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Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

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LEACH TESTS ON GROUTS MADE WITH ACTUAL AND TRACE METAL-SPIKED SYNTHETIC PHOSPHATE/SULFATE WASTE

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Richland, Washington 99352

ABSTRACT

Pacific Northwest Laboratory conducted experiments to produce empirical leach rate data for phosphate-sulfate waste (PSW) grout. Effective diffusivities were measured for various radionuclides (^{90}Sr, ^{99}Tc, ^{14}C, ^{129}I, ^{137}Cs, ^{60}Co, ^{54}Mn, and U), stable major components (NO_3^-, SO_4^{2-}, H_3BO_3, K and Na) and the trace constituents Ag, As, Cd, Hg, Pb, and Se. Two types of leach tests were used on samples of actual PSW grout and synthetic PSW grout: the American Nuclear Society (ANS) 16.1 intermittent replacement leach test and a static leach test.

Grout produced from both synthetic and real PSW showed low leach rates for the trace metal constituents and most of the waste radionuclides. Many of the spiked trace metals and radionuclides were not detected in any leachates. None of the effluents contained measurable quantities of ^{137}Cs, ^{60}Co, ^{54}Mn, ^{109}Cd, ^{51}Cr, ^{210}Pb, ^{203}Hg, or As. For those trace species with detectable leach rates, ^{125}I appeared to have the greatest leach rate, followed by ^{99}Tc, ^{75}Se, and finally U, ^{14}C, and ^{110m}Ag. Leach rates for nitrate are between those for I and Tc, but there is much scatter in the nitrate data because of the very low nitrate inventory.

In some cases, the size of samples leached appeared to affect the effective diffusion coefficient. Generally, for the slow-leaching constituents present in low inventories, greater sensitivity can be achieved by leaching larger samples. Some tests were conducted in which the original inventory was varied from a baseline value to about 10 times baseline in order to differentiate diffusion-controlled from solubility-controlled leaching. For these tests, only the data for uranium gave conclusive results: regardless of the amount of uranium placed in the grout, its concentration in the leachates was very low, implying solubility control. There was no significant difference in the leachate chemistry and calculated effective diffusion coefficients for species from real and synthetic PSW grouts.

EXECUTIVE SUMMARY

This report identifies empirical leach rates for various radionuclides (^{90}Sr, ^{99}Tc, ^{14}C, ^{129}I, ^{137}Cs, ^{60}Co, ^{54}Mn, and U), stable major components (NO_3^-, SO_4^{2-}, H_3BO_3, K and Na), and the trace constituents Ag, As, Cd, Hg, Pb, and Se. The leach rate values are direct inputs to performance assessment models that are used to forecast environmental impacts resulting from the disposal of grouted waste.

In general, grout produced from phosphate/sulfate waste (PSW) (both synthetic and real waste) shows low leach rates for the trace metal constituents and most of the waste radionuclides. Many of the spiked trace metals and radionuclides were not detected in any leachates. None of the effluents contained measurable quantities of ^{137}Cs, ^{60}Co, ^{54}Mn, ^{109}Cd, ^{51}Cr, ^{210}Pb, ^{203}Hg, or As.

For those trace species with detectable leach rates, ^{125}I appears to have the greatest leach rate, followed by ^{99}Tc, ^{75}Se, and finally U, ^{14}C, and ^{110m}Ag. Leach rates for nitrate are between those for I and Tc, but there is much scatter in the data because of the very low nitrate inventory.

Particular attention was placed on studies that address the effect of sample size on the effective diffusion coefficient (D_e), the effect of initial inventory on the effective diffusion coefficient, and comparison of actual PSW and synthetic PSW grout.

The comparisons of results with standard-sized grout specimens (35 mL) and large-sized (142 mL) specimens was not conclusive. For a few species (K, Na, U) the calculated D_e values are indistinguishable, but for other species (B, I, Tc) size appears to have an effect. The B and I data suggest that D_e values are lower for larger specimens, while the Tc data suggest the opposite (the larger specimen yielded a larger D_e). For many of the trace metals the larger specimen led to lower D_e limiting values when detection limits were observed. Thus, from a practical standpoint, for the slow-leaching constituents present in low inventories, greater sensitivity can be achieved by leaching larger samples.

The comparison of leach tests where the original inventory varied from a baseline value to about 10 times baseline is used to differentiate diffusion-controlled from solubility-controlled leaching. The only data set with variable inventory that gives conclusive results is that for U. Increasing the U content of the grout led to much lower D_e values. Regardless of the amount of U placed in the grout, its concentration in the leachates was very low, implying solubility control. The scatter in the Tc and I data in replicates of individual tests is as large as the difference between tests at different inventories. Although not statistically meaningful, both species yield higher D_e with the higher loadings. This trend is similar to that observed when increasing the loading of most macro constituents--that is, increasing the waste loading generally has an adverse impact on waste form leachability. The limited scale-up and variable inventory studies would profit from continued work in which larger ranges in size and inventory are studied.

There was no significant difference in the leachate chemistry and calculated effective D_es for species from real and synthetic PSW grouts. We note in particular the similar concentrations of total organic carbon in leachates from both types of grout. The similar leach rates for trace metals, which readily complex with chelating agents, for the two grout types further support our conclusion that organic chelates are not an important issue for PSW grout.

The chemistry of the leachates shows that the leachates from the real PSW grout are quite similar to those from the synthetic PSW grout. Furthermore, there are no significant differences in the chemistry of leachates from small and large grout specimens. Finally, results from the chemical analyses of these grouts, which are composed of 70% by volume phosphate waste and 30% by volume sulfate waste, are very similar to those for the 60%:40% PSW grouts studied previously.

The report also discusses other chemical analyses and geochemical computer code simulations that were used to identify mechanisms that control the release of species from the solid grout waste form during contact with ground water. Knowledge of the controlling chemical and physical processes is necessary to justify the extrapolation of the empirical laboratory data to long time periods and the very large scale of the grout disposal system.

It is difficult to explain the observed D_e values strictly on diffusion theory. For instance, D_e values generally continue to decrease with time. (Diffusion theory predicts a constant effective diffusivity versus time.) Furthermore, constituents that are not potentially solubility controlled and pH dependent generally show larger leach rates in static leach tests versus the ANS 16.1 leach tests. (The opposite would be expected with diffusion theory.) Constituents that show this trend include K, Na, I, and B. For species that readily precipitate at highly alkaline pH values, static leach tests often yield lower leach rates than do the ANS 16.1 leach tests because of the difference in steady-state pH values. The pH of the leachates is strongly influenced by the availability of carbonate. In the ANS 16.1 leach tests, the frequent replenishment of leachant and the bicarbonate in the leachant controls the pH at values between 8.3 and 8.5. In the static leach tests, where replenishment is limited, the carbonate becomes depleted and the precipitation of brucite [$Mg(OH)_2$] appears to control the pH at about 12.

Species that appear to be significantly influenced by pH/solubility processes are ^{90}Sr, ^{14}C, ^{60}Co, ^{54}Mn, U, Ag, As, Cd, Cr, Hg, Pb, and Se. If diffusion were the only mechanism causing the leaching, theory would predict that the static leach tests would yield lower leach rates, or D_e values, than would the ANS 16.1 leach tests. The lower values for D_e in the static leach tests should occur because the leached materials accumulate in the leachate and lower the driving force (the concentration gradient) for release. In the ANS 16.1 leach test, a high concentration gradient is established each time the solution is exchanged. The counter-intuitive results for K, Na, I and B might be explained by the precipitation of calcium carbonate on the grout surface, thereby reducing grout permeability and diffusion potential. The ANS 16.1 leach tests show significantly more precipitation of calcium and inorganic carbon than do the static tests. Carbonation of cement is a very common reaction, as evidenced by the mineralogic characterization of ancient cementitious artifacts (Roy and Langton 1982, 1983), 20-year-old hydrofracture grout (Stinton, McDaniel and Weeren 1984), and laboratory tests on cement waste forms (Bernard et al. 1982). Characterization of leached PSW grout will be performed at the end of tests to investigate the possible presence of a protective film of carbonate minerals.

Key species that continue to show the greatest leach rates and mobility in Hanford sediment-ground water systems include I, Tc, and NO_3^-. We now conclude that the U, Cr, and nearly all of the other regulated trace metals (Ag, As, Cd, Hg and Pb) need not be considered as potentially rapidly leached species. Selenium may leach somewhat faster, but probably not as fast as I, NO_3^-, or Tc.

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1.0 INTRODUCTION

A Grout Treatment Facility (GTF) has been constructed on the Hanford Site near Richland, Washington, and is being used to immobilize and dispose of low-level liquid, radioactive wastes as a solidified grout. The grout disposal program is funded through the U.S. Department of Energy (DOE) and is managed by Westinghouse Hanford Company (WHC), with technical support from Oak Ridge National Laboratory (ORNL) and Pacific Northwest Laboratory (PNL).[a]

In the GTF, low-level liquid wastes are mixed with blends of grout-forming solids (Portland cement, fly ash, clays, and other components) to produce a slurry. This slurry is pumped to near-surface disposal sites (engineered vaults) where the grout hardens, thus immobilizing the waste. As part of the program to demonstrate the acceptability of grout as a final disposal method, performance assessment studies are being conducted. These studies yield computer-generated predictions that are used to assess the impact of the grout disposal method on long-term public health and safety.

An assessment of the long-term risks posed by grout requires data on the ability of grout to resist leaching of waste species contained in the grout via contact with water that percolates through the ground. Data are also needed on the ability of soil (sediment) surrounding the grout to retard the mobility of any wastes released from grout. Any change that may occur with time (up to 10,000 years) in the ability of grout to contain wastes and the ability of sediment to retard waste migration must also be factored into a credible performance assessment.

