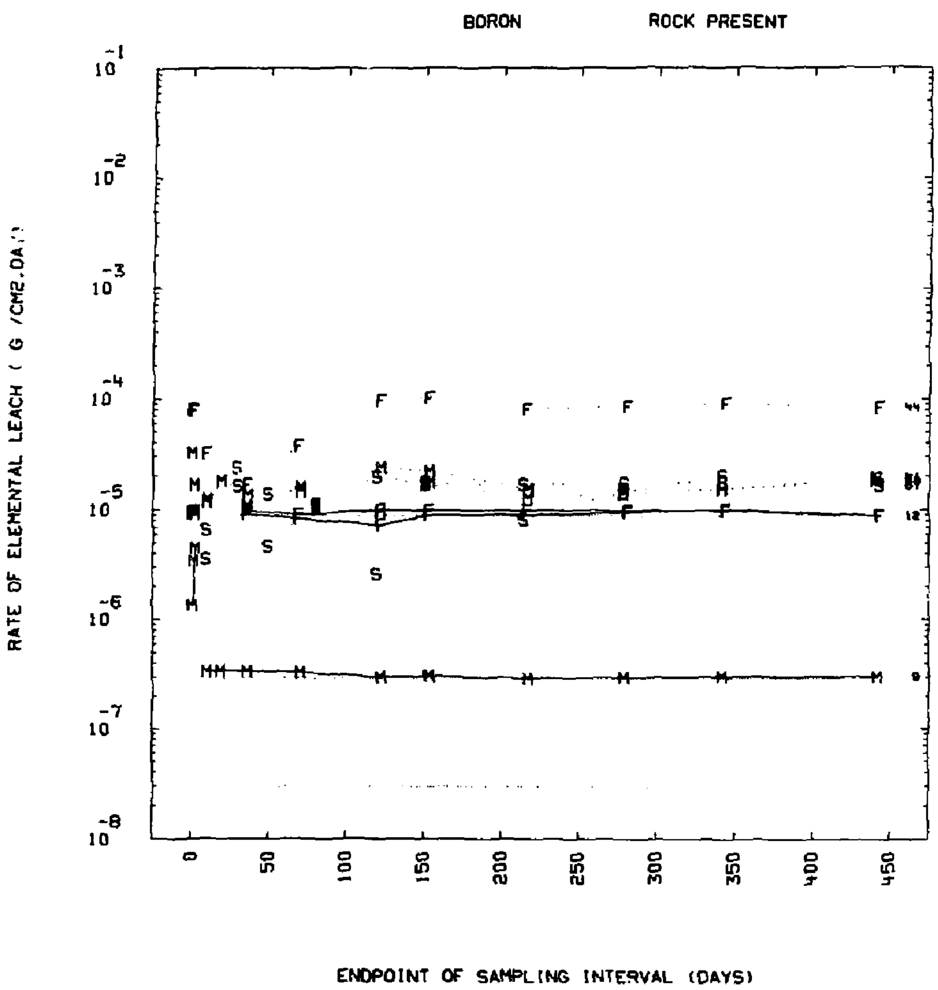
Graphs of Incremental Leach Rate for Stable Elements vs. Time

Flow rates are designated with the letters F for fast (300 ml/day), M for medium (10 ml/day) and S for slow (1 ml/day). Dotted lines represent the 75°C channels and solid lines represent the 25°C channels. Identification of channels is shown with a number on the right hand side of each graph. There are separate graphs for "no rock" channels (channels 2, 3, 6, 35, 37 and 38) and for "rock" channels (channels 9, 11, 12, 40, 41, 67 and 71).

The horizontal dotted lines represent limits of detection for the three flow rates. See text.



BORON
ROCK ABSENT
RATE OF ELEMENTAL LEACH (G /CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)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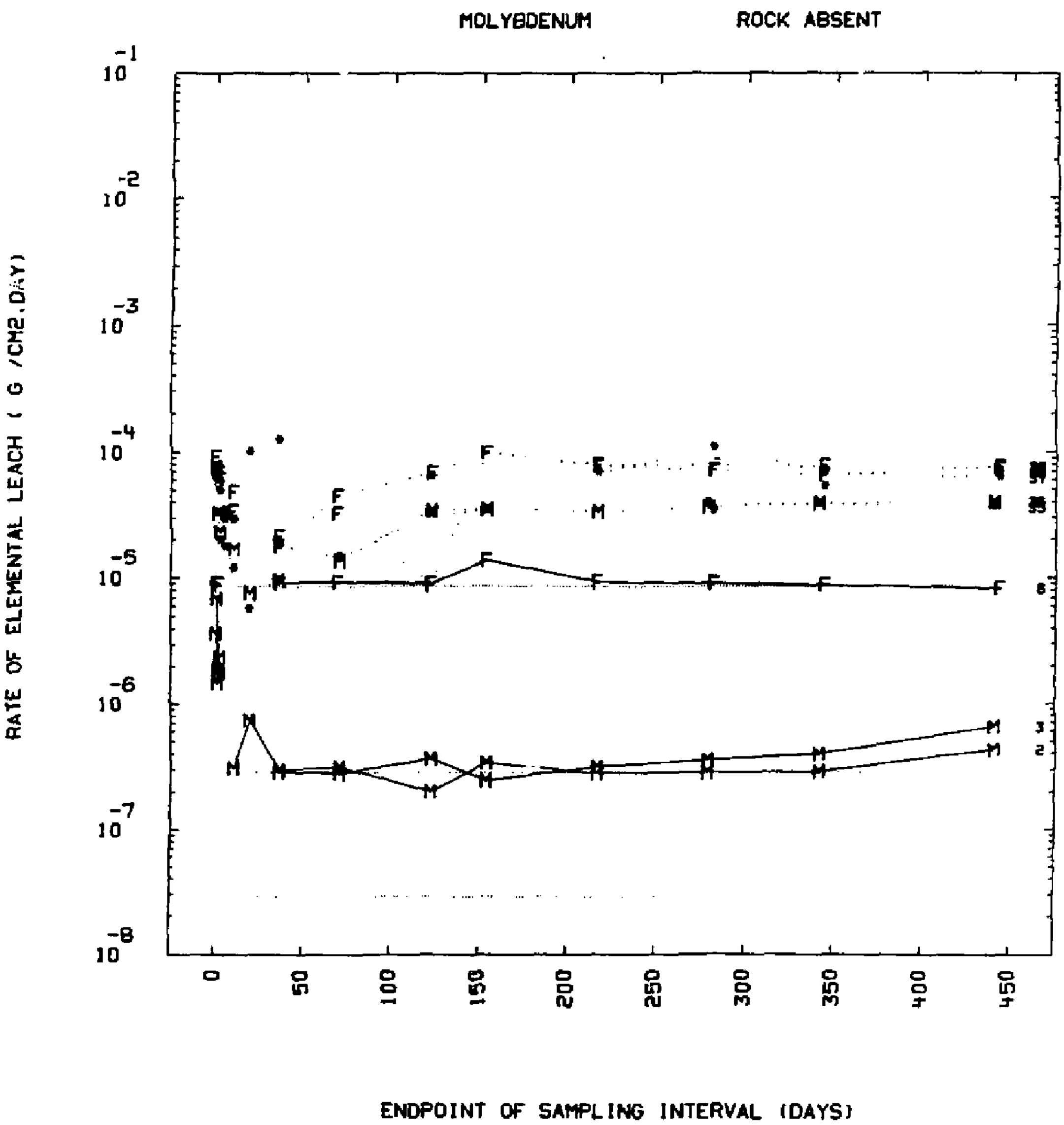
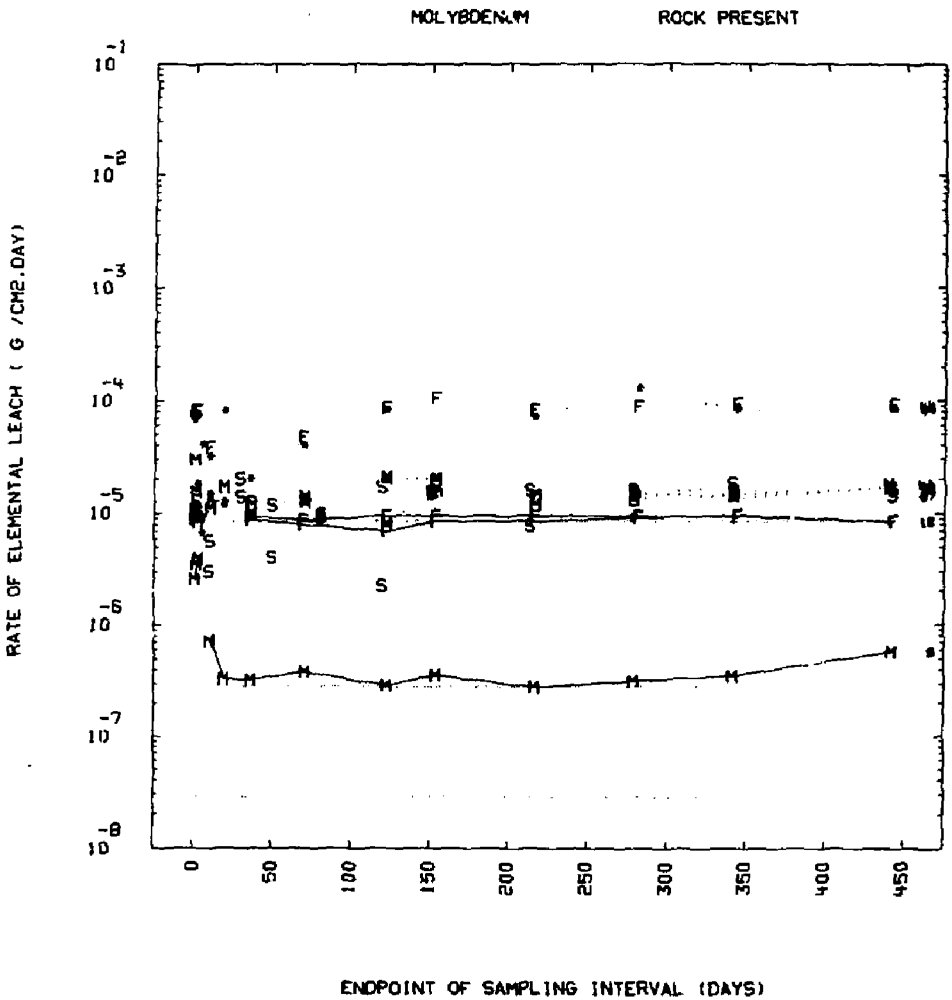
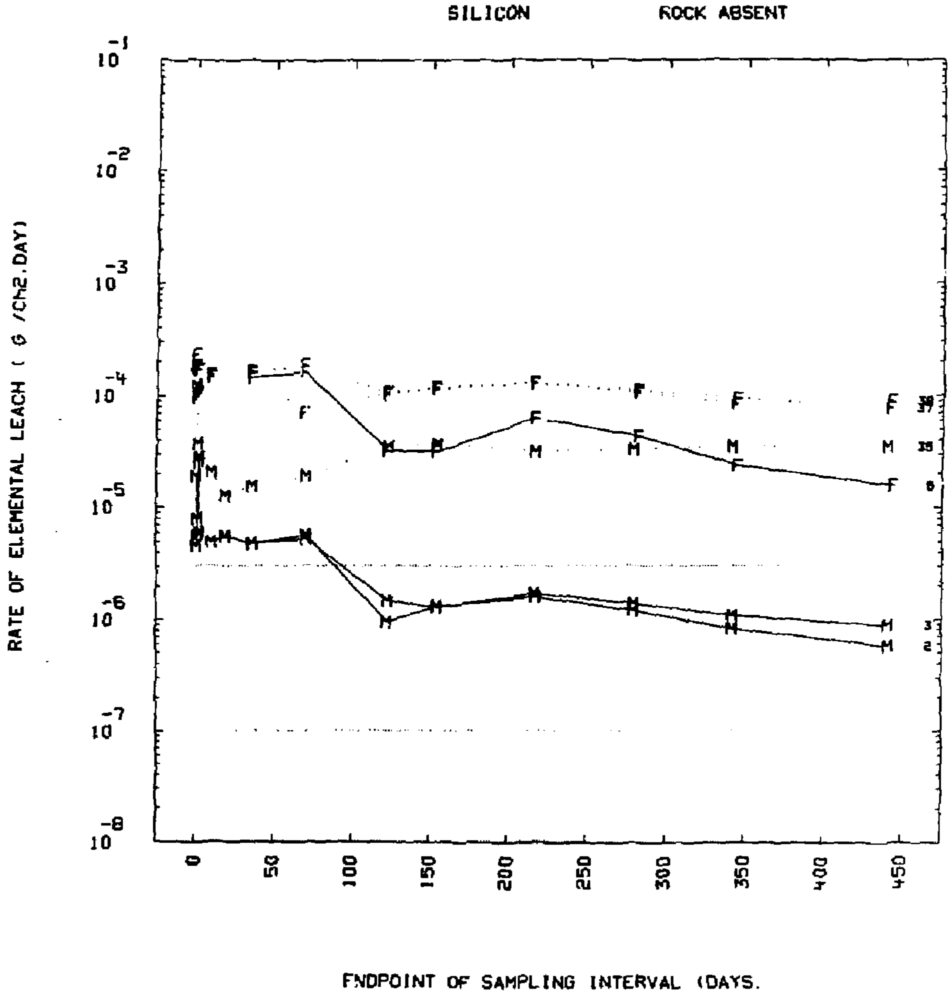
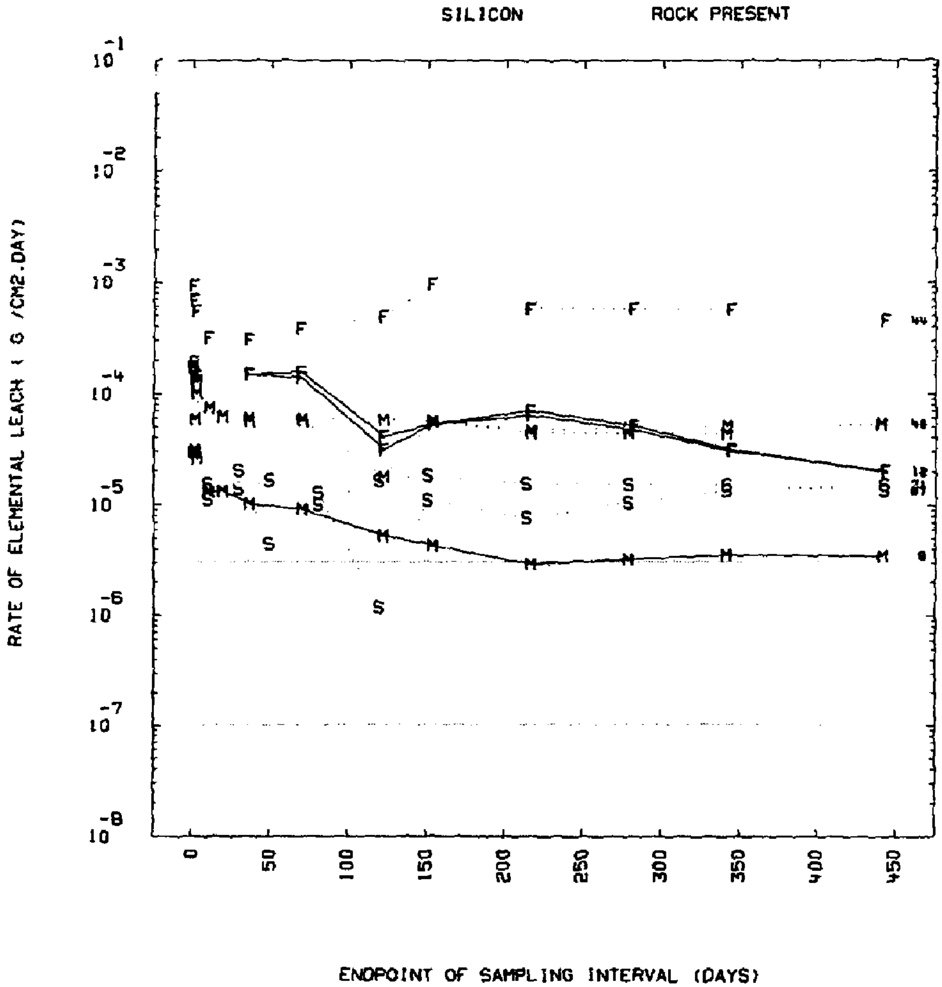
ROCK PRESENT
RATE OF ELEMENTAL LEACH (G /CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)


MOLYBDENUM
ROCK ABSENT
RATE OF ELEMENTAL LEACH (G /CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)



MOLYBDENUM
ROCK PRESENT
RATE OF ELEMENTAL LEACH (G /CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)


SILICON
ROCK ABSENT
RATE OF ELEMENTAL LEACH (G /CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS.