This report describes specific laboratory experiments that are producing empirical leach rate data for a particular waste stream, phosphate-sulfate waste (PSW). Empirical leach rates are being produced for specific radionuclides (^{90}Sr, ^{99}Tc, ^{14}C, ^{129}I, ^{137}Cs, ^{60}Co, ^{54}Mn, and U), stable major components (NO_3^-, SO_4^{2-}, H_3BO_3, K, and Na) and trace constituents (Ag, As, Cd, Cr, Hg, Pb, and Se). The leach rate values are direct inputs to the

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performance assessment models used to forecast environmental impacts. In addition, the report discusses other chemical analyses and geochemical computer code simulations that were used to identify mechanisms that control the release of species from the solid grout waste form during contact with ground water. Knowledge of the controlling chemical and physical processes is necessary to justify the extrapolation of the empirical laboratory data to long time periods and the very large scale of the grout disposal system. Particular attention was placed on studies that address the effect of sample size on measured effective diffusion coefficients, the effects of starting inventory on measured effective diffusion coefficients, and comparison of actual PSW and synthetic PSW grout.

The report is divided into sections that discuss probable hydrologic and chemical processes controlling grout leaching and subsequent migration, conceptual leaching models considered, materials used in leaching tests, methods used in leaching tests, and laboratory test results and conclusions. Appendices A through E contain the raw data used to support the analyses.

2.0 PROBABLE HYDROLOGIC AND CHEMICAL PROCESSES CONTROLLING LEACHATE GENERATION AND SUBSEQUENT MIGRATION

Hanford grouts are formed by mixing liquid waste with dry solids, including cement, fly ash, clay, and sometimes other additives. The cement acts as a binder while the fly ash reacts with excess calcium hydroxide from the cement, thereby reducing permeability and leach rates. Fly ash also improves the pumping characteristics of the slurry. Additives such as clay are used as suspending agents and to adsorb or sequester specific contaminants. For each specific type of liquid waste, a grout recipe will be developed to optimize the waste form's stability and long-term leaching characteristics. The wastes and solids used in the formulation may enter into reactions that control the rate and chemistry of leachate generation and the subsequent migration of leached species. A specific description of the PSW grout recipe is given in Section 4.0.

2.1 REACTIONS DURING GROUT HYDRATION AND SETTING

The dry Portland cement used in grout formulation is a mixture of tricalcium silicate ($3CaO \cdot SiO_2$), dicalcium silicate ($2CaO \cdot SiO_2$), tricalcium aluminate ($3CaO \cdot Al_2O_3$), tetracalcium aluminoferrite ($4CaO \cdot Al_2O_3 \cdot Fe_2O_3$), and other constituents. Upon wetting, these minerals hydrate, forming polymeric chains of mostly amorphous calcium silicates, crystalline aluminoferrites and aluminates, and portlandite [$Ca(OH)_2$]. When other chemicals are present, such as sulfate in wastes or bicarbonates in the ground-water leachant, other reactions occur, forming compounds such as calcium monosulfoaluminate, ($3CaO \cdot Al_2O_3 \cdot CaSO_4 \cdot 12H_2O$), gypsum ($CaSO_4 \cdot 2H_2O$), calcite ($CaCO_3$), and carbonated calcium aluminates and ferrites.

During hydration and curing, the permeability of the grout decreases significantly. The decreased permeability serves to physically isolate waste components inside the grout from future water contact. Furthermore, some of the waste constituents chemically react with the grout minerals or additives and become more strongly bound in the grout matrix. Some of the pH-sensitive cations such as trace metals and actinides can form highly insoluble hydroxides in the high pH environment inside the grout. Certain clay additives adsorb cations such as cesium. Matsuzuru and Ito (1977) show that the addition of 10% to 20% by weight zeolite (a material with clay-like adsorptive properties) to the dry grout ingredients can decrease the effective diffusivity of cesium by two to three orders of magnitude. In the PSW grout formulation, Indian Red pottery clay is added to adsorb cesium. Thus, some waste constituents are sequestered in the grout by strong chemical bonds, while other waste constituents are physically isolated in the small pores of the grout.

2.2 CONTAMINANT LEACHING

For grouts containing radioactive and chemical hazardous wastes, the release of wastes is most often described as an effective diffusion process. Pore water in the grout dissolves or desorbs wastes contained in the grout. Solubilized wastes then diffuse through the pores, out of the grout and the cement vault, and into the surrounding sediments. In reality, the actual processes that control grout leaching are complex, but most of the available literature on grout and cement leaching argue fairly conclusively that an effective (or lumped) diffusion model satisfactorily explains the observed short-term laboratory data (see Section 3.0 for references). With the effective diffusion model, most radionuclides and, by inference, inorganic hazardous chemicals leaching from cementitious waste forms exhibit a wide range of diffusion coefficients ranging from 10^{-6} to less than 10^{-12} cm^2/sec. In water, most cations and anions exhibit a diffusion coefficient of approximately 10^{-5} cm^2/sec (Dayal, Arora and Morcos 1983). The large range in the effective diffusion coefficients observed is a reflection of the other processes, such as adsorption, precipitation, and mineral substitution, that impede the release of some constituents.

The effective diffusion model is used because it is simple and yet satisfactorily describes the leaching observed in laboratory tests that were conducted over time periods ranging from months to a few years. More complicated models may require complete analysis of the chemical and mineralogical nature of the grout both before and after contact with leachant, and a complete chemical characterization of the leachate solution versus time.

Furthermore, the grout and its interstitial water probably vary both chemically and physically, with position relative to the grout surface such that bulk analyses of the grout solid and bulk leachate are only crude estimates of the reacting system. Micro-analytical techniques that allow analyses at the surface of the grout and at various depths may be necessary to adequately describe all of the interactions and to predict long-term changes in the waste retentive properties of the grout. Very few experimenters on low-level nuclear waste-form leaching have attempted detailed analyses of the bulk solids and leachates, let alone the potentially numerous micro-environments that can exist in the grout.

Should future analyses indicate that leaching of the PSW grout must be reduced, a protective barrier could be installed over the grout to provide the required protection. Although a protective barrier emplaced over disposed grout can nearly eliminate infiltration of water, moisture will still exist in the porous sediment surrounding the grout. Furthermore, although water is usually seen as a vehicle for transport (i.e., in advection and dispersion processes) it is also a conduit for transport (i.e., by diffusion). Therefore, while a moisture barrier is assumed to eliminate the relatively rapid release and transport of waste constituents from grout waste forms caused by advective transport, releases can still occur by diffusive transport through the virtually immobile soil water. It follows that the diffusive transport pathway would control the release and transport of wastes. The grout is also assumed to supply radionuclide concentrations at maximum (initial) levels at the grout-sediment interface until the source is depleted. Driven by these maximum, constant concentrations, the diffusion-dominated water pathway conducts contaminants vertically to the unconfined aquifer, but also laterally to the advection-dominated water transport pathways outside the barrier's influence.

Release from beneath a properly functioning moisture barrier is assumed to occur as a result of diffusive transport through the sediment pore water. This transport mechanism will apply if the barrier functions as designed. If the barrier fails [barrier failure scenarios have been studied in the Hanford Defense Waste Environmental Impact Statement (U.S. DOE 1987)], a coupled advection-diffusion transport model will be required to describe release and transport because both of these processes may provide significant contributions to the overall release. Such a combined advection-diffusion transport model will require detailed hydrologic knowledge of the neighboring unsaturated sediments and an understanding of the mechanisms of release of contaminants from the grout surface. Thus, with or without a protective barrier installed over the grout, water to varying extents can contact the grout, thereby leaching contaminants and serving as a vehicle and/or a conduit for moving those contaminants away from the grout. Therefore, the leaching process, especially as a function of rate of water contact, must be thoroughly understood to forecast rate of release of contaminants from the grout.

After contaminants from within the grout matrix diffuse to the surface and diffuse through or are carried by ground water through cracks in the disposal vault, they will contact the partially saturated sediments that surround the vault. Upon contacting the sediments, the leached contaminants can be advected away by percolating water or diffused away through the pore water contained in the partially saturated vadose sediments. By either pathway, the wastes will eventually reach the water table. In both the vadose sediments and saturated aquifer sediments, chemical reactions, such as adsorption and precipitation, and physical processes, such as diffusion and dispersion, will change the composition and concentration of the leachate. In the semi-arid climate at Hanford, it is likely that the concentrations of many chemical constituents in solution at the grout-sediment interface will be at their maximum values (i.e., limited by their solubilities). Also, after an initial stabilization period, it is unlikely that redox and pH conditions will change dramatically as the leachate is transported away from the sediments surrounding the grout. From these two assumptions, it is inferred that any dissolution/precipitation reactions that might occur should happen near and/or within the surface of the grout, the vault concrete, and the sediment directly contacting the vault.

2.3 RELEVANCE TO THE CURRENT DISPOSAL DESIGN

Phosphate-sulfate waste grout is disposed in a concrete vault 34 ft deep by 50 ft wide by 125 ft long. The vault is lined with two layers of geomembranes to prevent dewatering and release of fluids over the short term.

The laboratory studies described in this report do not simulate the current disposal scheme. These initial studies allow the grout to directly contact representative ground water. For the present, the layer of vault concrete and liners are not included. The results of these laboratory tests should overestimate the release of contaminants in the early period of waste form leaching because the vault and liner will provide additional barriers to release. In the long term, it is difficult to predict the effectiveness of the liners as water barriers, or the possible effects of the liners on the chemical reactions that influence leaching. In the long term, the vault concrete will react with ground water and the resultant chemical reactions should be very similar to reactions investigated in these grout/ground water tests. As long as it remains intact, the concrete vault will probably act as an additional diffusion barrier across which leached species must pass before reaching the sediment. The leached species will likely continue the same chemical reactions that occurred within the grout, as the concrete and grout are chemically similar. Therefore, these initial tests are useful in describing the transport through the concrete vault. It would be useful to develop a diffusion-controlled mathematical model that includes an outer layer of "clean" concrete surrounding an inner layer of "contaminated" grout. By varying the thickness of the outer layer and selecting appropriate effective diffusion coefficients for the grout and concrete, the net flux rate of contaminants to the sediment could be bounded. The effective diffusion coefficients for the concrete could also be varied to evaluate the sensitivity of the overall flux rate to the attributes of the concrete.

A significant issue in developing data for long-term performance assessment predictions is whether the laboratory grout leach experiments, which are of relatively short duration, yield relevant data. The aging of grouts may either improve (e.g., carbonation) or degrade (e.g., cracking) grout properties, perhaps resulting in significantly different rates of waste release from those measured on freshly made grout.