SILICON
ROCK PRESENT
RATE OF ELEMENTAL LEACH (G /CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)
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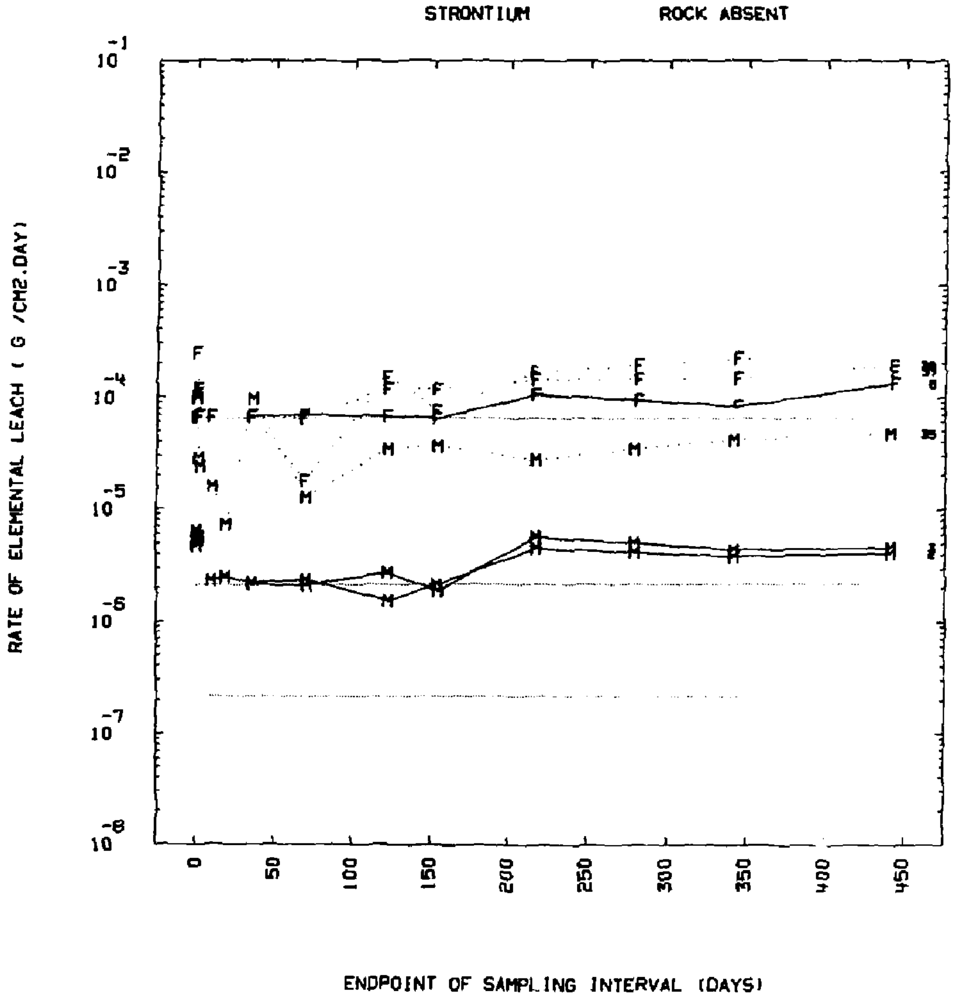
250
300
350
400
450


STRONTIUM
ROCK ABSENT
RATE OF ELEMENTAL LEACH (G /CM2.DAY)
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10^-3
10^-4
10^-5
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10^-8
0
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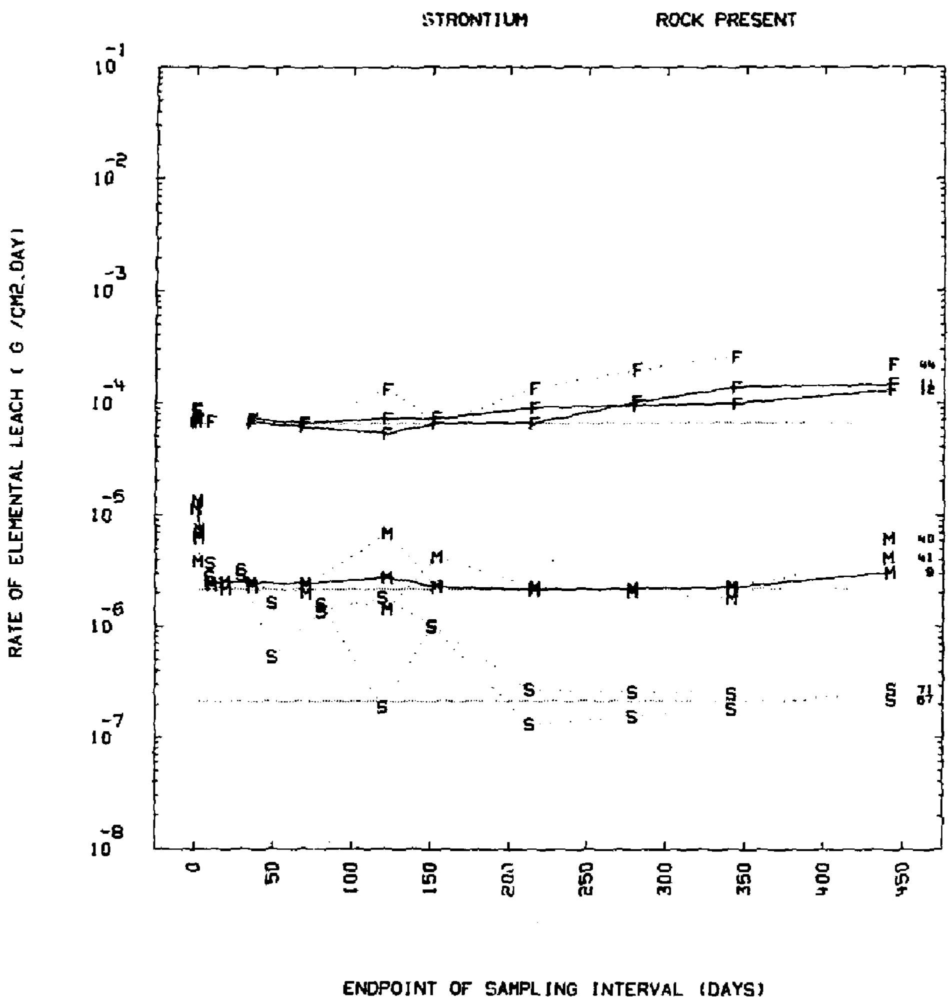
100
150
200
250
300
350
400
450
ENDPOINT OF SAMPLING INTERVAL (DAYS)



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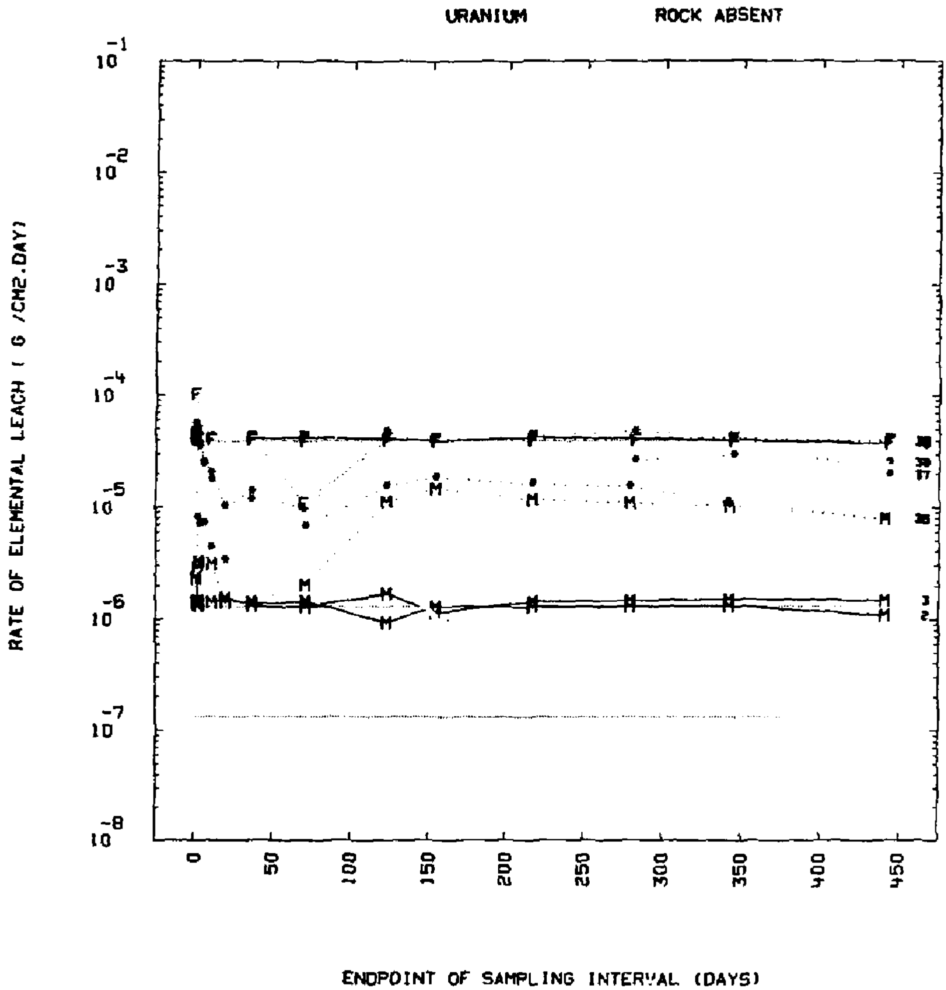
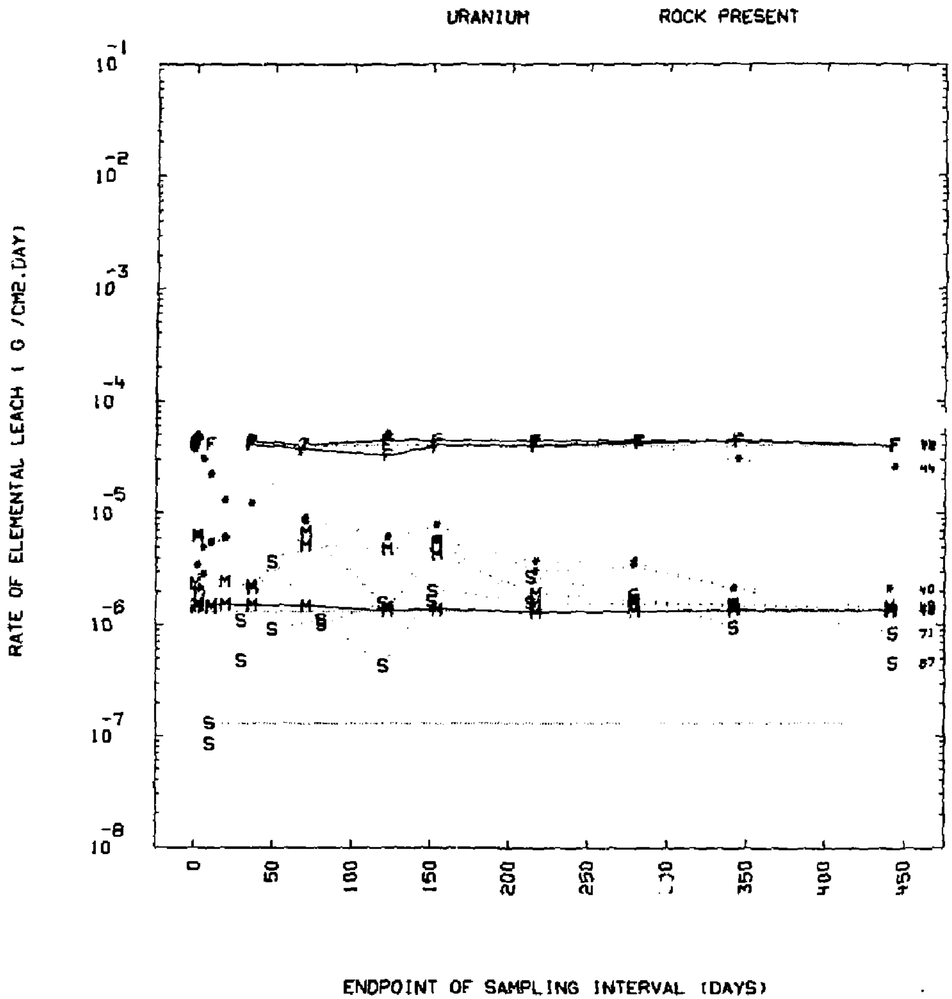
ROCK PRESENT
RATE OF ELEMENTAL LEACH (G /CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)


URANIUM
ROCK ABSENT
RATE OF ELEMENTAL LEACH (G /CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)


URANIUM
ROCK PRESENT
RATE OF ELEMENTAL LEACH (G /CM2.DAY)
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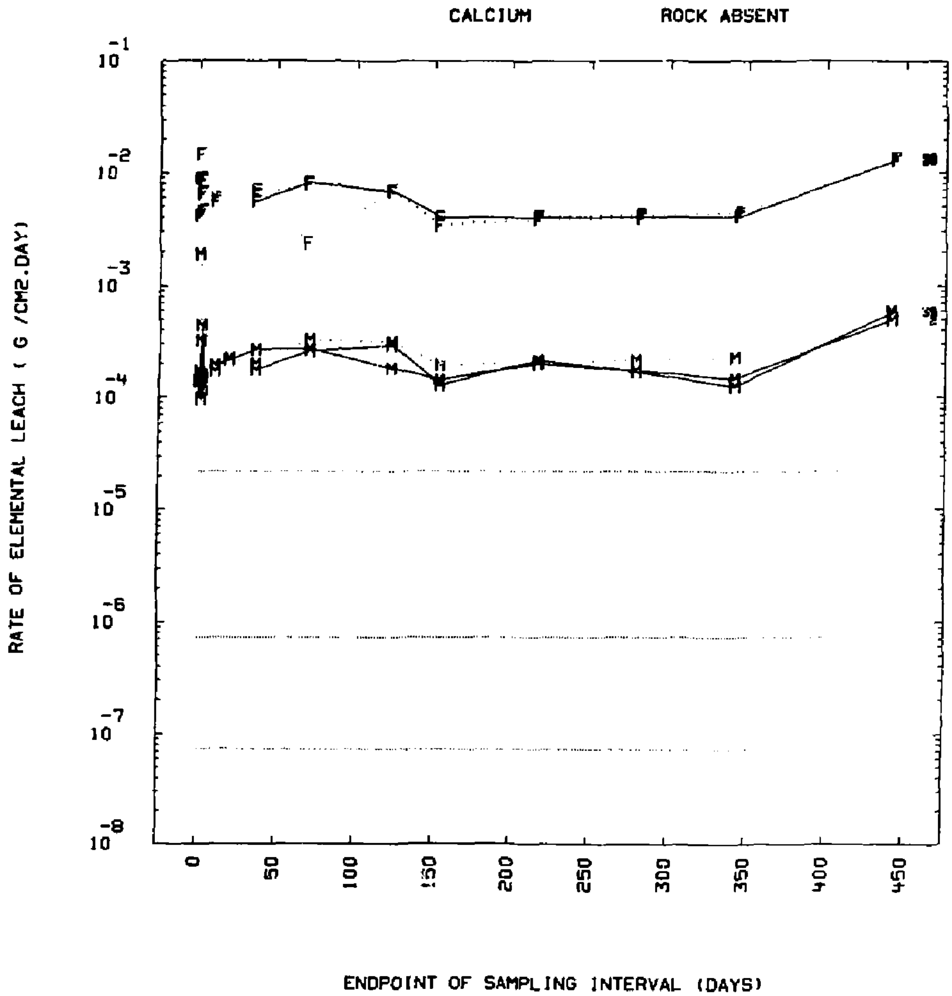
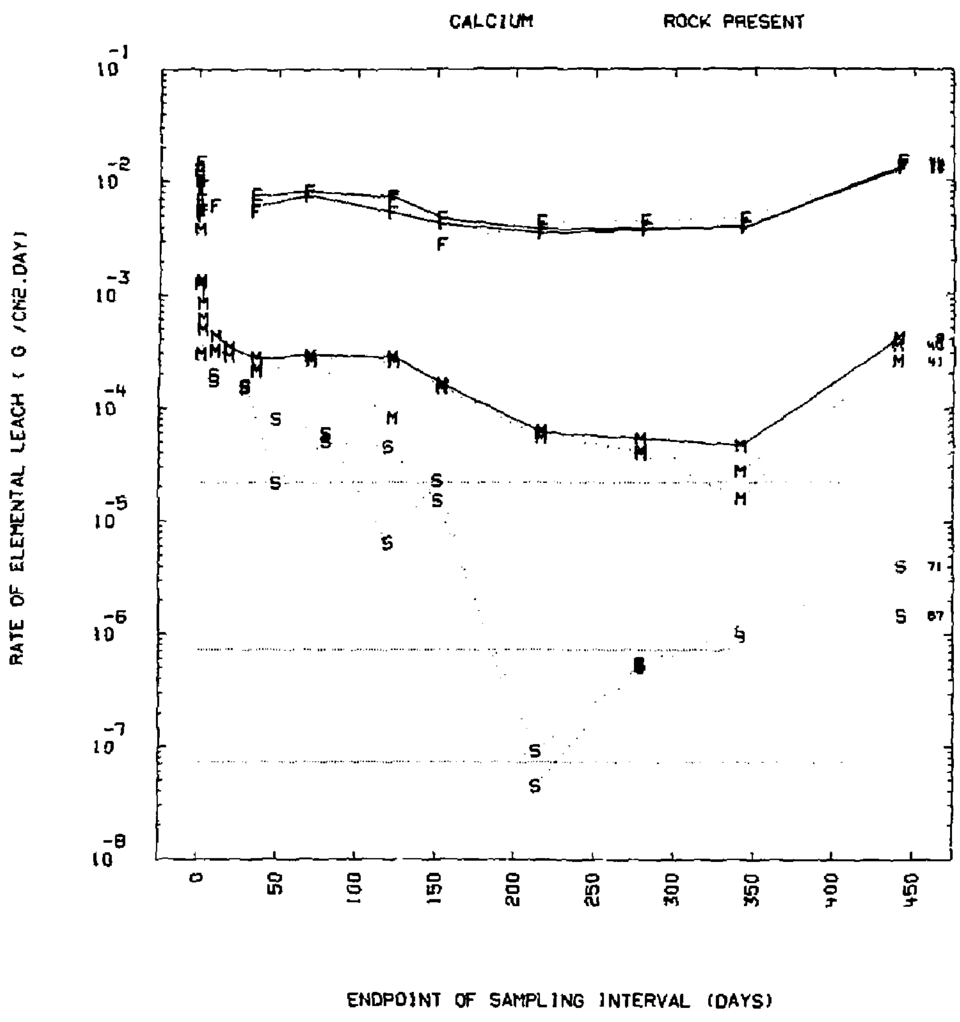
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
0
50
100
150
200
250
350
400
450
ENDPOINT OF SAMPLING INTERVAL (DAYS)


CALCIUM
ROCK ABSENT
RATE OF ELEMENTAL LEACH (G /CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)


CALCIUM
ROCK PRESENT
RATE OF ELEMENTAL LEACH (G /CM2.DAY)
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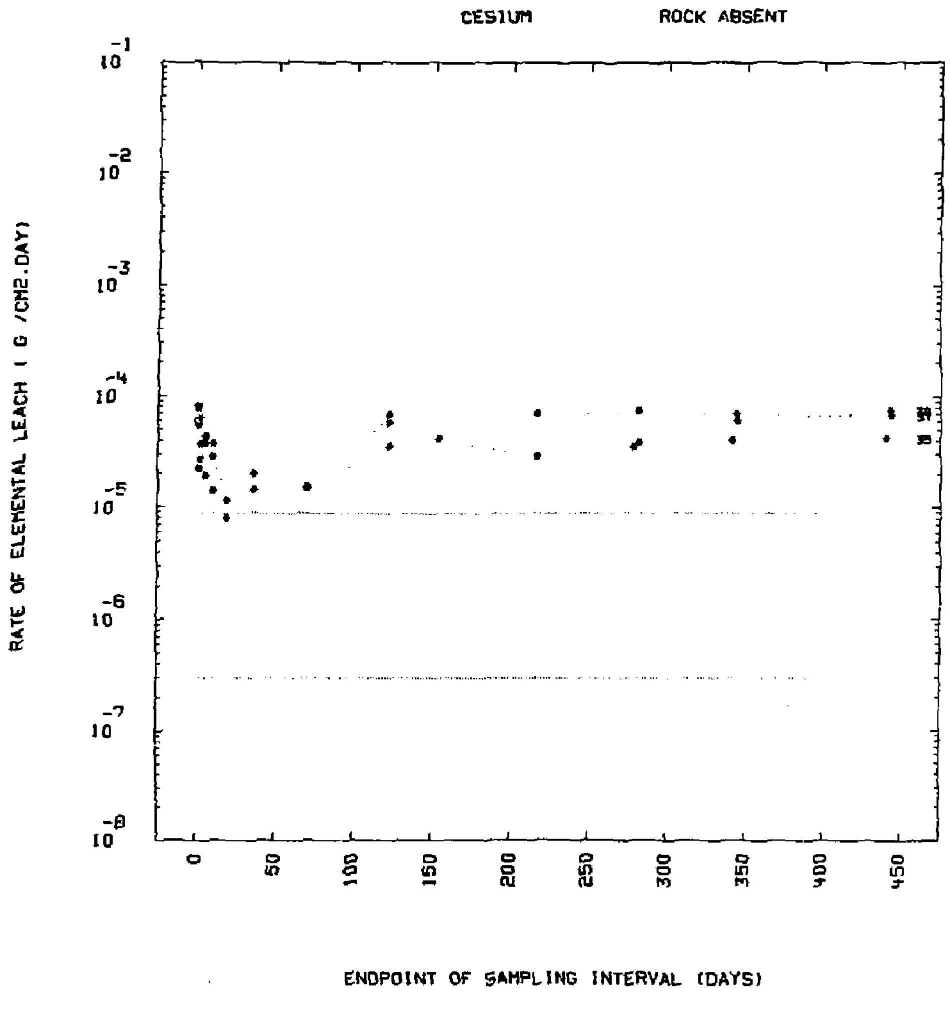
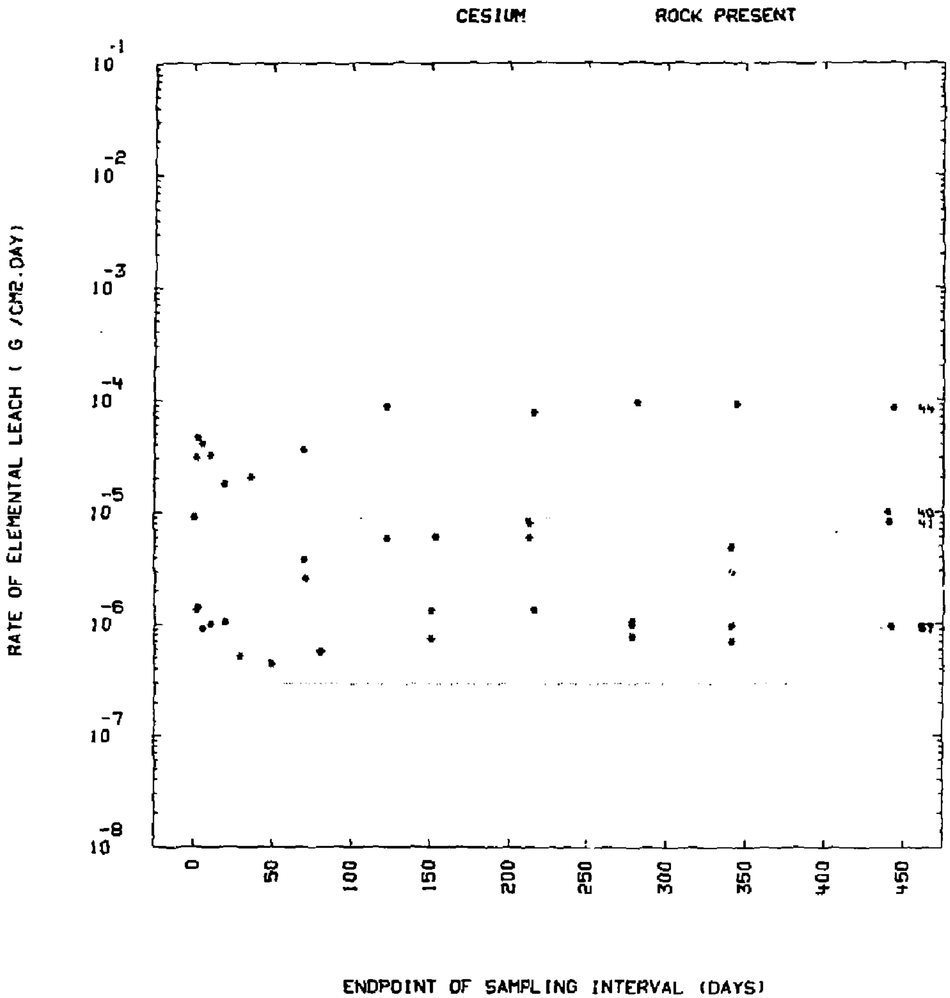
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
0
50
100
150
200
250
300
350
400
450
ENDPOINT OF SAMPLING INTERVAL (DAYS)



CESIUM
ROCK ABSENT
RATE OF ELEMENTAL LEACH (G /CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

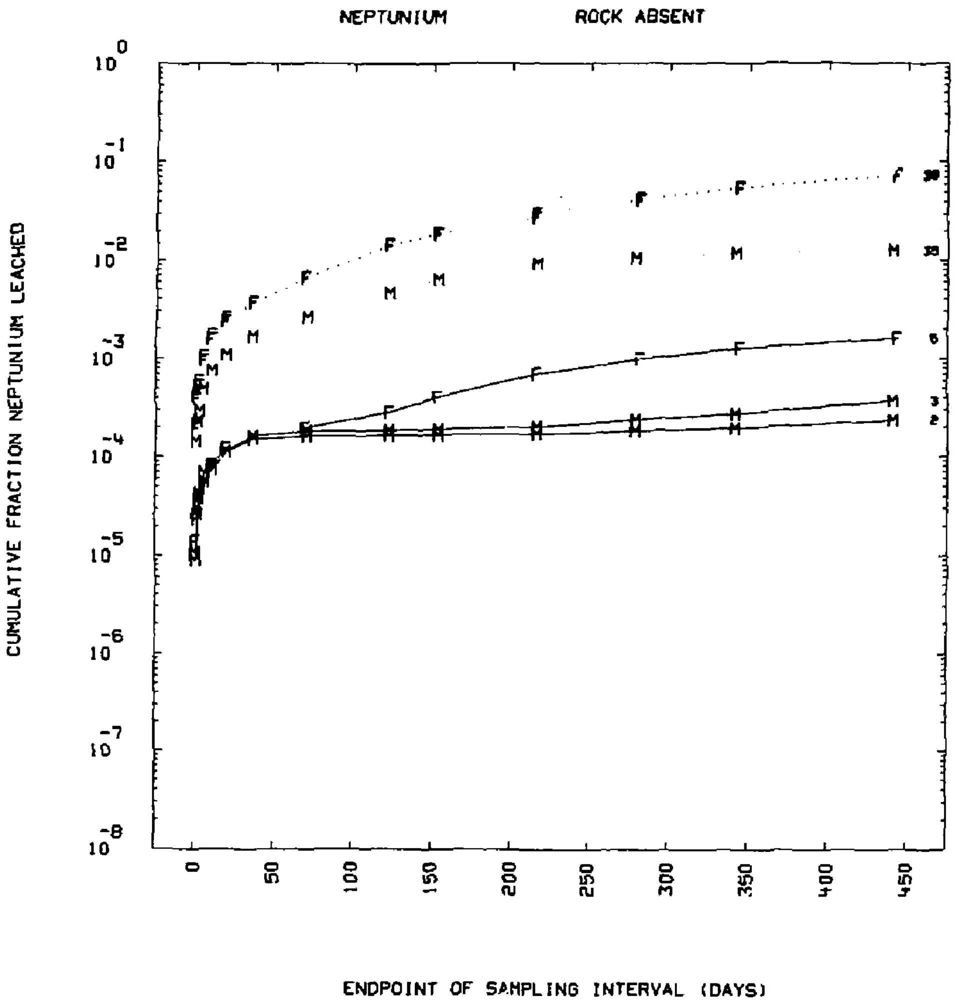


CESIUM
ROCK PRESENT
RATE OF ELEMENTAL LEACH (G /CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

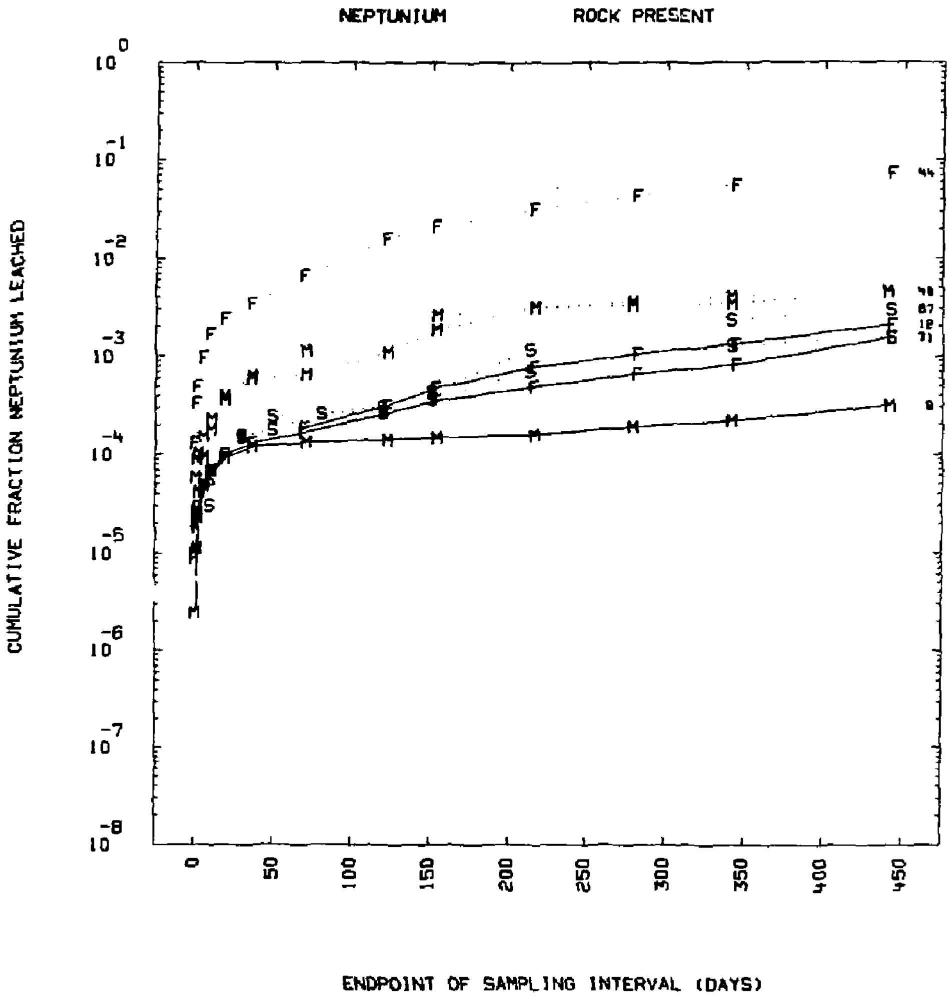
APPENDIX 13

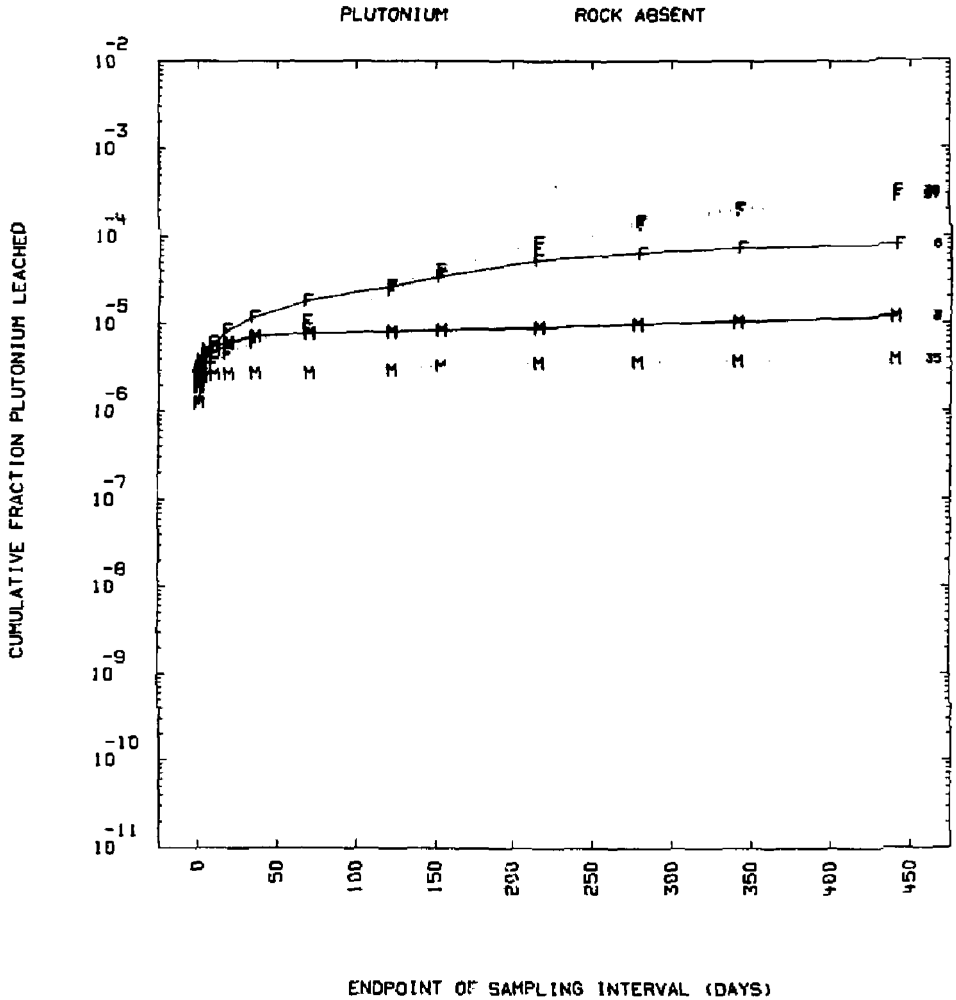
Graphs of Cumulative Leach Rate for Np and Pu vs. Time.