A key in predicting the performance of grout waste forms over extremely long time periods (up to 10,000 years) requires an understanding of the grout properties at specific ages. Ideally, grouts would be produced that have the appropriate "aged" composition in a reasonable time for testing. However, methods for producing "old" samples have not been developed to a defensible state. Historically, the prediction of properties of radioactive waste materials has been attempted through the study of natural analogs. The basis for this comparison is that the analogs have been stable for thousands to millions of years; therefore their counterparts should also be stable. However, cementitious materials, such as grout, in comparison to the relatively static systems of nature, are actually dynamic systems since their chemical and physical properties change continually with time. While attempts have been made to study ancient cementitious materials (Roy and Langton 1983), direct comparison with today's materials is impossible because of unknown starting compositions of the ancient mortars and different aging conditions. Grout durability studies that address this "aging" issue have been proposed and may be initiated at a later date.

In summary, the leach rates discussed in this report likely overestimate the actual flux from grout into the sediment given that the proposed disposal scheme includes liners, a concrete vault, and a gravel cocoon as an additional barrier. Future modeling activities and laboratory testing will attempt to quantify the actual release rates for the current disposal scheme.

3.0 CONCEPTUAL LEACH MODEL

Before designing and performing the laboratory leaching and adsorption tests, we reviewed available literature to identify the types of experiments and conceptual models that others have used. The conceptual models or the constructs used to analyze the empirical data are especially important because they dictate the types of experiments that should be run and what parameters should be measured or controlled. In another document (Serne et al. 1987), we concluded that the semi-infinite solid diffusion leach model was most appropriate. This type of diffusion model is the most popular release model used to describe the leaching of grouts and other cement waste forms. This model is used by researchers at Brookhaven National Laboratory (Kalb and Columbo 1984; Arora and Dayal 1984; Dayal, Schweitzer and Davis 1984; Dayal, Arora and Morcos 1983); at ORNL (Moore, Godbee and Kibbey 1977; Godbee, Anders and Nielson 1980; Clark 1977); at the Japan Atomic Energy Research Institute (Matsuzuru and Moriyama 1982; Moriyama, Dojiri and Matsuzuru 1977); and at the United Kingdom Atomic Energy Authority, Harwell (Sambell, Smitton and Elsden 1982). This model is used to analyze laboratory leach data on cylindrical blocks of cemented or grout waste forms in which nuclear wastes are incorporated. This model is endorsed by the American Nuclear Society (ANS) and is the basis for their recommended leach test ANSI/ANS-16.1, "Measurement of the Leachability of Solidified Low-Level Radioactive Wastes, by a Short-Term Test Procedure" (ANS 1986). The theoretical equations for diffusion-controlled leaching that follow are based on the following assumptions:

1. Once leaching commences, the concentration of the species being leached is zero in the solution at the waste form surface. In other words, dissolved waste is swept away from the surface as soon as it diffuses out of the waste form.

2. The leachant solution is continually moving past the waste form and its composition never changes significantly.

3. The solid waste form is homogeneous and remains essentially unchanged chemically and physically during the leach process. In other words, no significant chemical alterations occur and the mass

of constituents removed from the waste form is negligible in comparison to the total mass in the waste form. This is known as the semi-infinite requirement.

4. The surface is smooth and does not deteriorate with time or acquire a protective layer (i.e., the surface area is constant and equal to the geometric surface area).

5. There are no time-dependent interactions among the leachable species, the leachant, and the solid matrix.

6. The radionuclides and hazardous chemicals of interest are present as single chemical species.

7. The leachable species are mobilized by the leachant such that bulk diffusion is the limiting process.

Although the semi-infinite solid diffusion leach model is based on these seven simplifying assumptions, it has been accepted by many researchers. It is used to interpret laboratory leach tests on cement and grout waste forms in which the leachant is either changed periodically or contacts the solid in a once-through flow apparatus. This diffusion model appears to successfully describe most empirical data collected to date.

The mathematical description of a diffusion model that meets the above assumptions yields a diffusion coefficient for each leached species. The effective diffusion coefficient lumps all of the chemical and physical interactions that may actually be occurring into a single value that defines release rate.

There are two mathematical descriptions of the semi-infinite cylinder leach model commonly used to analyze laboratory data:

$$D_e = \frac{\pi}{4} \left(\frac{\sum_{n=1}^{N} a_n}{A_o} \right)^2 \left(\frac{V}{S} \right)^2 \frac{1}{t} \quad (3.1)$$

$$D_e = \pi \left(\frac{a_n}{A_o} \right)^2 \left(\frac{V}{S} \right)^2 \frac{T}{\left(\Delta t_n \right)^2} \quad (3.2)$$

where D_e = effective diffusion coefficient (cm^2/sec)

a_n = amount of species of interest leached during the leach interval (e.g., g or μCi)

A_o = total amount of species in solid waste form (e.g., g or μCi)

V = volume of solid waste form (cm^3)

S = geometric surface area of waste form (cm^2)

t = total elapsed time since start of leaching (sec) = $\Sigma(\Delta t)_n = t_n$

$T = [1/2(\sqrt{t_n} + \sqrt{t_{n-1}})]^2$

(Δt_n) = time duration of interval n (sec)

n = subscript number for each time interval

N = total number of time intervals = Σn.

Equation (3.1) is used to calculate the cumulative diffusion coefficient for species "i," and Equation (3.2) is used to calculate the instantaneous or incremental diffusion coefficient for species "i" at each leach interval "n." If the leach experiments satisfy the seven conditions previously mentioned, both equations will give the same effective diffusion coefficient at all times.

In the disposal system, the concrete vault into which the PSW grout is poured is surrounded by sediment partially saturated with water. The water flow rate in the sediments around the vault is expected to be fast relative to the diffusion rate of species through the vault concrete and grout. However, it is doubtful that the flow rate of water around grout is fast enough to meet the first assumption--i.e., that dissolved waste diffusing out of the grout will be swept away from the surface and satisfy the boundary condition, concentration = 0 at $t > 0$. If diffusion is the controlling process, the results of using this model should over-predict the release of species from PSW grout if the leachate is not rapidly swept away from the grout surface, because any buildup of concentration near the surface will decrease the diffusive driving force.

Over a 10,000-year time frame (which is assumed in the HDW-EIS to be the duration that the grout disposal system must provide protection of the public health and safety), the mass removed from the grout could begin to deplete the original waste inventory such that the third assumption, the semi-infinite solid, would lead to higher calculated releases than would a finite solid. Thus, the approach is conservative. ANSI/ANS-16.1 gives correction tables for various geometries to correct predicted release rates if the semi-infinite criterion is violated. Furthermore, Moriyama et al. (1975) and Nestor (1980) give exact mathematical expressions for calculating D_e values for certain finite geometric shapes. Exact solutions for finite spheres and parallelepipeds are also available. To ascertain whether more accurate results could be obtained using finite solid corrections, a useful rule of thumb is that corrections become important only if more than 20% of the total mass of a constituent of interest has leached from the waste form. A second check is to test whether the product, $D_e \cdot \sqrt{t}$, is much less than r, the characteristic length parameter for a solid shape. If so, to use the semi-infinite model equations over the time frame of interest is technically justifiable.

The D_e (cumulative values) listed in Appendix B are corrected when $\Sigma a_n/A_o$ exceeds 20%. The corrections are based on the characteristic lengths (diameter and height) of the sample cylinders per the protocol given by ANSI/ANS 16.1 (ANS 1986).

It seems quite likely that PSW grout and vault concrete disposed in Hanford sediments will react with the carbonate-rich ground waters to form calcite and carbonate-rich solids similar to those found in the artifacts from Cyprus and Greece. Carbonation of cement is a very common reaction, as evidenced by mineralogic characterization of ancient cementitious artifacts (Roy and Langton 1982, 1983) and 20-year-old hydrofracture grout (Stinton, McDaniel and Weeren 1984), and by laboratory tests on cement waste forms (Bernard et al. 1982). Whether these reactions would form protective layers on the grout that impede diffusion is uncertain. It does appear that chemical reactions such as these might further lower the release of certain species such as ^{90}Sr. The impact over long periods of time is less certain.

If Equation (3.1) is rearranged, we can get a relationship that, when plotted versus the square root of time, should yield a straight line:

$$\frac{\sum_{n=1}^{N} a_n}{A_o} \frac{V}{S} = 2 \sqrt{\frac{D_e t}{\pi}} \tag{3.3}$$

It is often found that actual leach data indicate a much faster release in the early time periods of the leach test and later satisfy the linear dependence on $\sqrt{t}$. Matsuzuru and Moriyama (1982); Godbee, Anders and Nielson (1980); Matsuzuru and Ito 1978; and Dayal, Arora and Morcos (1983) discuss leach experiments that show the initial rapid release. Data from these studies are analyzed using linear regression on Equation (3.4) to provide a best-fit D_e value (from the slope) and an empirical "instantaneous wash-off fraction, "α," from the intercept at t = 0:

$$\frac{\Sigma a_n}{A_o} \frac{V}{S} = 2 \left(\frac{D_e}{\pi}\right)^{1/2} \sqrt{t} + \alpha \, . \tag{3.4}$$

The actual mechanism or cause of the "instantaneous wash-off" has not been conclusively identified and perhaps could reflect that the experiments themselves do not satisfy all seven model assumptions discussed earlier. At any rate, after a relatively short time period, the data start obeying Equations (3.1) and (3.3)--i.e., leach rate is proportional to the square root of time. If we assume that the leach data would continue to follow Equation (3.4) for very long time periods, we would predict an initial pulse release (the magnitude equal to α) followed by a release rate proportional to the square root of time until the inventory is exhausted.

4.0 MATERIALS

The materials used in these experiments (i.e., actual phosphate/sulfate liquid waste, synthetic liquid waste, radioactive grout, and ground water) are described in this section.

4.1 LIQUID WASTE STREAM

The low-level liquid waste stream from which grouts were made for this study is comprised of phosphate and sulfate solutions that result, respectively, from a decontamination operation and a fuels storage basin water cleanup process at Hanford's N Reactor. The grouts were made using 70% by volume phosphate waste and 30% by volume sulfate waste.