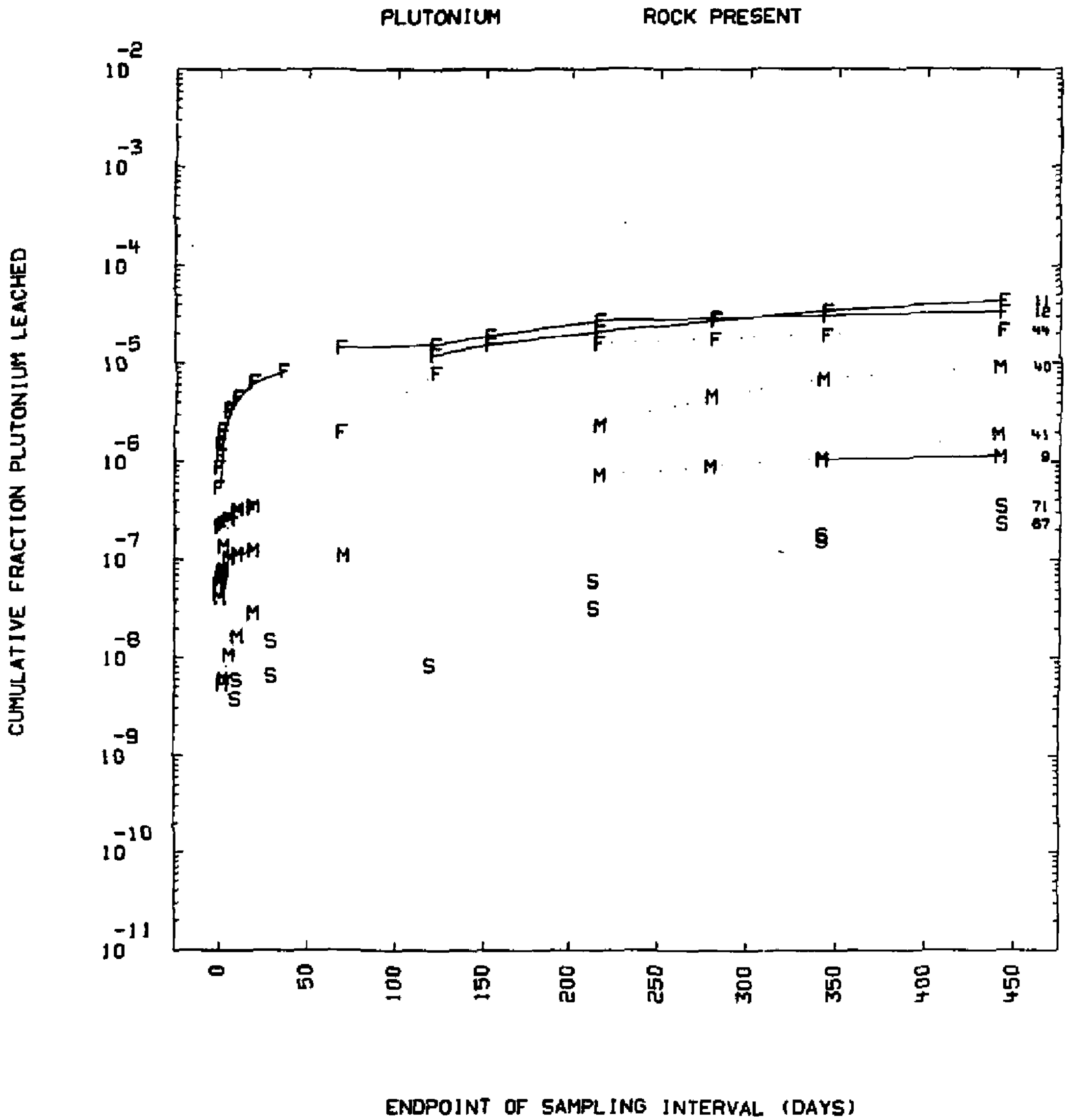
Flow rates are designated with the letters F for fas[illegible] ml/day), M for medium (10 ml/day) and S for slow (1 ml/day). Dott[illegible] represent the 75°C channels and solid lines represent the 25°C channe[illegible]fication of channels is shown with a number on the right hand side of [illegible] There are separate graphs for "no rock" channels (channels 2, 3, [illegible]and 38) and for "rock" channels (channel 9, 11, 12, 40, 41, 67 and [illegible]



NEPTUNIUM
ROCK ABSENT
CUMULATIVE FRACTION NEPTUNIUM LEACHED
ENDPOINT OF SAMPLING INTERVAL (DAYS)


NEPTUNIUM
ROCK PRESENT
CUMULATIVE FRACTION NEPTUNIUM LEACHED
ENDPOINT OF SAMPLING INTERVAL (DAYS)
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
0
50
100
150
200
250
300
350
400
450


PLUTONIUM
ROCK ABSENT
CUMULATIVE FRACTION PLUTONIUM LEACHED
ENDPOINT OF SAMPLING INTERVAL (DAYS)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10^{-10}
10^{-11}
0
50
100
150
200
250
300
350
400
450

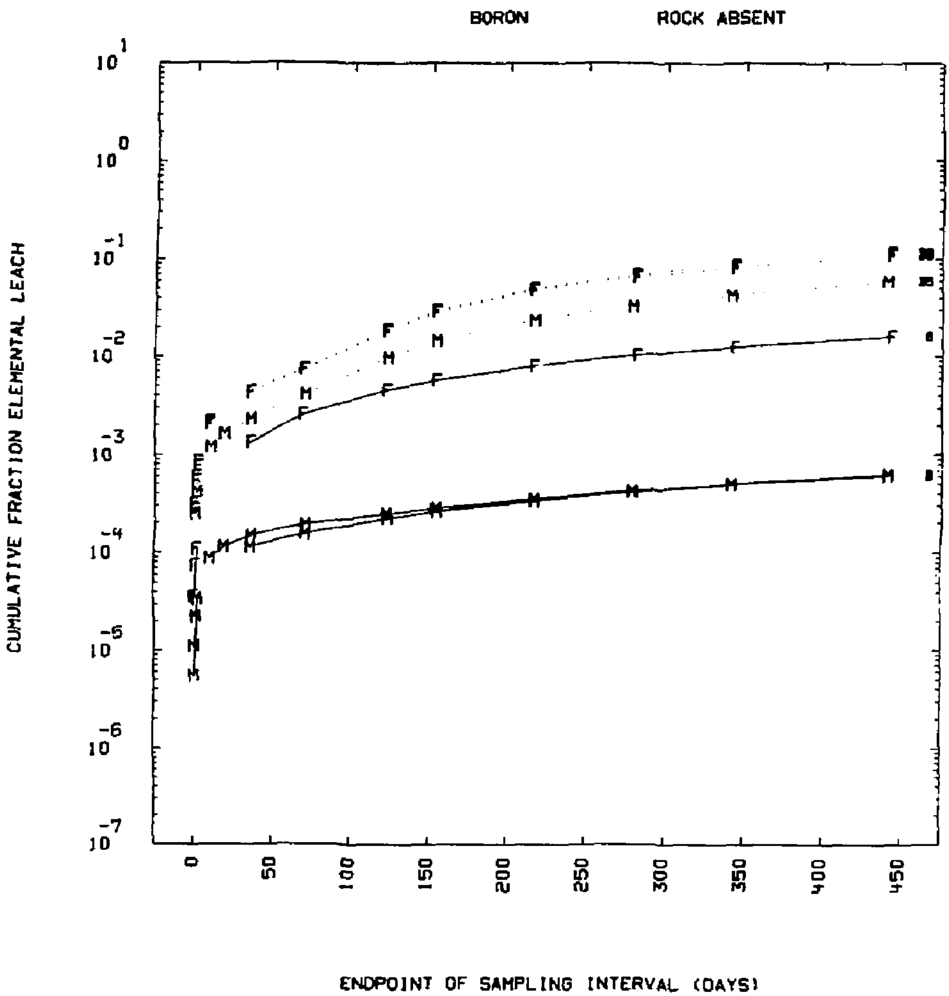


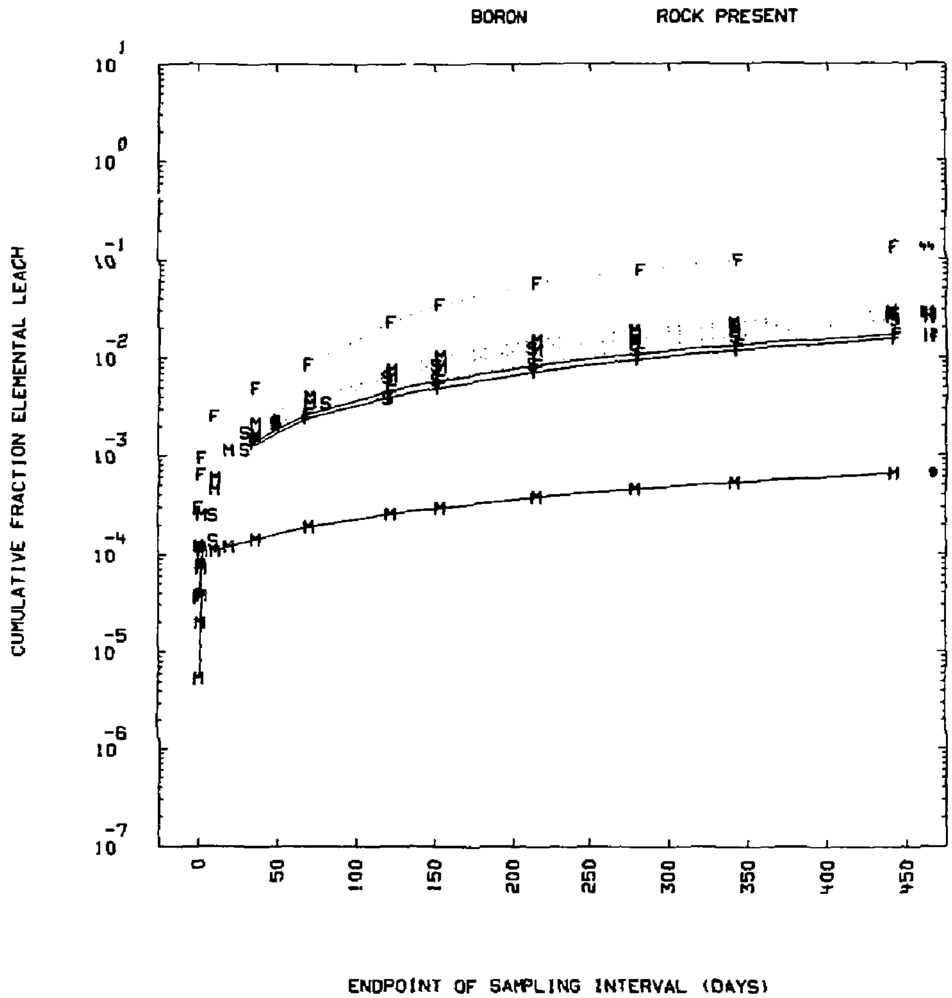
PLUTONIUM
ROCK PRESENT
CUMULATIVE FRACTION PLUTONIUM LEACHED
ENDPOINT OF SAMPLING INTERVAL (DAYS)

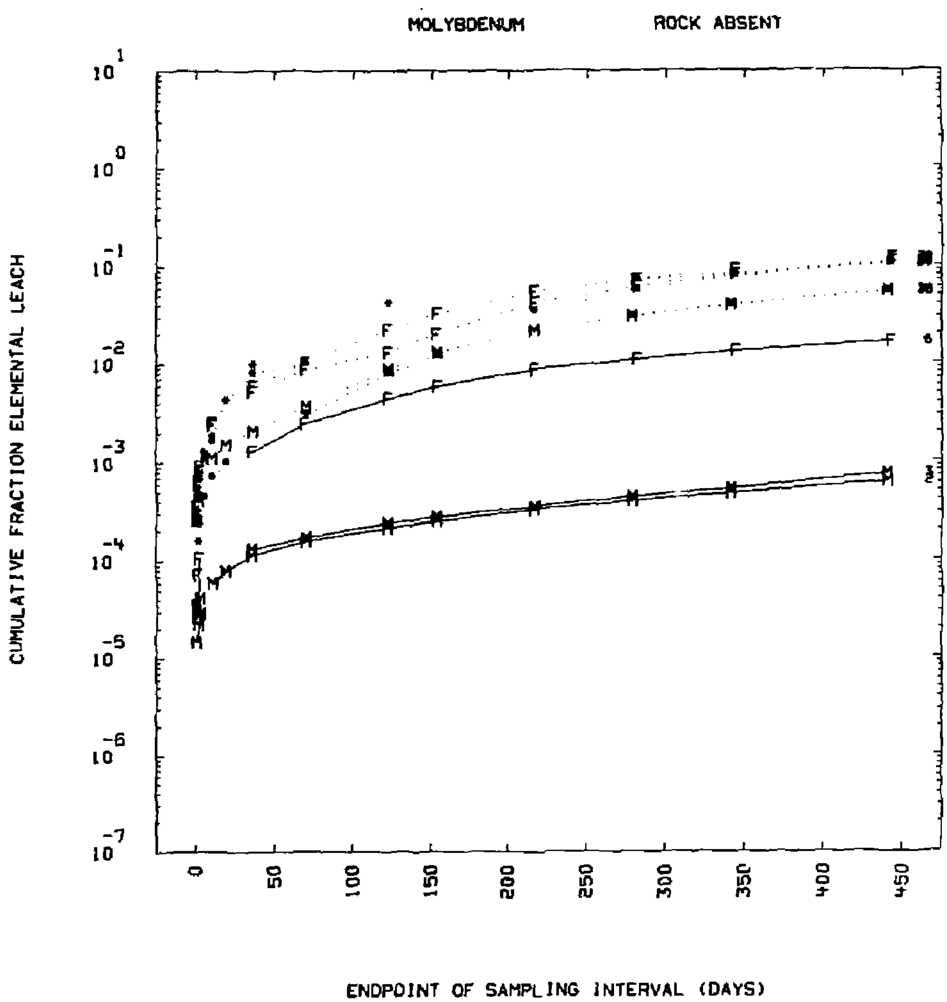
APPENDIX 14

Graphs of Cumulative Leach Rate for Stable Elements vs. Time.

Flow rates are designated with the letters F for fast (300 ml/day), M for medium (10 ml/day) and S for slow (1 ml/day). Dotted lines represent the 75°C channels and solid lines represent the 25°C channels. Identification of channels is shown with a number on the right hand side of each graph. There are separate graphs for "no rock" channels (channels 2, 3, 6, 35, 37 and 38) and for "rock" channels (channels 9, 11, 12, 40, 41, 67 and 71).