Actual phosphate and sulfate waste streams were obtained and analyzed. Some grout was prepared with a 70%/30% mixture of real waste, and other grouts were prepared with real liquid waste spiked with 50 mg/L U as $UO_2(NO_3)_2$. Most of the grouts that were prepared for leach testing contained synthetic PSWs that were spiked with radioisotopes of elements that appeared in preliminary performance assessment calculations to be of greatest concern (Sewart et al. 1987). Specific details on the chemical and radionuclide content of the liquid wastes follow.

4.1.1 Analysis of Actual Liquid Wastes

The sulfate waste was obtained from Rockwell Hanford Operations (Rockwell) on December 12, 1986. The sample was designated 100N SO_4 1212-2. The unneutralized phosphate waste was obtained from Rockwell in November 1983. The subsample for this work was stored in a plastic container for the 3 years between receipt of the two waste streams. On December 31, 1986, about 70 mL was removed from each waste stream. Exactly 1.0 mL of each waste type was diluted to 15.0 mL and counted for gamma emitters. A second aliquot was filtered through 0.22-μm membranes and then diluted 1.0 mL, to 15.0-mL total. The filter was also saved and counted. The radiocounting results are presented in Table 4.1.

TABLE 4.1. Radionuclide Content of Liquid Waste Streams (μCi/L)[a]

Sulfate Waste	Unfiltered	Filtered	Particles on Filter[b]
^{54}Mn	1.12×10^{1}	1.42	1.39×10^{1}
^{60}Co	9.93×10^{-1}	3.05×10^{-1}	9.25×10^{-1}
^{95}Zr	4.26×10^{-1}	$<5 \times 10^{-2}$	3.53×10^{-1}
^{95}Nb	1.03	$<5 \times 10^{-2}$	9.72×10^{-1}
^{144}Ce	1.27	$<5 \times 10^{-2}$	1.31
^{103}Ru	$<5 \times 10^{-2}$	$<5 \times 10^{-2}$	9.52×10^{-2}
Phosphate Waste			
^{54}Mn	1.16	9.83×10^{-1}	4.86×10^{-2}
^{60}Co	1.30×10^{2}	1.36×10^{2}	4.25×10^{1}

(a) Determined on 12/31/86.
(b) Counting geometry for filter paper was not established; thus, these values are only approximations.

In May 1984, the phosphate waste was analyzed and found to contain 8 μCi/L ^{54}Mn and 265 μCi/L ^{60}Co. With decay, assuming 2.6 years between analyses, the values in December 1986 would have been 1.5 μCi/L ^{54}Mn and 190 μCi/L ^{60}Co. Although the analyses for May 1984 and December 1986 do not agree exactly, they are similar. The May 1984 analysis also showed that the total alpha activity was <0.3 μCi/L.

The total chemical analysis of the real phosphate and sulfate waste streams was conducted on January 14, 1987. Previously (1984), the phosphate waste stream was analyzed; results from that analysis are shown in parenthesis in Table 4.2, next to results from the PNL analysis.

4.1.2 Synthetic Liquid Waste

Most of the grout samples used to develop leach rates of important radionuclides and trace metals were prepared using simulated liquid waste. The recipe for making simulated waste solutions was obtained from Rockwell.

TABLE 4.2. Chemical Analysis of Real Waste Streams (mg/L)

Component	Sulfate Waste	Phosphate Waste[a]
pH (units)	7.54[b]	<1.0[b]
Eh (mV)	390.0	NA[c]
Al	<0.3	0.65
B	0.4	0.1
Ba	<0.02	0.07
Ca	150.0	4.0 (2.7)
Co	<1.0	0.3
Cr	<0.2	1.4 (1.6)
Cu	0.1	0.7
Fe	0.1	338.0 (240)
Mg	14.0	0.9 (0.7)
Mn	0.03	40.0 (30)
Na	1850.0	9.6 (7.8)
Ni	<0.2	5.0 (1.9)
P	1.7	16000.0
Si	1.2	4.1 (2.4)
Sr	0.6	<0.02
Zn	0.2	1.7 (1.2)
Zr	0.1	0.3
U	<0.05	<0.05
PO_4	<10.0	51300.0 (50500)
SO_4	4300.0	<20.0
Citrate	NA	NA (4500)
NH_4^+	<0.5	11.2

(a) Parenthesis indicate results of previous analyses.
(b) Unneutralized waste streams; prior to making grout, both wastes were neutralized to pH=12 with NaOH.
(c) NA = not analyzed.

For this study, several of the trace constituents specified in the Rockwell recipe were not added. The recipes used by PNL for the two waste types are shown in Tables 4.3 and 4.4.

The pH 12 solutions contained visible precipitates, perhaps oxides and hydroxides. Results from a complete chemical analysis of the slurry (after acidification) and a 0.22-μm filtrate are shown in Table 4.5. The values for the filtrate are shown in parenthesis where they differ significantly from the values for the total slurry.

4.2 RADIOACTIVE GROUT

The composition of the radioactive PSW grout is shown in Table 4.6. To produce the grout, the liquid waste streams were mixed (70% phosphate/30% sulfate by volume) and blended with grout-forming solids. A ratio of 7 lb of solids to 1 gal of liquid waste (840 g/L) was used to produce the grout. Twelve batches of grout were made to facilitate analyses of leach rates for

TABLE 4.3. Simulated Phosphate Waste Prepared by PNL (1-L basis)

1. Add 280-mL distilled water
2. Add 25.5-mL Turco 4521A-17 (without inhibitor)
3. Add 0.12-g diethylthiourea
4. Add 11-mg $Cr(NO_3)_3 \cdot 9H_2O$
   0.27-mg $Cu\ SO_4 \cdot 5H_2O$
   1000.0-mg $Fe(NO_3)_3 \cdot 6H_2O$
   130.0-mg $Fe_2(SO_4)_3$
   87.0-mg $MnSO_4 \cdot 4H_2O$
   3.1-mg $ZnSO_4 \cdot 7H_2O$
   9.2-mg $Ni(NO_3)_2 \cdot 6H_2O$
   13.0-mg $Ca(NO_3)_2 \cdot 4H_2O$
   26.0-mg NaF
   36.0-mg NaCl
5. Add 19M NaOH solution until pH = 12.0 ± 0.1
6. Fill to 1.00 L with distilled water

TABLE 4.4. Simulated Sulfate Waste Prepared by PNL (1-L basis)

1. Add 300-mL distilled water
2. Add 4.5-g Na_2SO_4
3. Add 0.54-mg $BaCO_3$
   0.15-mg $Cd(NO_3)\cdot4H_2O$
   73.0-mg $Cr(NO_3)_3\cdot9H_2O$
   1.3-mg $Pb(NO_3)_2$
   0.13-mg $AgNO_3$
   1.2-mg $CuSO_4\cdot5H_2O$
   97.0-mg $Fe(NO_3)_3\cdot6H_2O$
   160.0-mg $Fe_2(SO_4)_3$
   10.0-mg $MnSO_4\cdot4H_2O$
   170.0-mg $ZnSO_4\cdot7H_2O$
   15.0-mg $Ni(NO_3)_2\cdot6H_2O$
   240.0-mg $Al(NO_3)_3\cdot9H_2O$
   20.0-mg KNO_3
   68.0-mg $CaSO_4$
   88.0-mg NaF
   66.0-mg NaCl
4. Add 19M NaOH solution until pH = 12.0 ± 0.1
5. Fill to 1.00-L with distilled water

specific trace metals and radionuclides. Table 4.7 summarizes the contents of each batch; specific details on each batch are described in the following paragraphs.

Batch #1 contained ^{14}C spiked into the simulated phosphate/sulfate liquid waste. Exactly 250 mL of mixed PSW liquid was traced with 0.01 mL of $NaH^{14}CO_3$ solution (pH=9.8). The activity of the ^{14}C spike was 1.76 mCi/mL. The dry solids (210 g) were added to the spiked PSW liquid, and grout was produced. The ^{14}C activity was approximately 0.5 mCi/L of grout.

Batch #2 contained stable As, ^{109}Cd, and ^{230}Hg spiked into simulated phosphate/sulfate liquid waste. Exactly 250 mL of mixed PSW liquid was

TABLE 4.5. Chemical Analysis of Simulated Waste Streams (mg/L)[a]

Component	Sulfate Waste	Phosphate Waste[a]
pH	12.0	12.0
Al	16.8 (11)	<0.3
B	0.08	0.06
Ba	0.24	<0.02
Ca	25.0 (2.8)	3.1 (8)
Co	<0.1	<0.1
Cr	9.3 (0.58)	1.6 (<0.2)
Cu	0.35	0.12
Fe	327 (<0.5)	157.0 (5.7)
K	5.0	<3.0
Li	0.06	0.23
Mg	0.61	0.54
Mn	3.8 (<0.2)	23.0 (0.7)
Na	2075.0 (2050)	17500.0 (17400)
Ni	3.1 (<0.2)	<0.2
P	<1.0	B350.0 (8270)
Pb	0.9 (<0.6)	<0.6
Si	0.19	0.32
Sr	0.075	0.03
Zn	39.0 (<0.2)	1.0 (<0.2)
Zr	0.11	0.09
F	NA[b] (40)	NA (50)
Cl	NA (40)	NA (20)
NO_3	NA (260)	NA (600)
PO_4	NA (<5)	NA (26000)
SO_4	NA (4100)	NA (100)

(a) Parenthesis indicate filtrate analysis.
(b) NA = not analyzed.

TABLE 4.6. Composition of Radioactive PSW Grout

	Material	Fraction
Solids	Portland type I and II cement	41 wt%
	Class F fly ash	40 wt%
	Attapulgite clay	11 wt%
	Indian red pottery clay	8 wt%
Liquids	Sulfate waste components	30 vol%
	Phosphate waste components	70 vol%

spiked with As (as As_2O_5 dissolved in distilled water) to obtain a 5 mg/L concentration, 0.002 mL of ^{203}Hg (8.32 mCi/mL) dissolved in 0.1N HCl, and 0.002 mL of ^{109}Cd (9.137 mCi/mL) dissolved in 0.1N HCl. The dry solids (210 g) were added to the spiked solution and grout was produced. The approximate concentrations per liter of grout were 3.3 mg/L of As and 0.05 mCi/L of ^{203}Hg and ^{109}Cd.