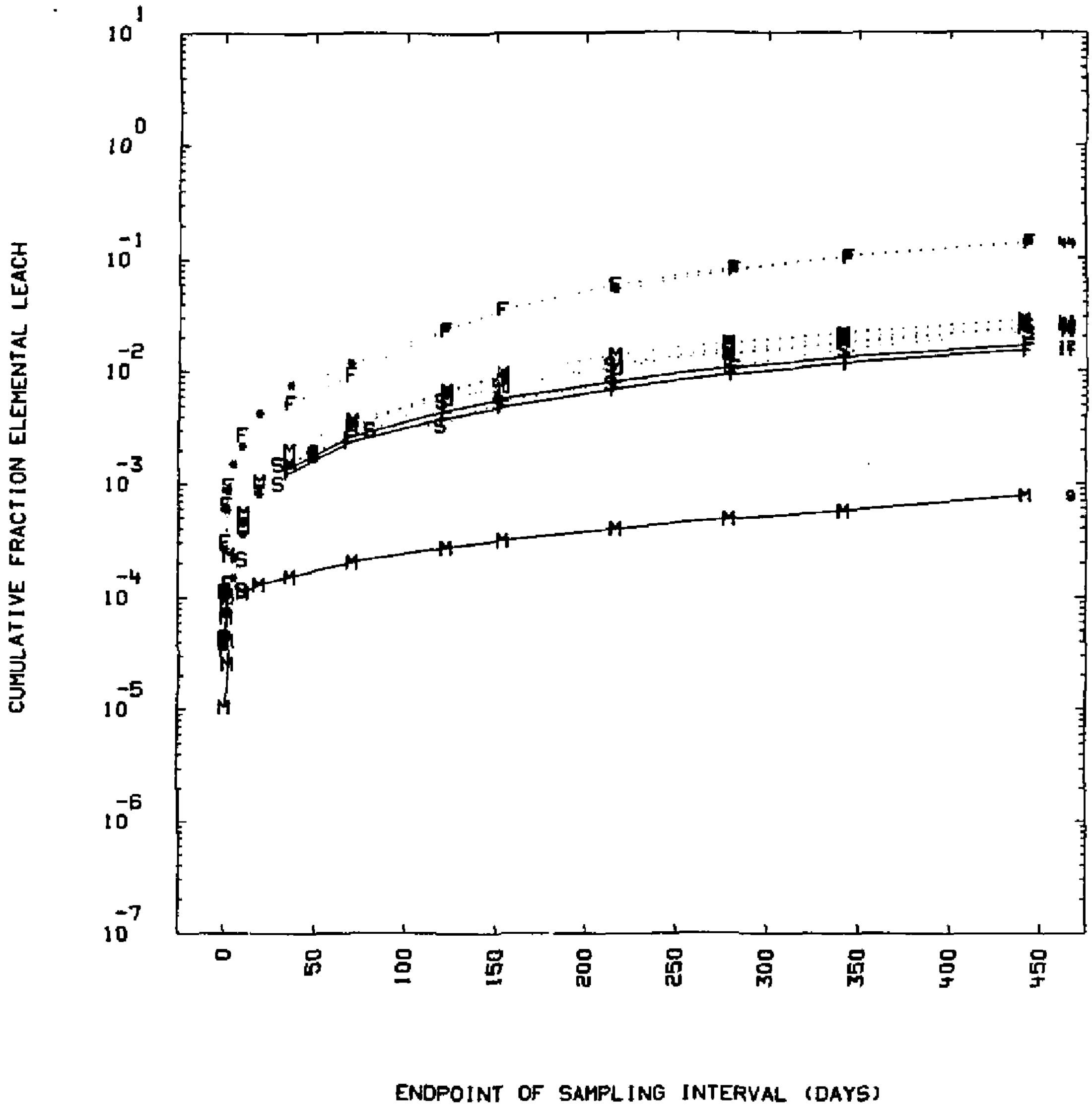

BORON
ROCK ABSENT
CUMULATIVE FRACTION ELEMENTAL LEACH
ENDPOINT OF SAMPLING INTERVAL (DAYS)

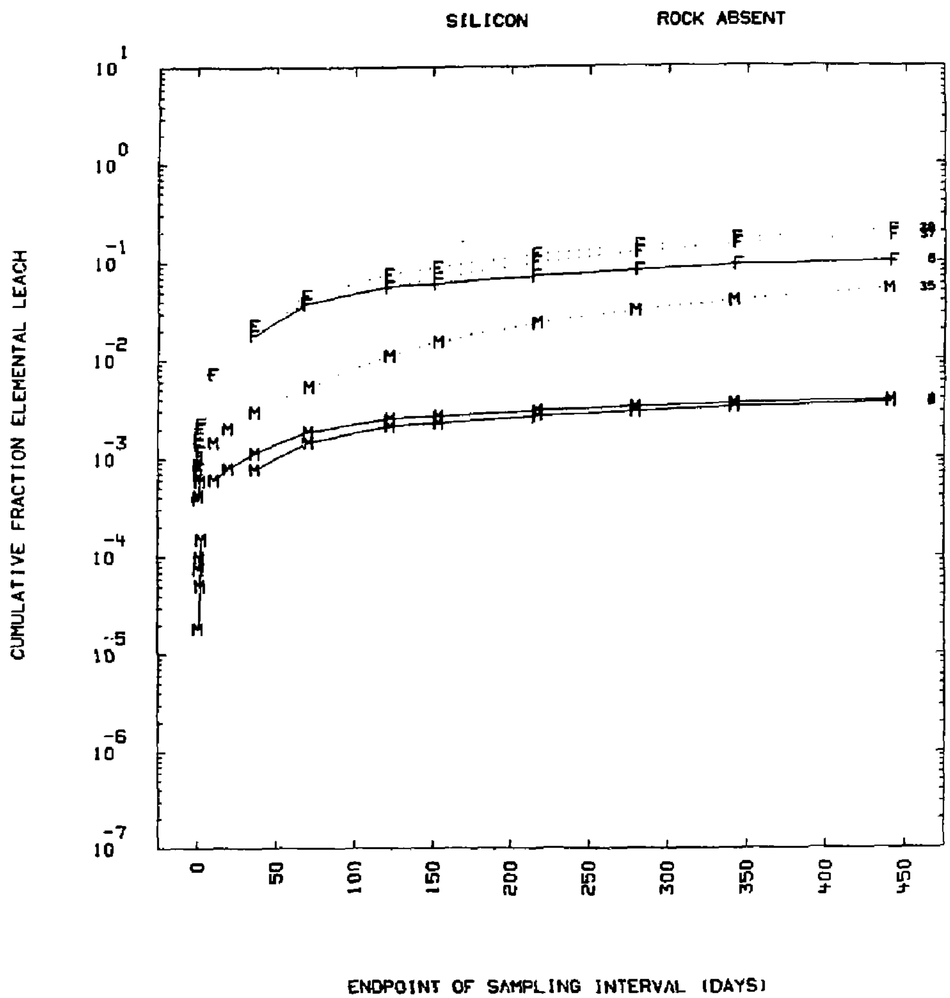

BORON
ROCK PRESENT
CUMULATIVE FRACTION ELEMENTAL LEACH
ENDPOINT OF SAMPLING INTERVAL (DAYS)



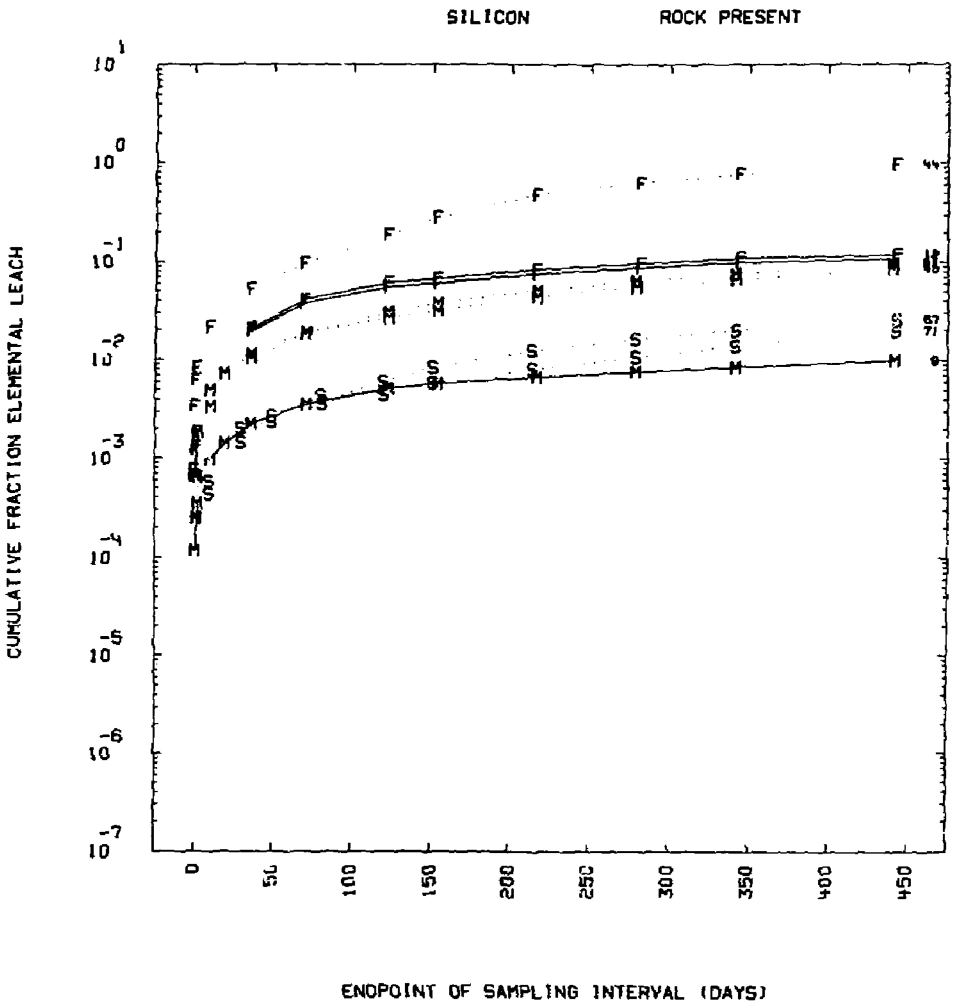
MOLYBDENUM
ROCK ABSENT
CUMULATIVE FRACTION ELEMENTAL LEACH
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
0
50
100
150
200
250
300
350
400
450
ENDPOINT OF SAMPLING INTERVAL (DAYS)

MOLYBDENUM ROCK PRESENT

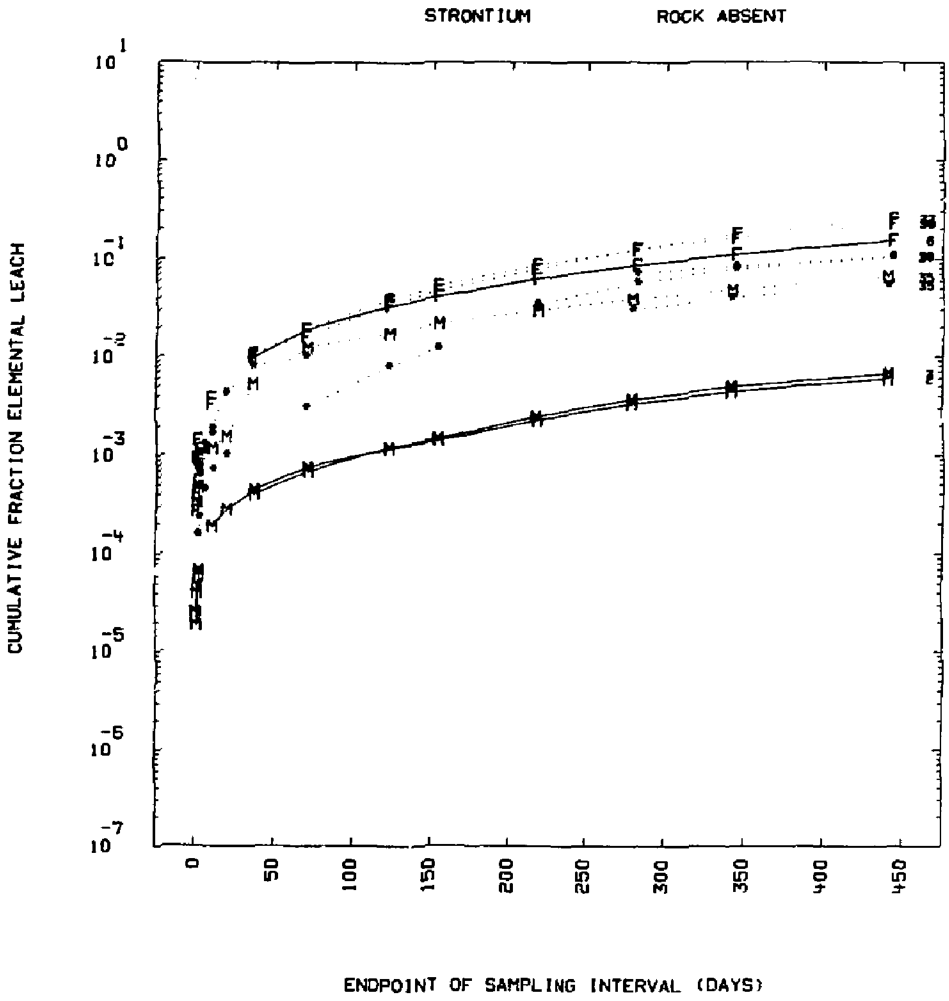




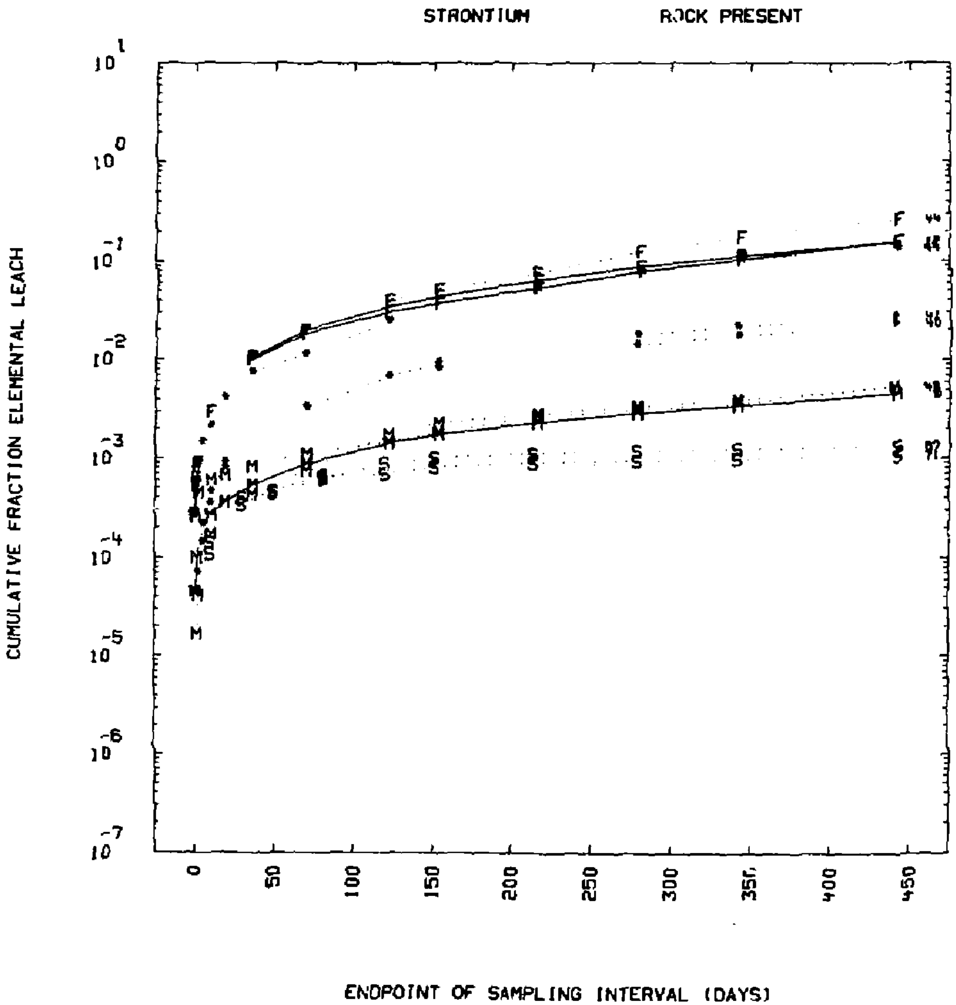
SILICON ROCK ABSENT
CUMULATIVE FRACTION ELEMENTAL LEACH
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
0
50
100
150
200
250
300
350
400
450
ENDPOINT OF SAMPLING INTERVAL (DAYS)

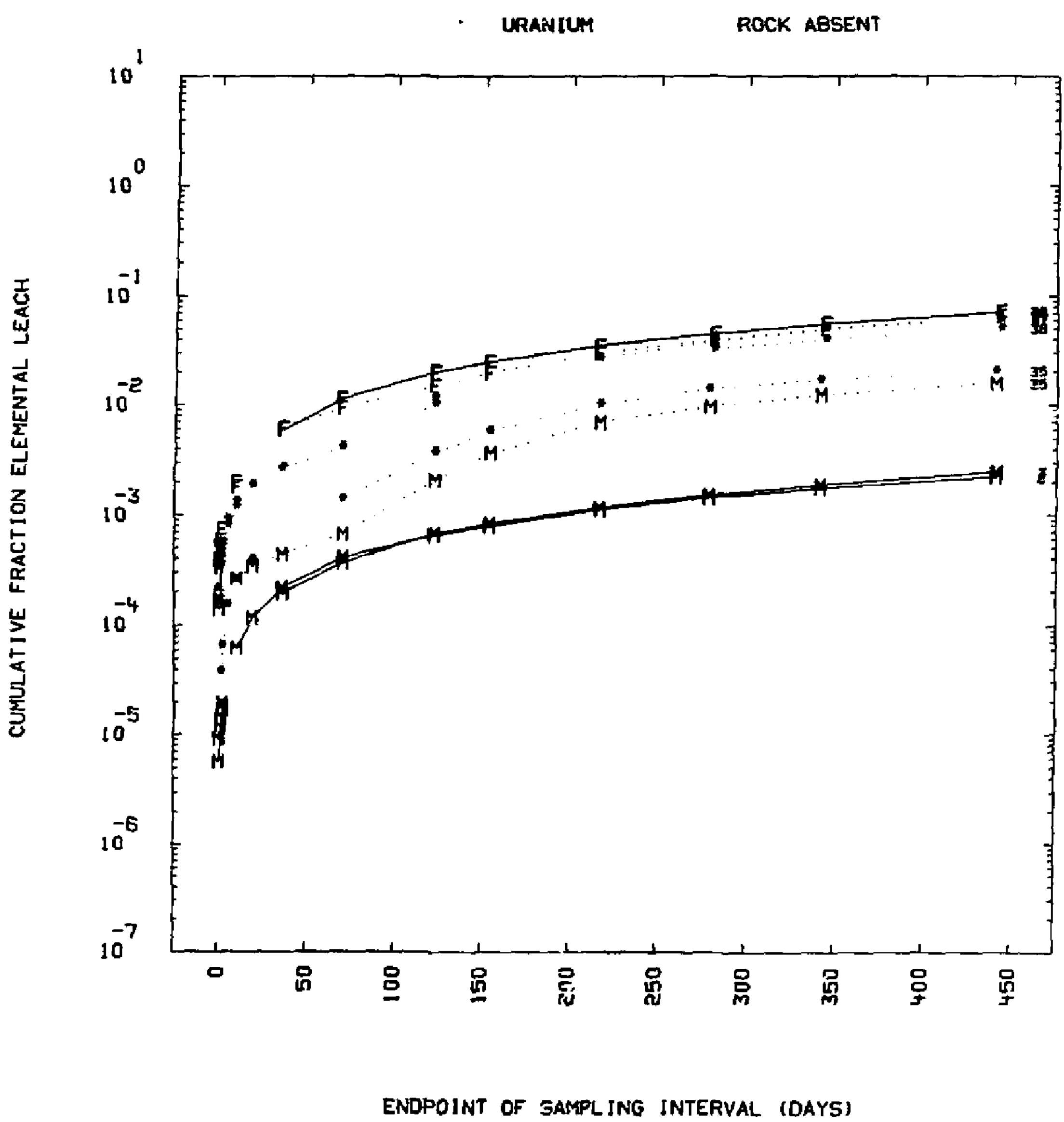


SILICON
ROCK PRESENT
CUMULATIVE FRACTION ELEMENTAL LEACH
ENDPOINT OF SAMPLING INTERVAL (DAYS)
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
0
50
100
150
200
250
300
350
400
450