Batch #3 contained ^{75}Se and ^{110m}Ag spiked into simulated phosphate/sulfate liquid waste. Exactly 250 mL of mixed PSW liquid was spiked with 0.0022 mL of ^{75}Se (7.55 mCi/mL) as selenate (Na_2SeO_4) dissolved in water, and 0.0424 mL of ^{110m}Ag (1.71 mCi/mL) as $AgNO_3$ dissolved in 0.1M nitric acid. The dry solids (210 g) were added to the spiked solution, and grout was produced. The approximate concentrations per liter of grout were 0.05 mCi/L for ^{75}Se and ^{110m}Ag.

Batch #4 contained ^{125}I, ^{51}Cr, and ^{210}Pb spiked into simulated phosphate/sulfate liquid waste. Exactly 500 mL of mixed PSW liquid was spiked with 4.06 mL of ^{125}I (0.00814 mCi/mL) as sodium iodide (I) in dilute sodium hydroxide solution, 0.0424 mL of ^{51}Cr (0.766 mCi/mL) as sodium chromate (CrO_4^{2-}) dissolved in distilled water, and 0.118 mL of ^{210}Pb (0.264 mCi/mL) as Pb^{2+} dissolved in dilute HNO_3. The dry solids (420 g) were added to the spiked solution, and grout was produced. The approximate concentrations per liter of grout were 0.05 mCi/L for ^{125}I and ^{51}Cr, and 0.048 mCi/L for ^{210}Pb.

Batch #5 contained ^{125}I and ^{51}Cr spiked into simulated phosphate/sulfate liquid waste. Exactly 500 mL of mixed PSW liquid was spiked with 0.406 mL

TABLE 4.7. Posphate/Sulfate Waste (70% Phosphate/30% Sulfate) Leach Test Matrix

Batch	Waste	Spike	A_o	Size[(a)]	Goal[(b)]	Date Prepared
1	Syn.	^{14}C	0.5 mCi/L	STD	D_e (data only)	2/20/87
2	Syn.	As	3.3 mg/L	STD	D_e (data only)	2/20/87
		^{203}Hg	0.05 mCi/L			
		^{109}Cd	0.05 mCi/L			
3	Syn.	^{75}Se	0.05 mCi/L	STD	D_e (data only)	3/4/87
		^{110m}Ag	0.05 mCi/L			
4	Syn.	^{125}I	0.05 mCi/L	STD/Large	Scale-up and A_o	3/6/87
		^{51}Cr	0.05 mCi/L			
		^{210}Pb	0.05 mCi/L			
5	Syn.	^{125}I	0.5 mCi/L	STD/Large	Scale-up and A_o	3/4/87
		^{51}Cr	0.5 mCi/L			
6	Syn.	^{99}Tc	0.08 mCi/L	STD/Large	Scale-up and A_o	2/20/87
7	Syn.	^{99}Tc	0.2 mCi/L	STD/Large	Scale-up and A_o	2/20/87
8	Syn.	U(VI)	5 mg/L	STD/Large	Scale-up and A_o	2/19/87
9	Syn.	U(VI)	50 mg/L	STD	A_o	2/19/87
10	Real	U(VI)	50 mg/L	STD/Large	Real vs. Syn., A_o and Scale-up	3/6/87
11	Real	--	--	STD	Real vs. Syn.	3/6/87
12	Syn.	--	--	STD	Mechanisms, Solids analysis	3/6/87

(a) Sizes: standard (STD) = 35 mL; large = 142 mL.
(b) Goals include a) D_e only (obtain leach data for important element only). All experiments provide D_e data, b) Scale-up--check S/V ratio correspondence to theory, c) A_o--see if diffusion theory holds with changes in total inventory, and d) Real vs. Syn.--see if real liquid waste stream gives the same results as the synthetic waste.

of ^{125}I (0.814 mCi/mL) as sodium iodide in dilute sodium hydroxide, and 0.424 mL of ^{51}Cr (0.766 mCi/mL) as sodium chromate solution. The dry solids (420 g) were added to the spiked solution, and grout was produced. The approximate concentrations per liter of grout were 0.5 mCi/L for ^{125}I and ^{51}Cr.

Batch #6 contained ^{99}Tc spiked into simulated phosphate/sulfate liquid waste. Exactly 500 mL of mixed PSW liquid was spiked with >0.380 mL of ^{99}Tc (0.1315 mCi/mL) as pertechnetate (TcO_4^-) in 0.1M NH_4OH. The dry solids (420 g) were added to the spiked solution and grout was produced. The approximate concentration of ^{99}Tc per liter of grout was 0.077 mCi/L.

Batch #7 contained ^{99}Tc spiked into simulated phosphate/sulfate liquid waste. Exactly 500 mL of mixed PSW liquid was spiked with 0.850 mL of ^{99}Tc (0.1315 mCi/mL) as TcO_4^- in 0.1M NH_4OH. The dry solids (420 g) were added to the spiked solution and grout was produced. The approximate concentration of ^{99}Tc per liter of grout was 0.172 mCi/L.

Batch #8 contained U spiked into simulated phosphate/sulfate liquid waste. Exactly 496.75 mL of mixed PSW liquid was spiked with 3.25 mL of $UO_2(NO_3)_2$ solution (1000 mg/L U). The dry solids (420 g) were added to the spiked solution and grout was produced. The approximate concentration of U per liter of grout was 5.0 mg/L.

Batch #9 contained U spiked into simulated phosphate/sulfate liquid waste. Exactly 233.75 mL of mixed PSW liquid was spiked with 16.25 mL of $UO_2(NO_3)_2$ solution (1000 mg/L U). The dry solids (210 g) were added to the spiked solution and grout was produced. The approximate concentration of U per liter of grout was 50 mg/L.

Batch #10 contained U spiked into real phosphate/sulfate liquid waste. Exactly 32.5 mL of U as $UO_2(NO_3)_2$ (1000 mg/L U) was mixed with 140.25 mL of sulfate waste and 327.25 mL of phosphate waste. The mixture was then neutralized to pH 12 using a 19$\underline{M}$ NaOH solution. The dry solids (420 g) were added to the liquid and grout was produced. The approximate concentration of U per liter of grout was 50 mg/L.

Batch #11 did not contain spikes. Actual phosphate/sulfate liquid wastes were mixed (70% phosphate/30% sulfate by volume) and neutralized with 19M NaOH. Exactly 500 ml of the neutralized slurry was mixed with 420 g of dry blend to produce grout.

Batch #12 did not contain spikes. A 70:30 mixture of synthetic phosphate/sulfate liquid waste was prepared, and exactly 500 mL was mixed with 420 g of dry blend to produce grout.

Each batch of grout slurry was poured into plastic containers that were capped to prevent moisture loss. The grout samples were then cured at room temperature for the periods listed in Table 4.8. According to the test criteria, a 28-day curing period is required prior to testing. The actual curing times listed in Table 4.8 exceed 28 days.

Before starting each experiment, each grout sample was removed from its container, weighed, and measured. Obvious cracks or defects were noted, and severely cracked samples were discarded. Cracking was usually caused by

TABLE 4.8. Curing Time for Various Tests

Batch	Days of Curing at Room Temperature in Plastic Containers
1	123
2	81
3	69
4	67
5	69
6	102
7	102
8	102
9	103
10	109
11	109
12	109

removing a sample from its hard plastic container. On all the samples, a few specks of loose grout clung to the main piece of grout. These specks were wiped off before weighing the sample.

Twelve of the small samples of grout were dried for 3 days at 105°C. These samples contained 51.0% water, as determined by simple weight loss measurement. Two subsamples of the dried grout (Batch 2 and Batch 7) were submitted for total chemical analyses by total fusion (lithium metaborate) and inductively coupled plasma (ICP) measurement, and direct analyses by x-ray fluorescence (XRF). Because neither ICP nor XRF analyses provide complete information on all important chemical constituents, a complete mass balance is not possible. Table 4.9 contains the available data from the ICP and XRF analyses. The data in this table represent the best method when one method (ICP or XRF) is clearly superior. The table also contains the chemical composition of 60:40 synthetic PSW grout used in earlier leach studies (Serne et al. 1987). The sum of the chemical constituents (94% to 96%) suggests that there are other unaccounted constituents, or that the data are not accurate. However, the values reported in the table were assumed to be correct and were used to establish initial inventories, A_o, in the leach equations presented previously [i.e., Equations (3.1) through (3.4)]. Unlike many other leach studies, our A_o values reflect the total content of chemical constituents in the grout, not just the contribution from the radioactive liquid waste streams. For components such as K and Na and certain trace metals, the bulk of the mass could be in the dry blend.

4.3 HANFORD GROUND WATER

Using data from the Hanford Ground-Water Monitoring Program, a well was identified on the Hanford Site (well #6-S3-25) that is free of contamination and provides water representative of natural waters in the unconfined aquifer underlying Hanford. Periodically, large volumes of water are pumped from this well into prerinsed plastic containers. The well water is filtered through a 0.22-μm membrane and stored for use in various laboratory experiments. Water from this well was used as the leachant for the leach tests in this study.

TABLE 4.9 Chemical Composition of Simulated (70%:30%) PSW Grout (wt%)

	Batch 2	Batch 7	Method[a]	Average	60:40% PSW Grout
Al_2O_3	11.90	11.5	Fusion	11.7	10.5
B_2O_3	0.28	0.31	Fusion	0.3	0.2
BaO	0.10	0.10	Either	0.1	0.1
CaO	31.20	31.62	XRF	31.4	25.5
CuO	0.01	0.013	Either	0.01	0.02
Cr_2O_3	0.011	0.009	XRF	0.01	--[b]
Fe_2O_3	5.26	5.13	XRF	5.2	4.2
K_2O	0.56	0.60	Either	0.6	0.6
MgO	1.92	1.87	Fusion	1.9	1.8
MnO_2	0.53	0.52	Fusion	0.5	0.05
Na_2O	3.29	3.32	Fusion	3.3	2.6
NiO	0.03	0.01	XRF	0.02	--
PbO	0.01	<0.01	XRF	0.01	--
SO_4	1.68	1.4	Fusion	1.68	2.2
SiO_2	35.80	34.7	Fusion	35.25	31.3
SrO	0.14	0.14	Either	0.14	0.12
TiO_2	1.96	1.86	Fusion	1.91	1.9
V_2O_3	0.06	0.06	Either	0.06	0.05
ZrO_2	0.06	0.06	Either	0.06	0.05
Cl	0.01	0.01	Either	0.01	--
NO_3	0.043	0.04	Fusion	0.04	0.04
PO_4	1.29	0.78	XRF	1.04	1.7
Li_2O	--	--	Fusion	--	0.07
ZnO	0.015	0.015	XRF	0.015	0.01
Volatiles/ Bound water	--	--	Meas.	--	9.16
	94.07	96.15			92.24

(a) Methods of analysis:
Fusion - total fusion, acid dissolution, ICP analysis.
XRF - direct measurement.
Either - both methods gave same result.
Meas. - measured by weight loss on sequential heatings.

(b) --: Not measured.

A complete chemical analysis of the water is done on each new batch. No significant changes in the water composition from batch-to-batch and during storage in the laboratory have been observed. The chemical composition of three batches of this ground water is shown in Table 4.10. The computer code MINTEQ (Felmy, Girvin and Jenne 1984) was used to determine whether this ground water is in equilibrium with any common minerals found in Hanford

TABLE 4.10. Composition of Hanford Well Water

Analysis	Units	Date Sampled 11-10-86	Date Sampled 05-11-87	Date Sampled 11-11-87
pH		8.05	8.36	8.47
Eh	mV	315	351	385
Al	mg/L	0.029	<0.03	0.064
B	mg/L	0.077	0.08	0.089
H_3BO_3	mg/L	0.44	0.46	0.52
Ba	mg/L	0.053	0.056	0.043
Ca	mg/L	51.7	50.6	58.8
Cd	mg/L	<0.004	<0.004	<0.004
Cr	mg/L	<0.02	<0.02	<0.02
Cu	mg/L	0.005	<0.004	<0.004
Fe	mg/L	0.008	<0.005	0.019
K	mg/L	7.3	8	7.4
Mg	mg/L	13.2	13.4	14.0
Mn	mg/L	0.117	0.087	0.16
Na	mg/L	23.8	25.0	24.8
P	mg/L	<0.1	<0.1	0.17
as PO_4	mg/L	<0.3	<0.3	0.51
Pb	mg/L	<0.06	<0.06	<0.06
Si	mg/L	14.6	15.	15.5
Sr	mg/L	0.229	0.236	0.238
Zn	mg/L	<0.02	<0.02	<0.02
F^-	mg/L	0.68	<0.7	0.57
Cl^-	mg/L	21	21	22.5
NO_2^-	mg/L	<0.1	<0.3	<0.3
NO_3^-	mg/L	<0.5	<0.5	<0.5
$SO_4^=$	mg/L	63	67	70.5
$PO_4^{\equiv}$	mg/L	<1.0	<1.0	<1.0
HCO_3^-	mg/L	251.7	188	174
$CO_3^=$	mg/L	0.0	0.0	0.0
Total Alk	mg/L	123.8	92.2	85.68
OH^-	mg/L	0	0.0	0.0
TOC	mg/L	0.27	0.45	0.84
IC	mg/L	35.2	34.1	33.0
Cations	meq/L	4.90	4.92	5.36
Anions	meq/L	6.07	5.06	4.99

sediments and carbon dioxide gas. Using average analyses based on the values in Table 4.10, MINTEQ calculations show the Hanford ground water to be slightly enriched in dissolved CO_2 (pCO_2 = -2.9 atm versus -3.5 atm in equilibrium with air). MINTEQ also indicates that the ground water might be in equilibrium with several minerals, including barite ($BaSO_4$), boehmite [AlO(OH)], dolomite [$Ca,Mg(CO_3)_2$], calcite ($CaCO_3$), magnesite ($MgCO_3$), sepiolite [$Mg_4(Si_6O_{15})(OH)_2 \cdot 6H_2O$], gibbsite [$Al(OH)_3$], amorphous silica ($SiO_2$am), $MnHPO_4$, willemite (Zn_2SiO_4), otavite ($CdCO_3$), cerussite ($PbCO_3$), and analcime ($NaAlSi_2O_6 \cdot H_2O$).

Thus, the concentrations of Ca and Mg in the ground water appear to be controlled by either their respective pure carbonates or the mixed carbonate dolomite. Either gibbsite or boehmite might be controlling the Al concentration. Amorphous SiO_2 appears to be controlling Si concentrations. The carbonate system might also be controlling Cd and Pb concentrations, and a zinc silicate and barium sulfate may be controlling the Zn and Ba concentrations, respectively. The concentrations of most trace metals appear to be below the solubility limits of common minerals and, thus, may be controlled by adsorption reactions.

5.0 METHODS

The procedures used to leach the PSW grout are described in this section. Two types of leach tests were used: an intermittent solution exchange test and a static leach test.

5.1 ANS 16.1 LEACH TESTS

The ANSI/ANS-16.1 intermittent replacement leach test (ANS 16.1 leach test) consists of a procedure whereby the leachate is sampled and replaced at specific intervals (ANS 1986). For all of the ANS 16.1 leach tests involving PSW grout, we used intact right cylinders of two sizes: 3.2 cm dia. by 4.2 ± 0.3 cm long, and 4.6 ± 0.1 cm dia. by 8.5 ± 0.3 cm long. The leachant was Hanford ground water from well #6-S3-25. The ground water was filtered through a 0.22-μm filter prior to use. The ANS 16.1 leach tests were conducted at room temperature.

To initiate the tests, a volume of ground water equal to 10 times the geometric surface area of the grout specimen was added to wide-mouth polyethylene jars. Using unwaxed dental floss, the grout specimens were anchored securely to the lids of each jar and then suspended in the leachant. Two containers were used for each specimen in a sequence that allowed determination of the amount of radionuclide adsorbed on the inside surface of the containers. All the tests were performed in duplicate or triplicate.

At each sampling interval the leachate was removed, filtered through a 0.22-μm Millex-GS Millipore filter®, and analyzed. Measurements of pH, Eh, and alkalinity were taken as quickly as possible. The pH was measured using a Corning Model 130 pH meter® and combination electrode. The Eh was measured

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® Corning Model 130 pH meter is a registered trademark of Corning Glass Works, Medfield, Massachusetts.

using a Corning Model 130 pH meter and a Bradley James combination reference-platinum electrode®. The alkalinity, reported as milligrams per liter carbonate, was measured by standard methods using a Mettler DL40 memotitrator® and a micro-combination pH electrode [method #403 from Greenberg et al. (1981)]. The remaining samples were preserved in 25-mL plastic scintillation vials for additional analyses, as described below:

1. Approximately 20 mL were provided for ion chromatography (IC) anion analyses.

2. Approximately 20 mL and 5 mL were provided for ICP emission spectrometry and graphite furnace atomic absorption analysis, respectively. The samples were acidified with Ultrex HCl® to a pH of <2.

3. Approximately 15 mL were provided for total carbon (TC) and total organic carbon (TOC) analysis.

4. Exactly 15 mL acidified to pH <2 were provided for gamma ray radionuclide counting and uranium measurement; approximately 5 mL (no acidification) were provided for beta counting.

5. To monitor radionuclide and chemical plateout on containers at each sampling interval, the containers were rinsed with a solution consisting of 10 mL of deionized water and 10 mL of a pH 2 nitric acid. Exactly 15 mL and 1 mL of this solution were provided for gamma radionuclide and beta counting, respectively.

The cations in solution were measured using an ICP Jarrell Ash model #975 plasma-autocomp spectrophotometer®. The instrument can simultaneously measure over 30 elements, but we report data for only the following: Al, B,

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® Mettler DL40 memotitrator is a registered trademark of Mettler Instrument Corporation, Highstown, New Jersey.

® Ultrex acids are a registered trademark of J. T. Baker Chemical Company, Jackson, Tennessee.

® Jarrell Ash model #975 plasma-autocomp spectrophotometer is a registered trademark of Allied Analytical Systems, Waltham, Massachusetts.

Ba, Ca, Cd, Cr, Cu, Fe, K, Mg, Mn, Na, P, Pb, S, Si, Sr, and Zn. A Perkin Elmer HGA-5000 graphite furnace atomic absorption spectrophotometer® with a Zeeman background corrector was used to measure total As.

The anions in solution were measured using a Dionex Model #12 ion chromatograph®. The constituents measured were F^-, Cl^-, NO_2^-, NO_3^-, SO_4^{-2}, and PO_4^{-3}. Partway through the testing we started measuring F^- with an ion-specific electrode because the procedure is more sensitive than IC.

The TOC and total inorganic carbon (TIC) were measured using a Dohrmann DC80 carbon analyzer®.

The beta emitters ^{14}C, ^{99}Tc, and ^{125}I were counted on a Beckman Instruments LS 9800 liquid scintillator®. Exactly 1.0 mL of sample was added to 14 mL of Insta-Gel cocktail® (catalog #600-2177). The mixture was counted for 1 hour.

The gamma emitters ^{109}Cd, ^{203}Hg, ^{51}Cr, and ^{210}Pb were counted on a Princeton Gamma-Tech intrinsic germanium detector® with a beryllium window. The acidified solutions (15 mL in a 25-mL liquid scintillation vial) were counted for 1 to 7 hours, depending on activity. The gamma emitters ^{75}Se, ^{110m}Ag, and ^{51}Cr were counted on a 5-in. x 5-in. sodium iodide detector. Both gamma detectors are connected to a Nuclear Data Model 6700 analyzer®. The Nuclear Data system contains a peak search/strip software package that

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® Dionex Model #12 ion chromatograph is a registered trademark of Dionex Corporation, Sunnyvale, California.

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® LS 9800 liquid scintillator is a registered trademark of Beckman Instruments, Fullerton, California.

® Insta-Gel cocktail is a registered trademark of Packard Instrument Company, Inc., Downer's Grove, Illinois (catalog #600-2177).

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separates individual spectra. The radionuclides of interest were analyzed at the following specific energies: ^{51}Cr, 320 keV; ^{75}Se, 265 keV; ^{109}Cd, 88 keV; ^{110m}Ag, 658 keV; and ^{210}Pb, 47 keV.