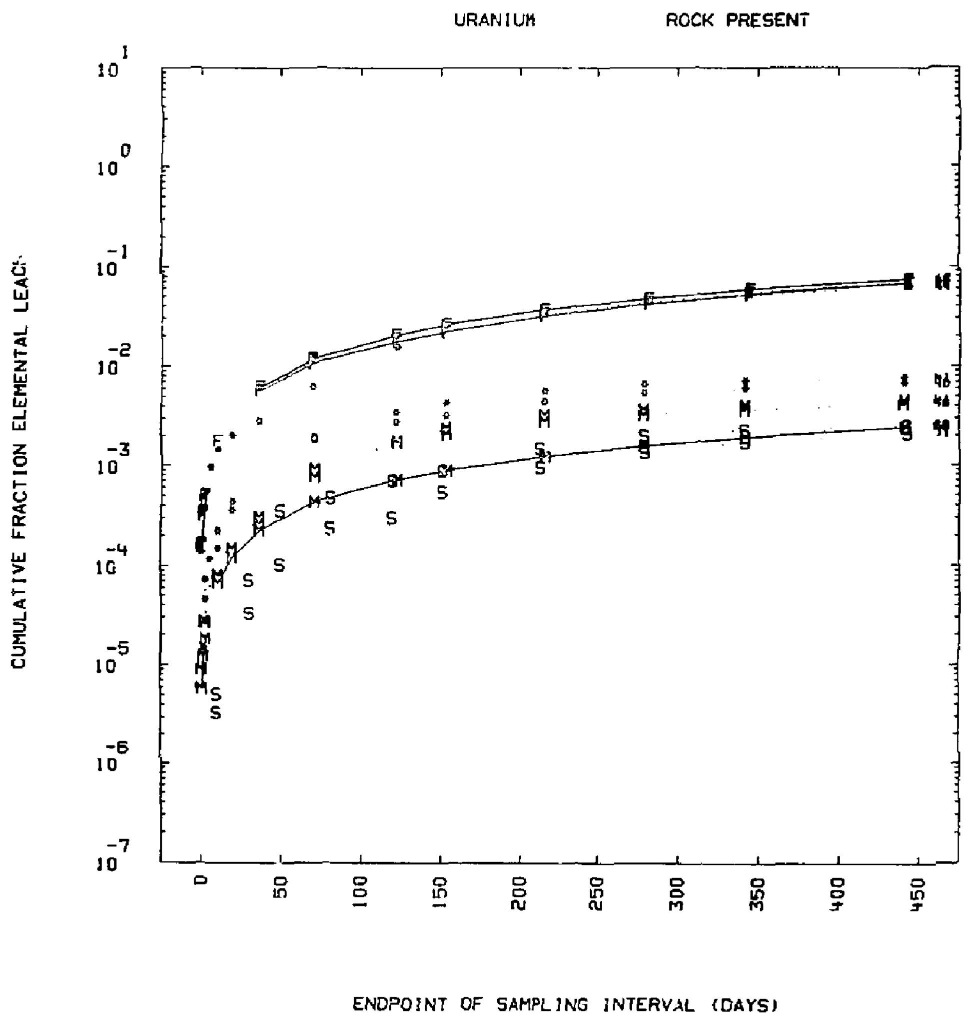


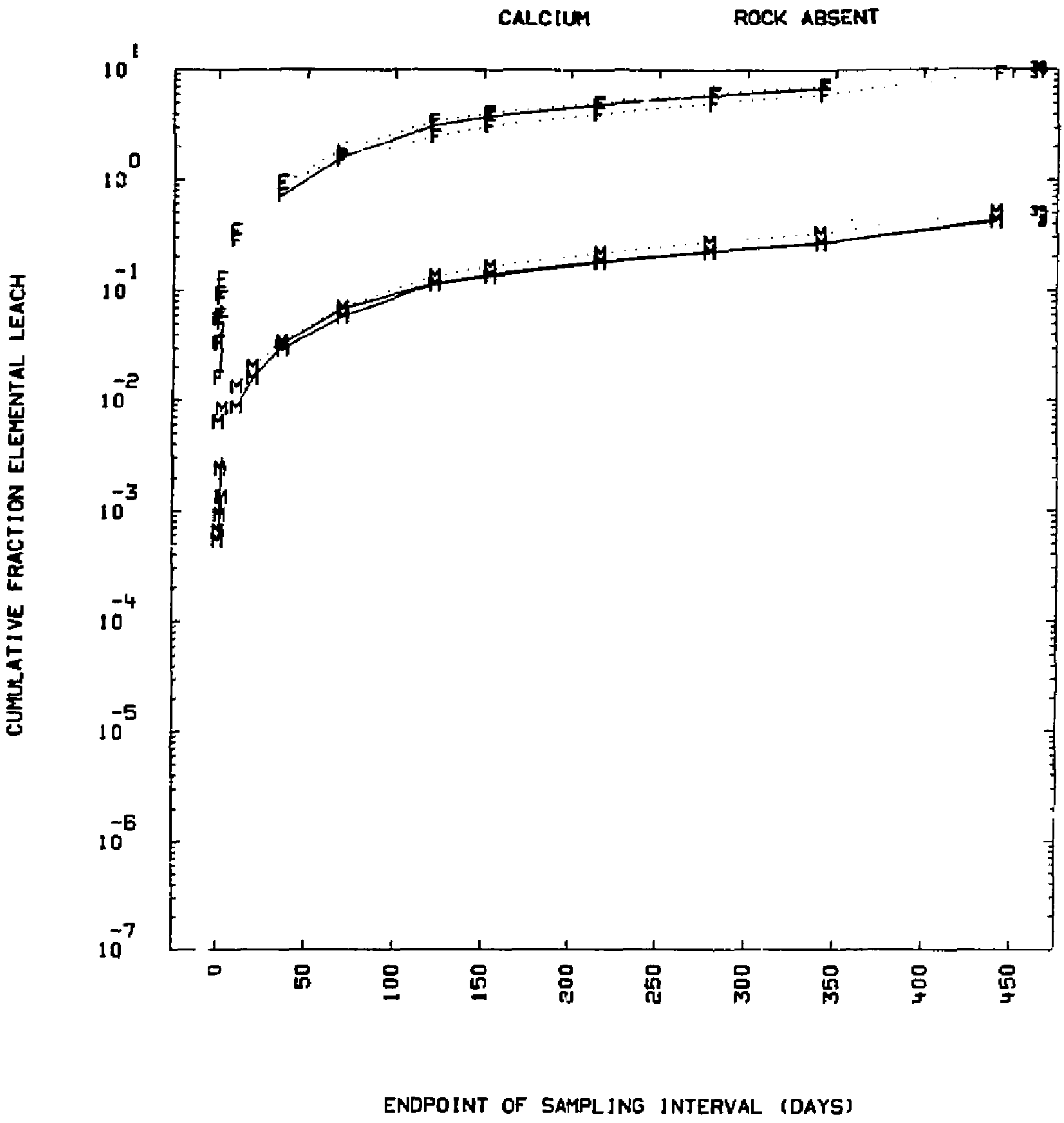
STRONTIUM
ROCK ABSENT
CUMULATIVE FRACTION ELEMENTAL LEACH
ENDPOINT OF SAMPLING INTERVAL (DAYS)

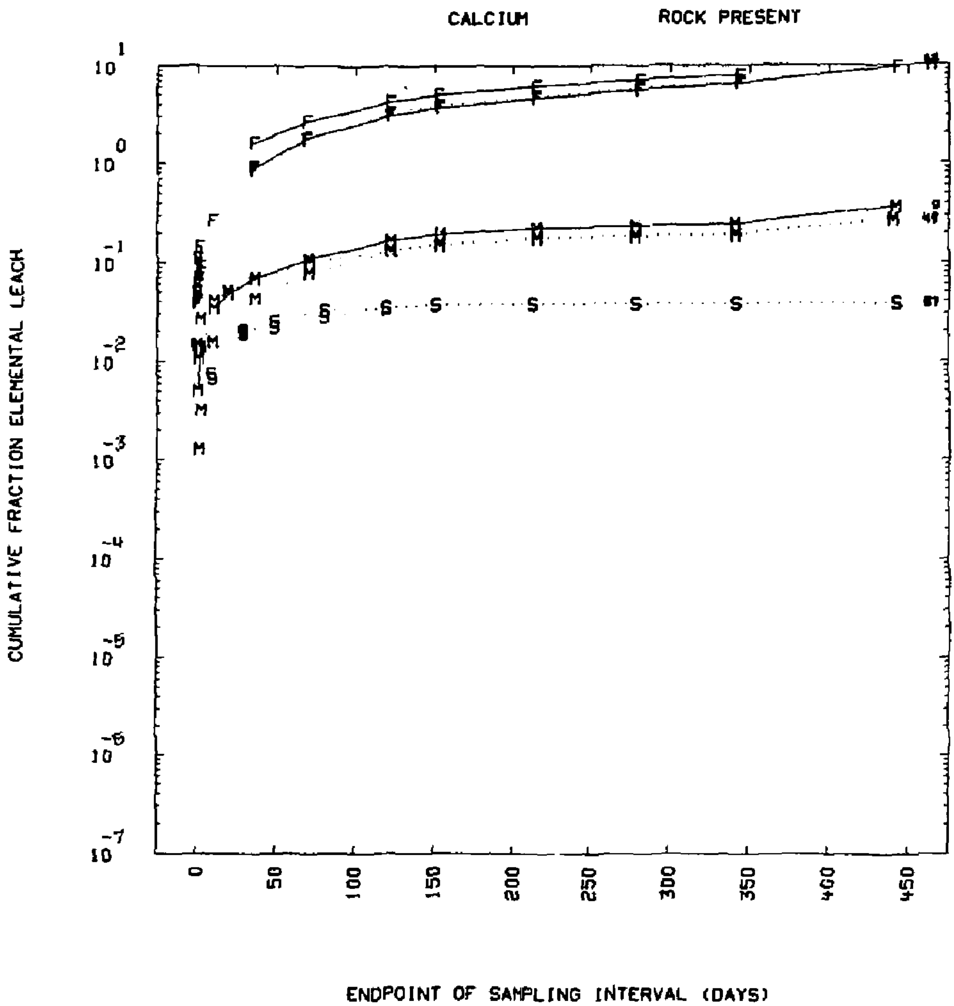

STRONTIUM
ROCK PRESENT
CUMULATIVE FRACTION ELEMENTAL LEACH
ENDPOINT OF SAMPLING INTERVAL (DAYS)
0
50
100
150
200
250
300
350
400
450

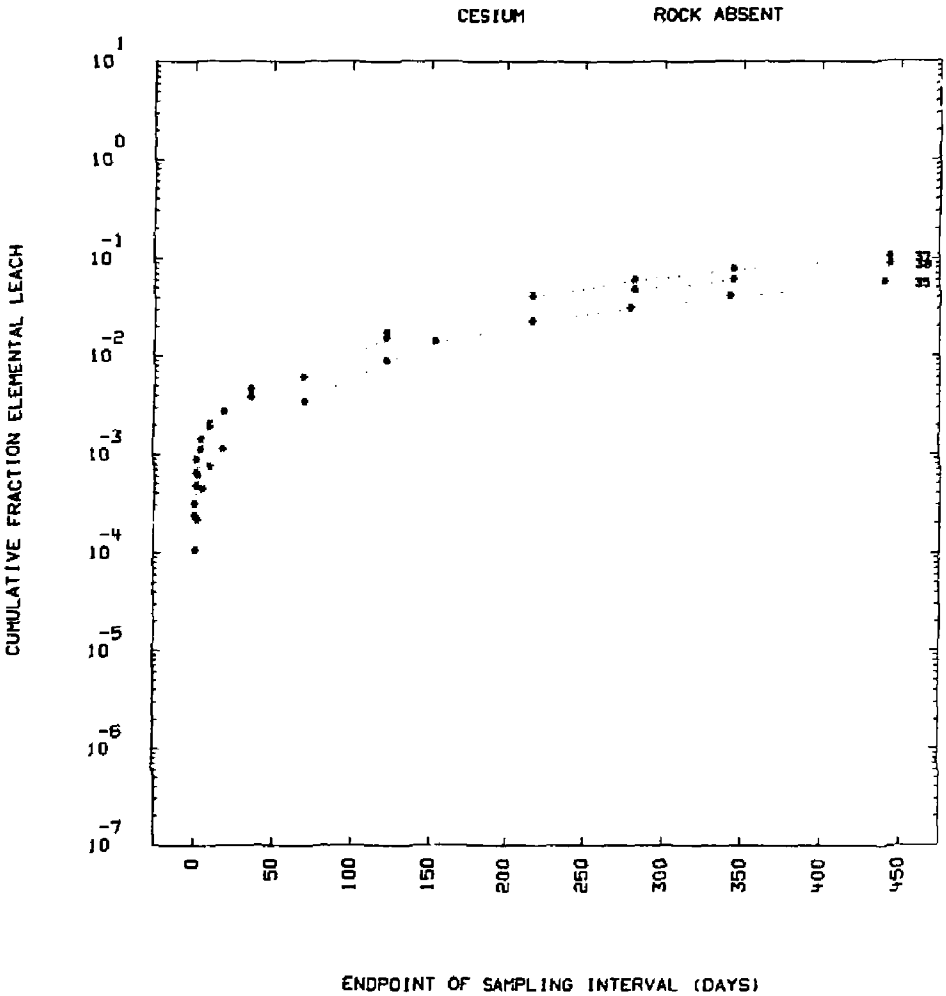


URANIUM
ROCK ABSENT
CUMULATIVE FRACTION ELEMENTAL LEACH
10^1
10^0
10^-1
10^-2
10^-3
10^-4
10^-5
10^-6
10^-7
0
50
100
150
200
250
300
350
400
450
ENDPOINT OF SAMPLING INTERVAL (DAYS)

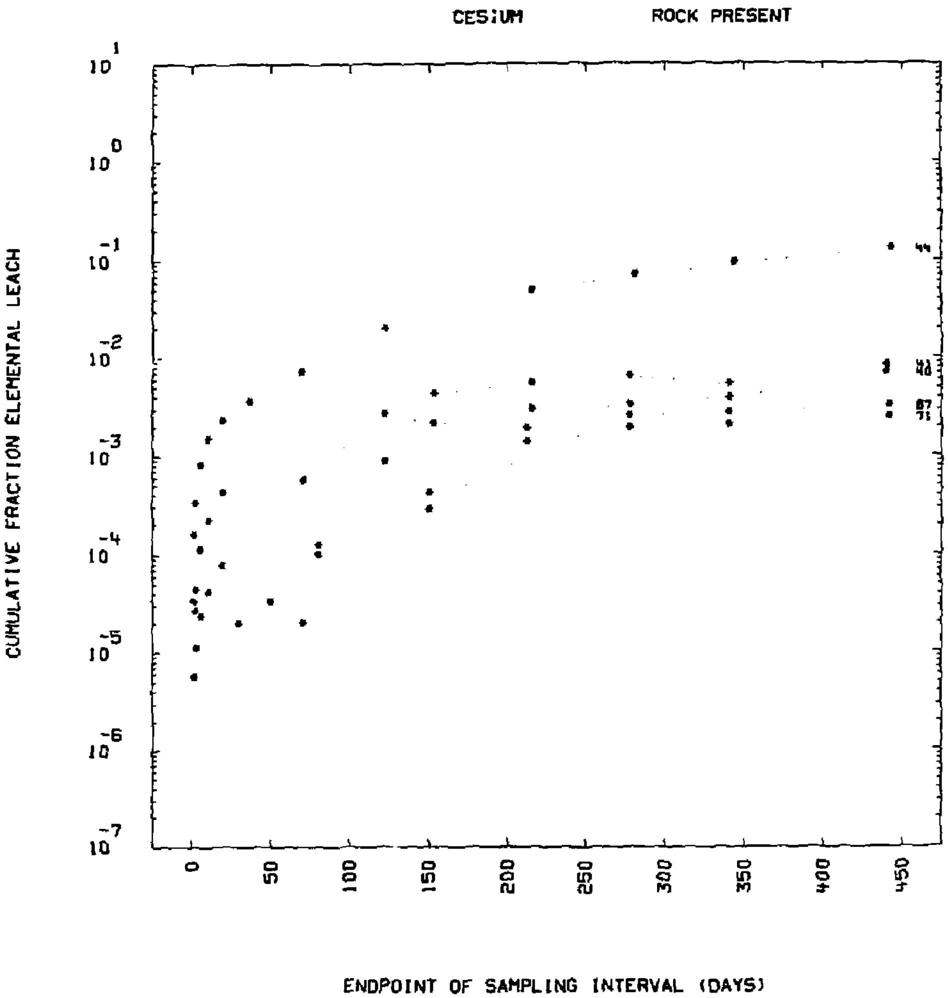

URANIUM
ROCK PRESENT
CUMULATIVE FRACTION ELEMENTAL LEACH
ENDPOINT OF SAMPLING INTERVAL (DAYS)


CALCIUM
ROCK ABSENT
CUMULATIVE FRACTION ELEMENTAL LEACH
ENDPOINT OF SAMPLING INTERVAL (DAYS)


CALCIUM
ROCK PRESENT
CUMULATIVE FRACTION ELEMENTAL LEACH
ENDPOINT OF SAMPLING INTERVAL (DAYS)
0
50
100
150
200
250
300
350
400
450

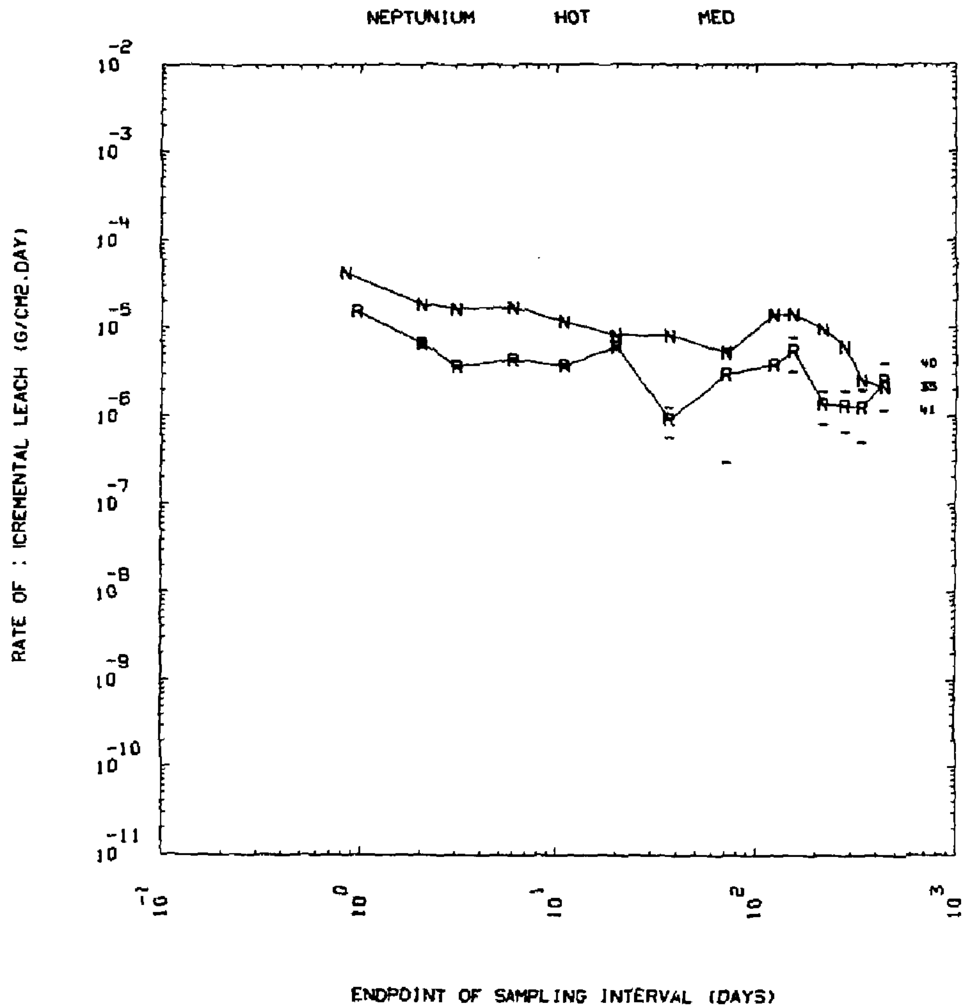


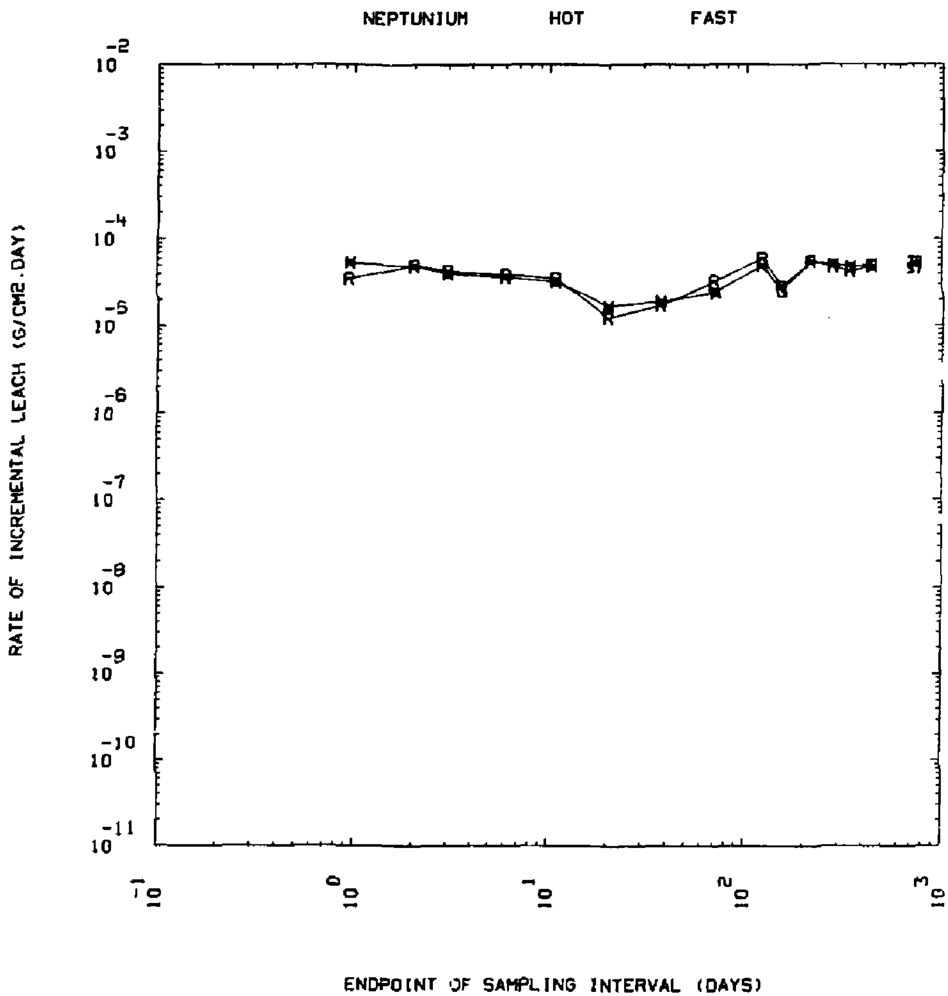
CESIUM
ROCK ABSENT
CUMULATIVE FRACTION ELEMENTAL LEACH
10^1
10^0
10^-1
10^-2
10^-3
10^-4
10^-5
10^-6
10^-7
0
50
100
150
200
250
300
350
400
450
ENDPOINT OF SAMPLING INTERVAL (DAYS)


CESIUM
ROCK PRESENT
CUMULATIVE FRACTION ELEMENTAL LEACH
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
0
50
100
150
200
250
300
350
400
450
ENDPOINT OF SAMPLING INTERVAL (DAYS)

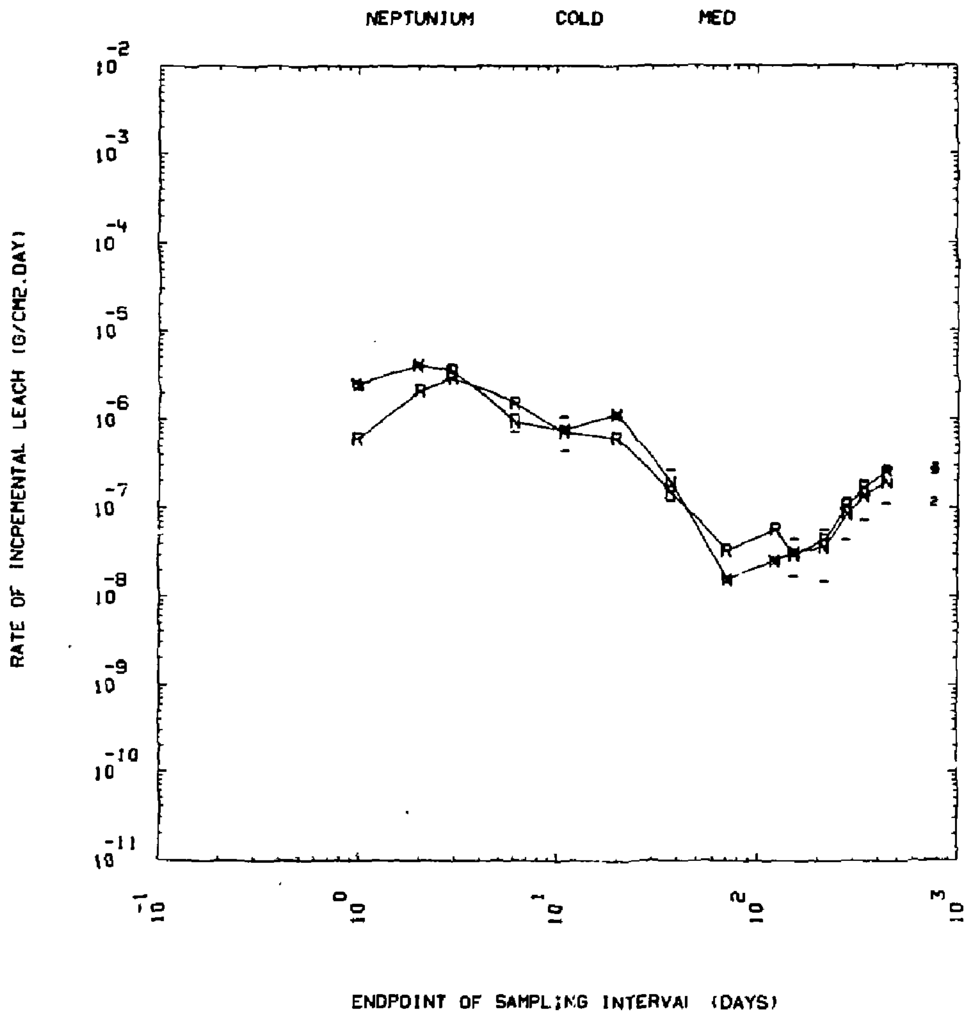
APPENDIX 15

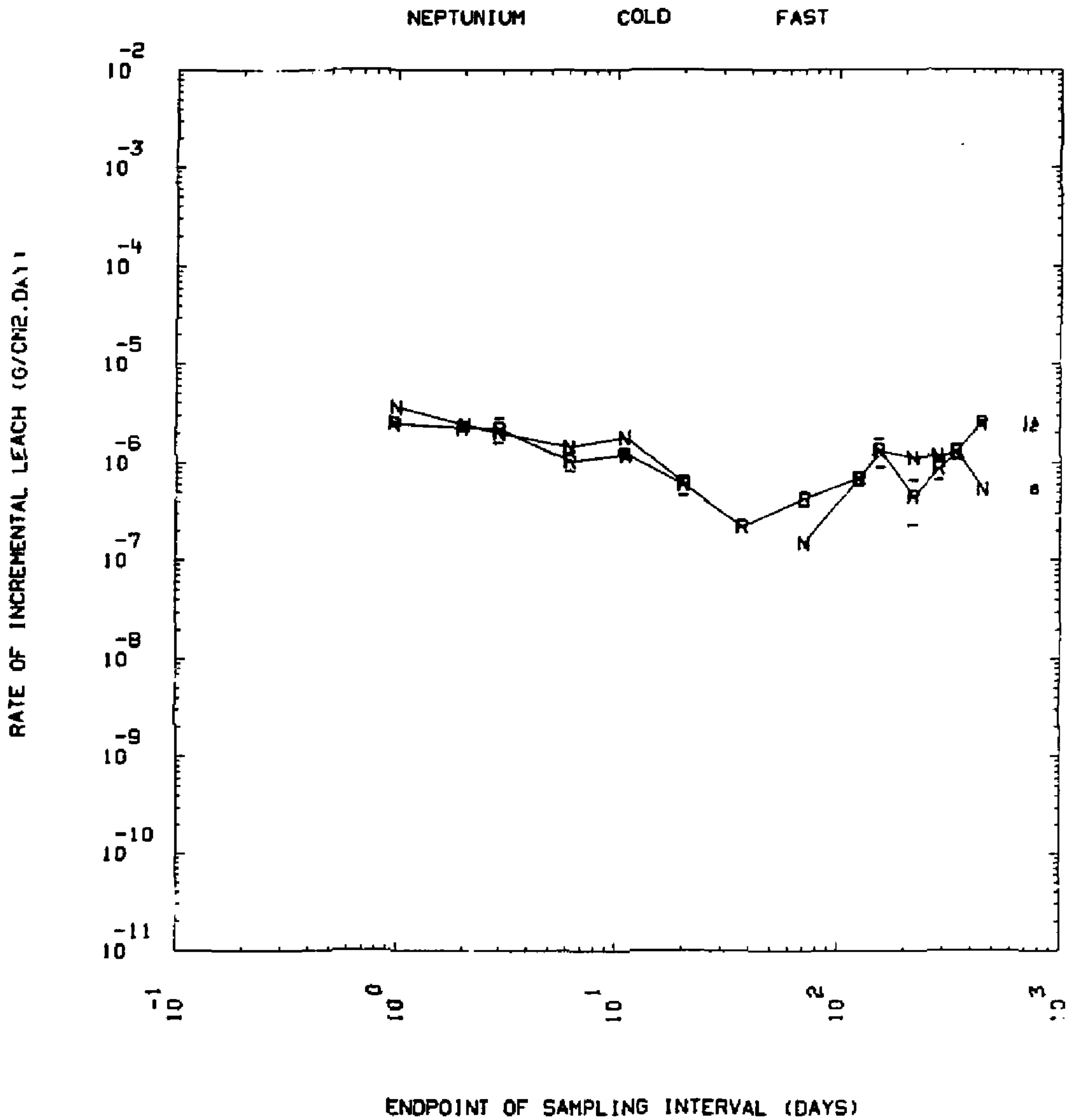
Graphs of Incremental Leach Rate for Np and Pu vs. Time: Comparison of "rock" (R) vs. "no rock" (N) channels. See text.