The U concentration in solutions was determined on a model UA-3 laser fluorescence spectrophotometer® (uranium analyzer) manufactured by Scintrex Ltd.

The actual phosphate and sulfate liquid waste streams were counted on the intrinsic germanium detector. For the liquid waste streams, both unfiltered and 0.22-μm filtered samples were counted. The leachates from real grout waste forms were counted on the 5-in. x 5-in. sodium iodide detector because the activities were very low. The leachates were also counted on the liquid scintillator with the window open from 0 to 1 MeV to determine whether any detectable beta emissions could be found.

5.2 STATIC LEACH TESTS

For each batch of PSW grout, two right cylinders of grout were suspended in separate wide-mouth polyethylene jars filled with Hanford ground water to a volume equal to 10 times the geometric surface area of the grout sample. At the prescribed times, 50 mL of leachate were removed from the container and filtered through a 0.22-μm membrane. The effluents were analyzed for the same constituents and treated exactly as described for the ANS 16.1 test leachates. To replenish the leachate removed for analysis, 50 mL of fresh Hanford ground water was added and the experiment was continued. Each of the specimen leachates were sampled in rotation such that the interval between sampling any one container was maximized (e.g., a leachate sample was removed from container #1 at 4 days, from container #2 at 18 days, from container #1 at 48 days, etc.). The sampling schedule to date is shown in Table 5.1. It is believed that the impact of replenishing the leachate with 50 mL of ground

® Model UA-3 laser fluorescence spectrophotometer (uranium analyzer) is a registered trademark of Scintrex Ltd., Concord, Ontario, Canada.

TABLE 5.1. Sampling Schedule for ANS 16.1 Leach Tests and Static Leach Tests

ANS 16.1 Leach Tests		Static Leach Tests	
Sample #	Cumulative Time	Sample #	Cumulative Time
1	2 hours	1	4 days
2	7 hours	2	18 days
3	1 day	3	47 or 48 days
4	2 days	4	90 days
5	3 days	5	150 days
6	4 days	6	208 or 211 or 223 days
7	18 or 19 days		
8	47 or 48 days		
9	90 days		
10	150 days		
11	208 or 210 or 211 days		

water should have little effect on the solution chemistry--by the time a given leachate is sampled again, the solution is assumed to have re-equilibrated as if there never was a disturbance.

5.3 ADDITIONAL ANALYSES OF GROUT SAMPLES

When the leach tests are completed, the intact grout cylinders will be partially characterized. Characterization methods currently being explored are thin sectioning followed by x-ray diffraction analyses of sections near the surface versus sections from the interior, scanning electron microscopy with an XRF microprobe, and petrographic microscopy. Other surface analysis techniques may be considered if studies prove they would be useful.

6.0 RESULTS AND DISCUSSION

The results of the leach tests are presented in this section, along with an interpretation of the results. Several of these tests are continuing, and new interpretations may follow.

6.1 LEACHATE CHEMISTRY FOR ANS 16.1 AND STATIC LEACH TESTS

Data from the ANS 16.1 and static leach tests are provided in Appendices A and B. Appendix A lists the chemical composition of the leachate solutions. Appendix B lists the radionuclide counting data, corrected for decay and effective diffusion coefficient calculations, for all constituents that leached. Tables A.1 through A.10 and Figure 6.1 show an immediate rise in solution pH from the ambient ground-water value of 8.36 upon contact with the grout in both tests. For the ANS 16.1 leachates, the 2-hour through 2-day, 18-day, and 47-day samples show pH values between 9 and 11.2. All

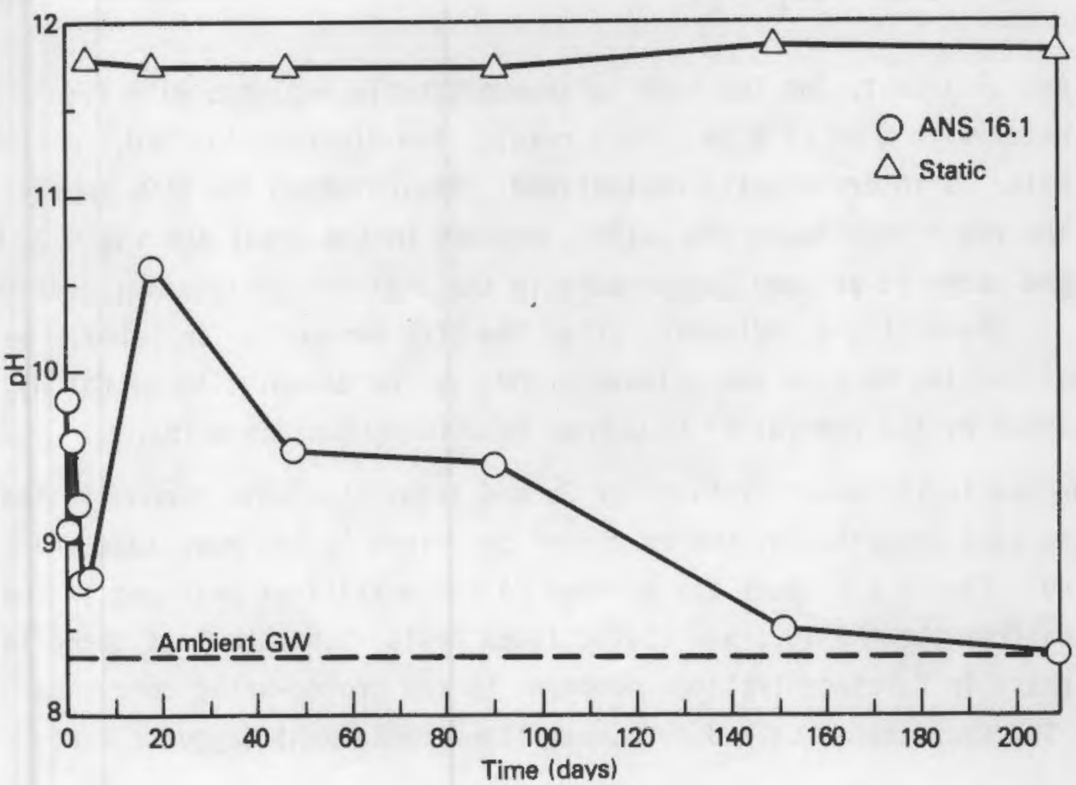

FIGURE 6.1. pH Values for ANS 16.1 and Static Leach Test Leachates from Intact Grout Cylinders

of the leachates collected after 150 days show that pH values fell to between 8.0 and 9.2. In contrast, the pH values from static leach tests stabilized between 11.8 and 11.9 after 18 days of contact. The data points in Figure 6.1 are an average of the six ANS 16.1 test data sets and four static leach test data sets listed in Appendix A. In general, no significant differences were observed between individual tests of each type, even though both synthetic and actual liquid wastes were used in the ANS 16.1 test. (All of the following figures in this section show the average solution concentration of the cited constituents for each test type.)

In both the static leach and ANS 16.1 tests, the portlandite [$Ca(OH)_2$] in the grout probably dissolves, causing the pH to rise as OH- is added to the solution. The following equations describe the reactions that occur:

$$Ca(OH)_2 + HCO_3^- \rightarrow CaCO_3\downarrow + OH^- + H_2O \quad (6.1a)$$

$$Ca(OH)_2 \rightarrow Ca^{2+} + 2OH^- \quad (6.1b)$$

$$OH^- + HCO_3^9 \rightarrow CO_3^{2-} + H_2O \quad (6.2)$$

In the ANS 16.1 test, the leachate is intermittently replaced with fresh ground water with a pH of 8.36. As a result, the bicarbonate (HCO_3) content of the water is intermittently replenished. Replenishing the HCO_3 supply allows the reaction between the $Ca(OH)_2$ present in the grout and the HCO_3 in the ground water to proceed longer than in the static experiments (Equation 6.1a). In the static experiments, after the HCO_3 content is depleted, the pH continues to rise because the release of OH- by the dissolution of $Ca(OH)_2$ is not balanced by the removal of HCO_3 from solution (Equation 6.1b).

Changes in the concentrations of Ca and total inorganic carbon in the leachates also suggest that the reactions described by the equations are occurring. Figure 6.2 shows the average Ca concentrations measured in the leachates from the ANS 16.1 and static leach tests. In each test there is a net decrease in Ca concentrations compared to the ground-water concentrations. The decrease in Ca and carbonate (see Appendix A) suggests that

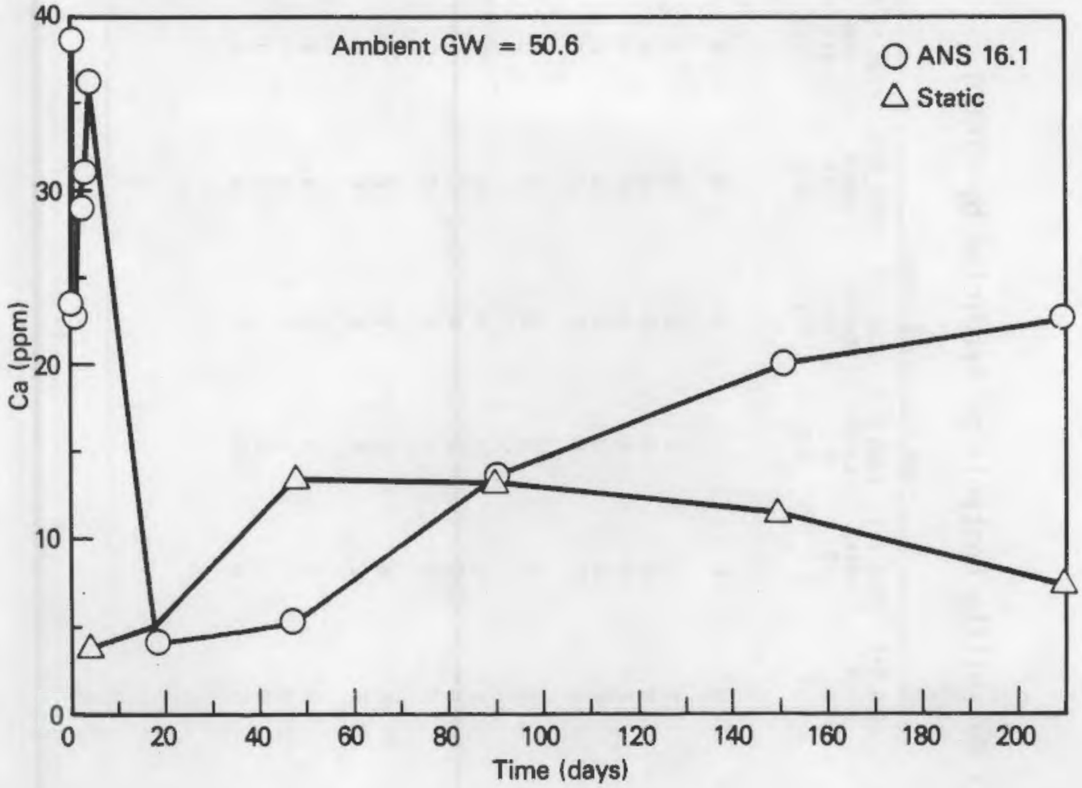

FIGURE 6.2. Ca Concentration for ANS 16.1 and Static Leach Test Leachates from Intact Grout Cylinders