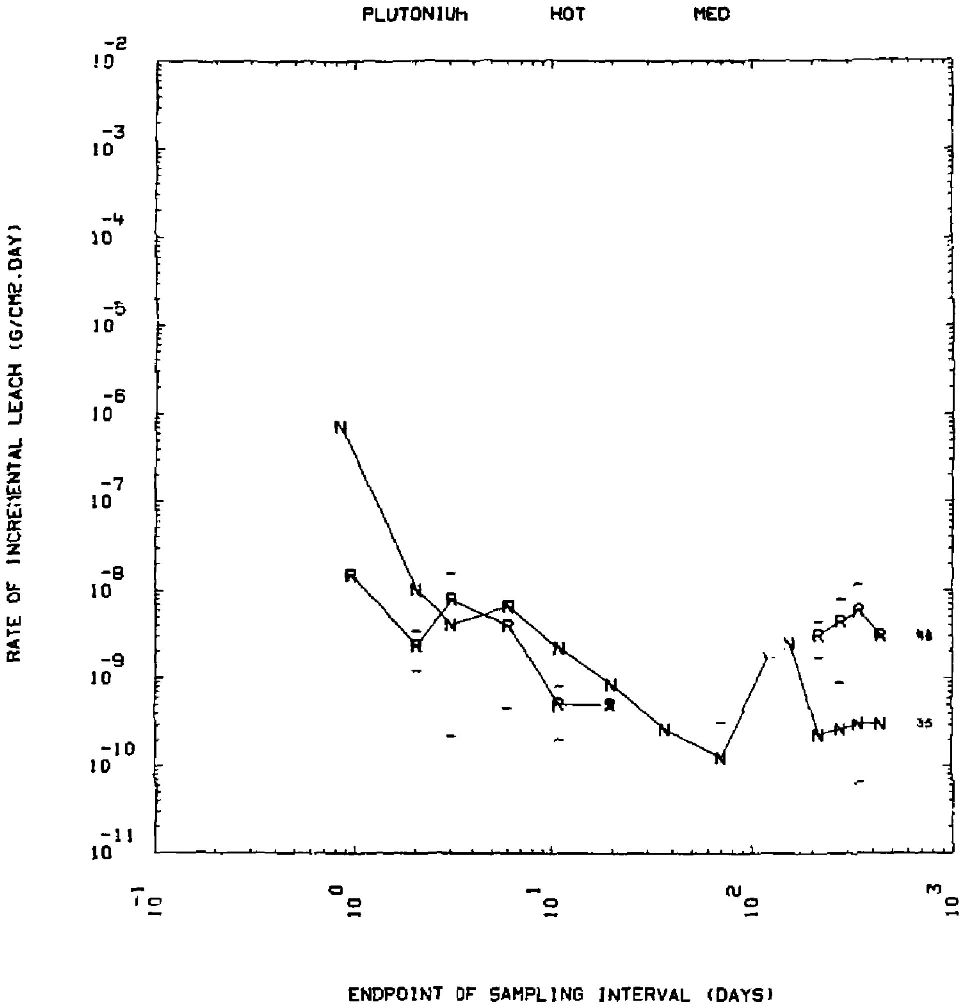

NEPTUNIUM HOT MED
RATE OF INCREMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

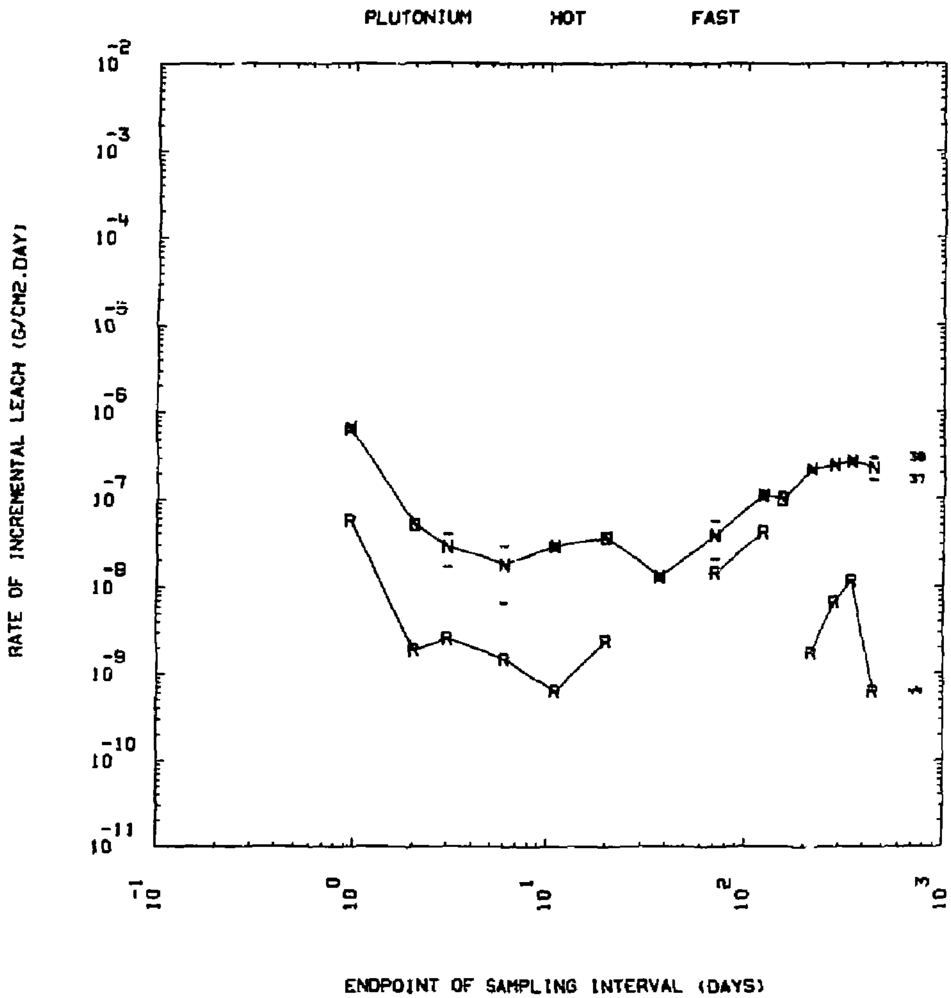


NEPTUNIUM HOT FAST
RATE OF INCREMENTAL LEACH (G/CM2.DAY)
10^-2
10^-3
10^-4
10^-5
10^-6
10^-7
10^-8
10^-9
10^-10
10^-11
10^-1
10^0
10^1
10^2
10^3
ENDPOINT OF SAMPLING INTERVAL (DAYS)

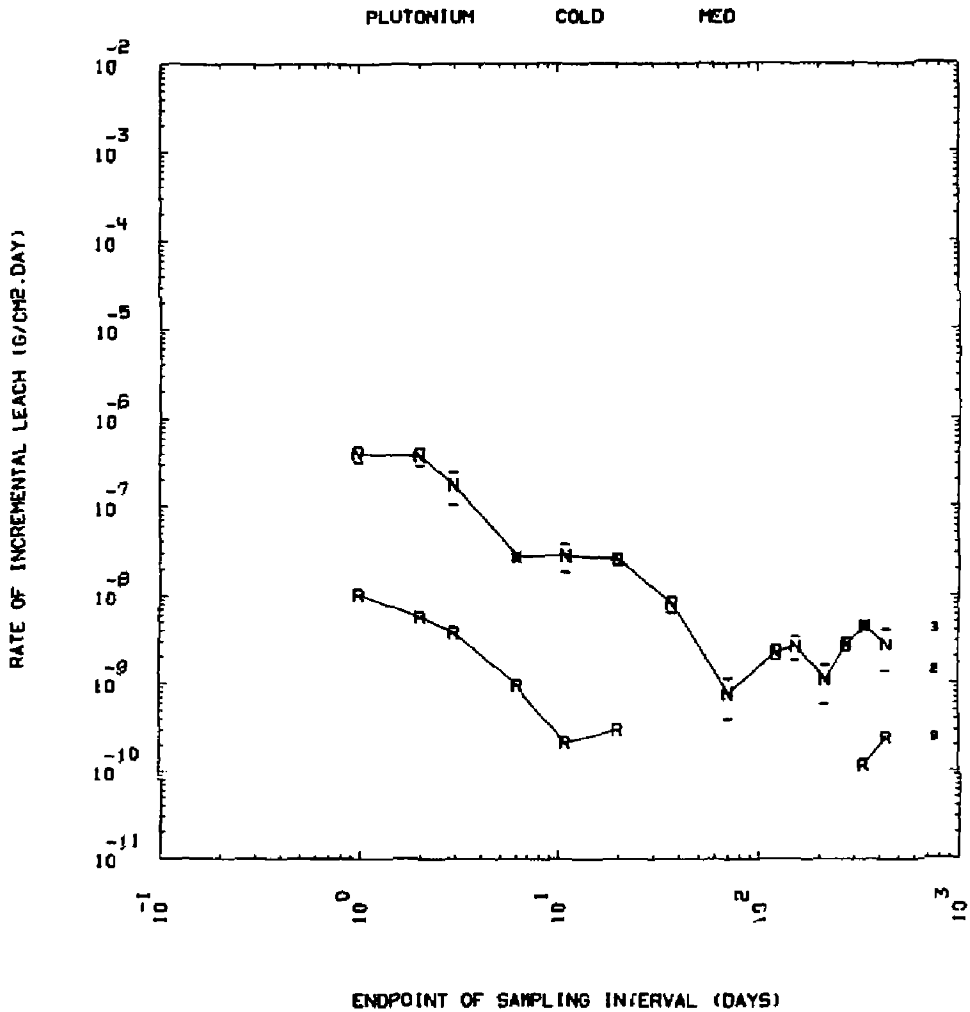

NEPTUNIUM COLD MED
RATE OF INCREMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

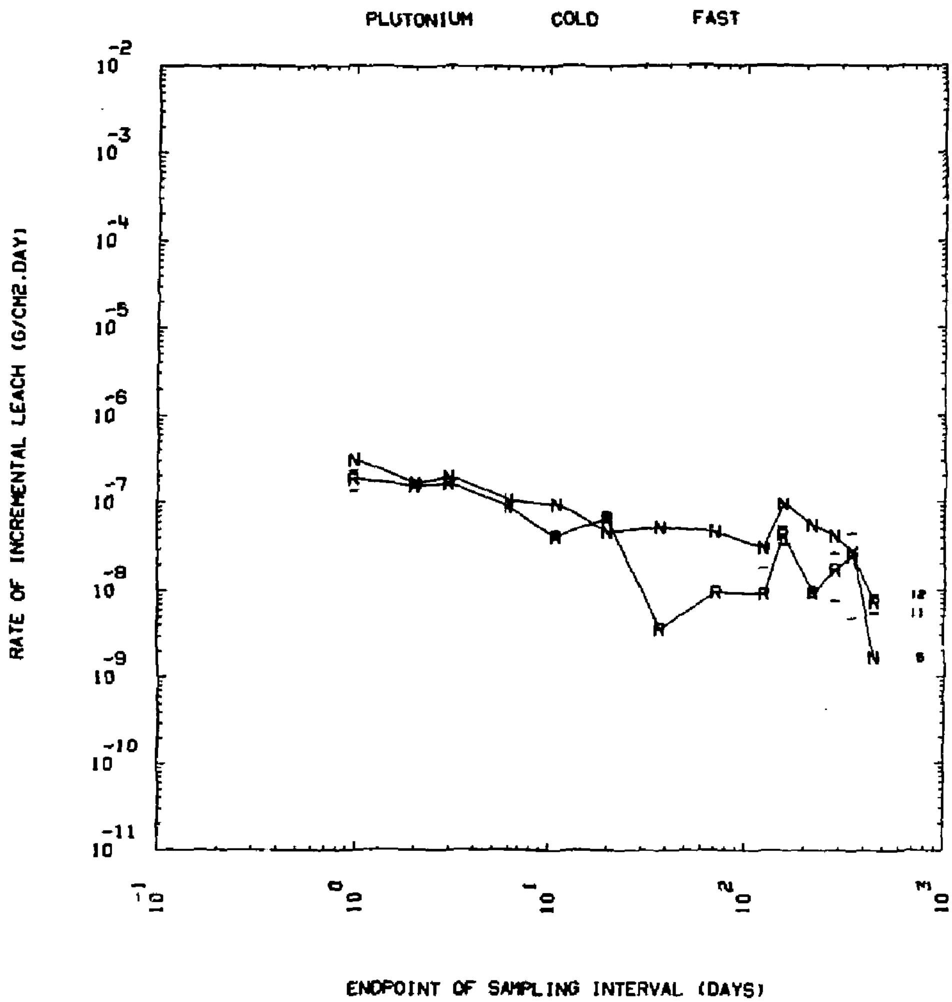

NEPTUNIUM COLD FAST
RATE OF INCREMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

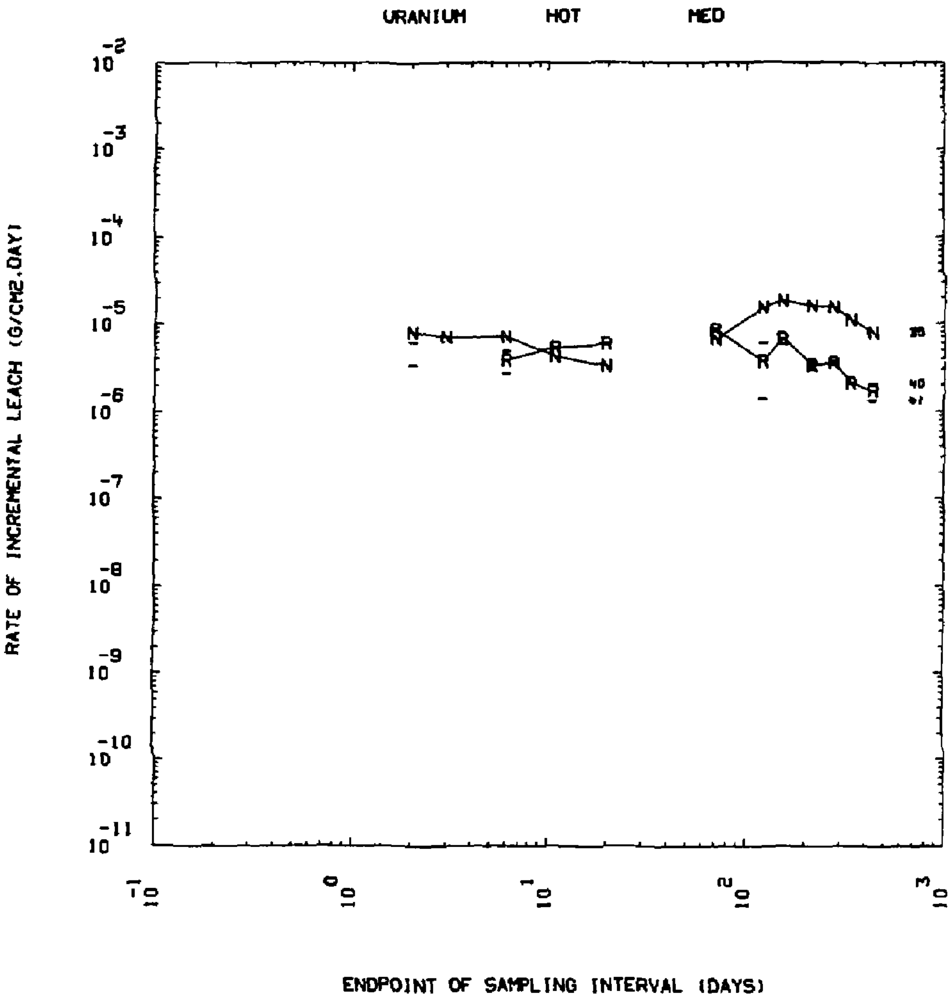

PLUTONIUM HOT MED
RATE OF INCREMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)
35



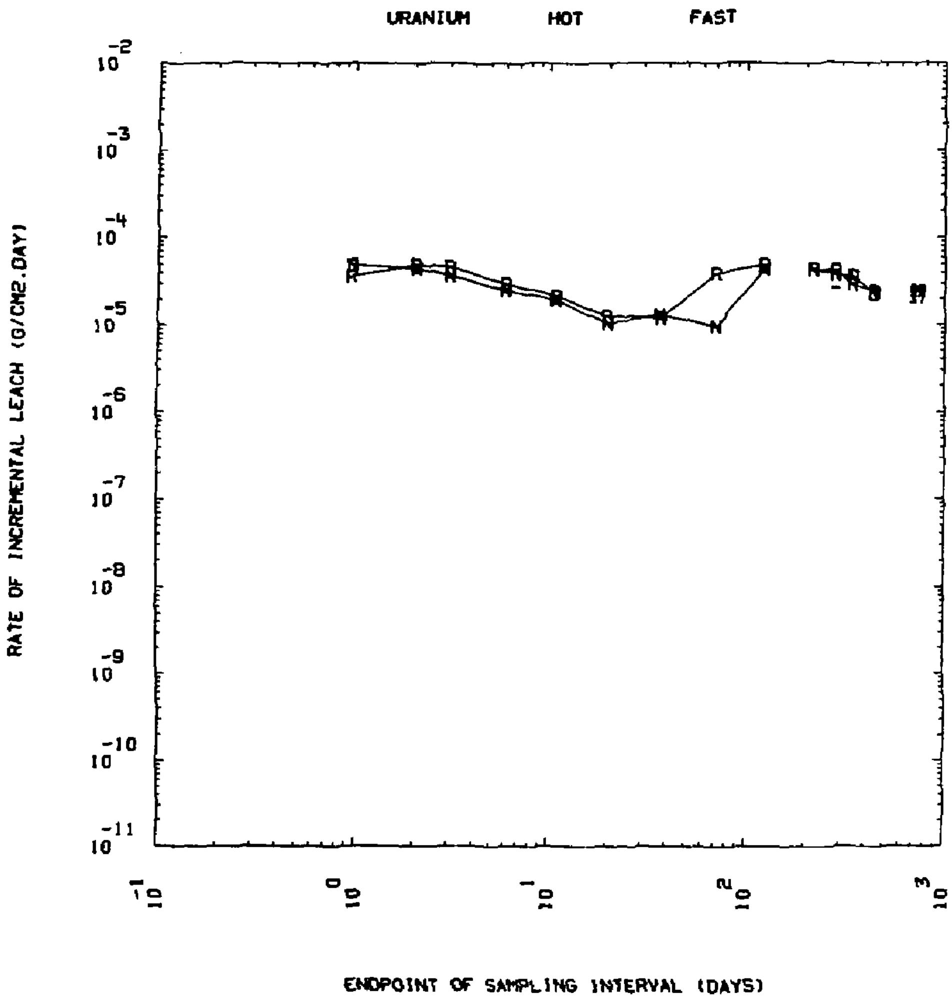
PLUTONIUM HOT FAST
RATE OF INCREMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)


PLUTONIUM COLD MED
RATE OF INCREMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)


PLUTONIUM COLD FAST
RATE OF INCREMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)



URANIUM HOT MED
RATE OF INCREMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)


URANIUM HOT FAST
RATE OF INCREMENTAL LEACH (G/CM2.DAY)
ENDPOINT OF SAMPLING INTERVAL (DAYS)

APPENDICES