$CaCO_3$ is precipitating. MINTEQ ion speciation/solubility calculations were completed on the final leachates sampled in both tests. Table 6.1 summarizes the results from these calculations. These calculations suggest that the leachates from the static leach test are in equilibrium with dolomite [$CaMg(CO_3)_2$], possibly in equilibrium with aragonite or Mg-calcite, and over-saturated in calcite. The kinetics of dolomite precipitation are usually very slow, so it is more likely that aragonite or a mixed Mg-Ca carbonate is precipitating. The final leachates from the ANS 16.1 tests were predicted to be in equilibrium with aragonite, calcite, dolomite, and possibly magnesite and Mg-calcite. These MINTEQ calculations strongly suggest that at least one carbonate mineral is a solubility control in these experiments.

Although the ANS 16.1 test leachates exhibit higher concentrations of Ca and inorganic carbon than do those from the static tests, the actual mass

TABLE 6.1. Saturation Levels of Potential Solubility Controls as Predicted by MINTEQ

Sample	Static Leach Tests				ANS 16.1 Leach Tests					
Sample	PSWS 5-4	PSWS 7-4	PSWS 9-4	PSWS 10-4	PSWA 5-1	PSWA 7-1	PSWA 7-6	PSWA 9-1	PSWA 10-1	PSWA 10-6
Cylinder Size	Large	Large	Small	Large	Small	Small	Large	Small	Small	Large
Days	223	208	208	211	210	208	208	208	211	211
pH	11.85	11.42	11.78	12.22	9.1	8.3	8.0	8.2	8.2	8.24
Solid phases										
Portlandite	U[a]	U	U	U	U	U	U	U	U	U
Calcite	O	O	O	O	E	E	E	E	E	O
Aragonite	O	E	O	E	E	E	E	E	E	E
Dolomite	E	E	E	E	E	E	E	E	E	O
Mg-Calcite	O	E	O	E	E	E	U	E	E	E
Magnesite	U	U	U	U	E	E	U	U	U	E
Brucite	E	E	E	E	U	U	U	U	U	U
Diaspore	O	O	O	E	O	O	O	O	O	O
Boehmite	U	U	U	U	U	E	U	E	E	E
Gibbsite	U	U	U	U	U	E	U	E	E	E
Hydroxyapatite	O	O	O	O	O	E	E	E	E	E
Mn HPO_4	(b)	(b)	(b)	(b)	E	E	E	E	E	E
Gypsum	U	U	U	U	U	U	U	U	U	U
Ettringite	U	U	U	U	U	U	U	U	U	U
Calcium Monosulfate	U	U	U	U	U	U	U	U	U	U
Strontianite	O	O	E	E	U	U	U	U	U	U

(a) U - Undersaturated.
O - Oversaturated.
E - Equilibrium.
(b) Mn not entered as component in these MINTEQ calculations.

precipitated is larger. This difference occurs because the entire inventory of ANS 16.1 test leachate solution is changed at each sampling time (580 to 1500 mL), whereas in the static leach test, only 50 mL of solution are changed in one of the leach vessels at each sampling time. After 210 days, the ANS 16.1 standard size (35-mL) samples show a net precipitation of at least 183 ± 16 mg of calcium and 49.5 ± 4.5 mg of inorganic carbon, whereas the static leach tests show a net precipitation of only 36.8 ± 5 mg of calcium and 20.5 ± 2 mg of inorganic carbon. The large-sized samples (142 mL) leached by the ANS 16.1 test procedure show 518 ± 21 mg of calcium and 183 ± 37 mg of inorganic carbon removal. These calculated precipitation values account only for losses from the original leachant and do not account for mass that leaches out of the grout and reprecipitates. Appendix C contains estimates of the masses of Ca, carbon, and other constituents either leached or precipitated in all the leach tests.

There are also distinct differences in the Mg, Na, and K leachate concentrations between the two tests. Figures 6.3, 6.4, and 6.5 show the leachate concentrations for Mg, Na, and K, respectively. In the ANS 16.1 tests, the Mg concentrations show a slight dip from 13.4 to 9.7 to 12.7 mg/L between 2 hours and 4 days. At the longer times (18 and 47 days), the leachate concentration of Mg drops to values below 8, then rebounds to values between 8 and 8.36 for the ground-water leachant. In contrast, the Mg concentration of the static leach test leachate rapidly decreases after 4 days of contact, and then remains below the detection limit. MINTEQ code calculations suggest that the rapid decrease in Mg concentrations in the static tests is due to the precipitation of brucite $[Mg(OH)]_2$ and/or mixed Mg-Ca carbonates. According to the MINTEQ calculations for the ANS 16.1 leach tests, the final samples taken after 200 days of contact are in equilibrium with dolomite $[MgCa(CO_3)_2]$ and three of the six samples are in equilibrium with magnesite ($MgCO_3$). It may be possible that some Mg is leaching from the grout in the ANS 16.1 tests, and precipitating as $MgCO_3$ or mixed Mg-Ca carbonates. At a minimum, 24 ± 3 and 59 ± 4 mg of Mg precipitated in the ANS 16.1 leach tests (standard- and large-sized grout, respectively), and at least 11.3 mg of Mg precipitated in the static leach tests.

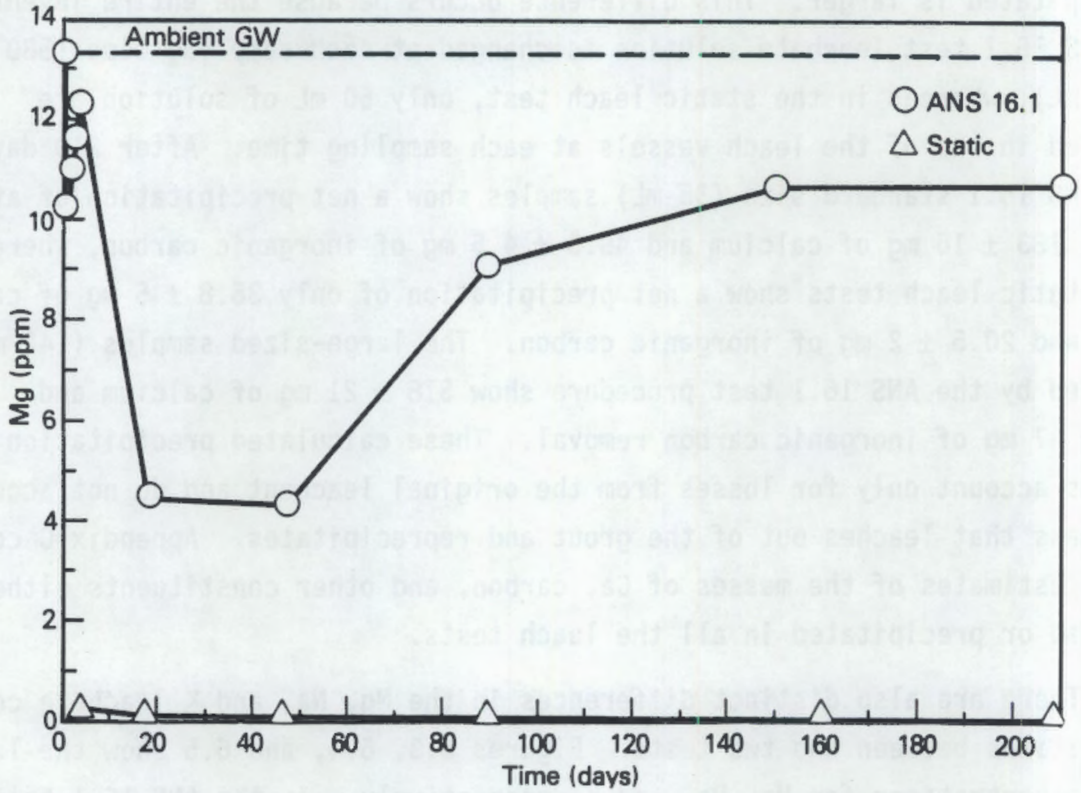

FIGURE 6.3. Mg Concentration for ANS 16.1 and Static Leach Test Leachates from Intact Grout Cylinders

The ANS 16.1 leach tests show a net release of Na and K from the grout. The ambient Na concentration of Hanford ground water is about 25 mg/L, whereas most of the leachates show concentrations around 35 to 50 mg/L, and the leachates at 47 days of contact show values between 60 and 130 mg/L. Mass balance calculations suggest that at least 175 ± 40 and 460 ± 30 mg of Na leach from the grout after 210 days of leaching for the ANS 16.1 test (standard- and large-sized grout, respectively). This range amounts to 24 ± 15% and 17 ± 2% of the total Na present in the standard- and large-sized grout, respectively. In the static leach test, the Na concentration steadily increases with time and after 150 days of leaching shows a value of 300 mg/L. Mass balance calculations suggest that at least 230 mg of Na have leached from the grout after 210 days, which represents 35 ± 5% of the total. The higher Na release in the static test may reflect 1) a different leaching process due to the higher pH of the static test (e.g., perhaps a sodium-bearing mineral from the clay component of the grout is present and is more

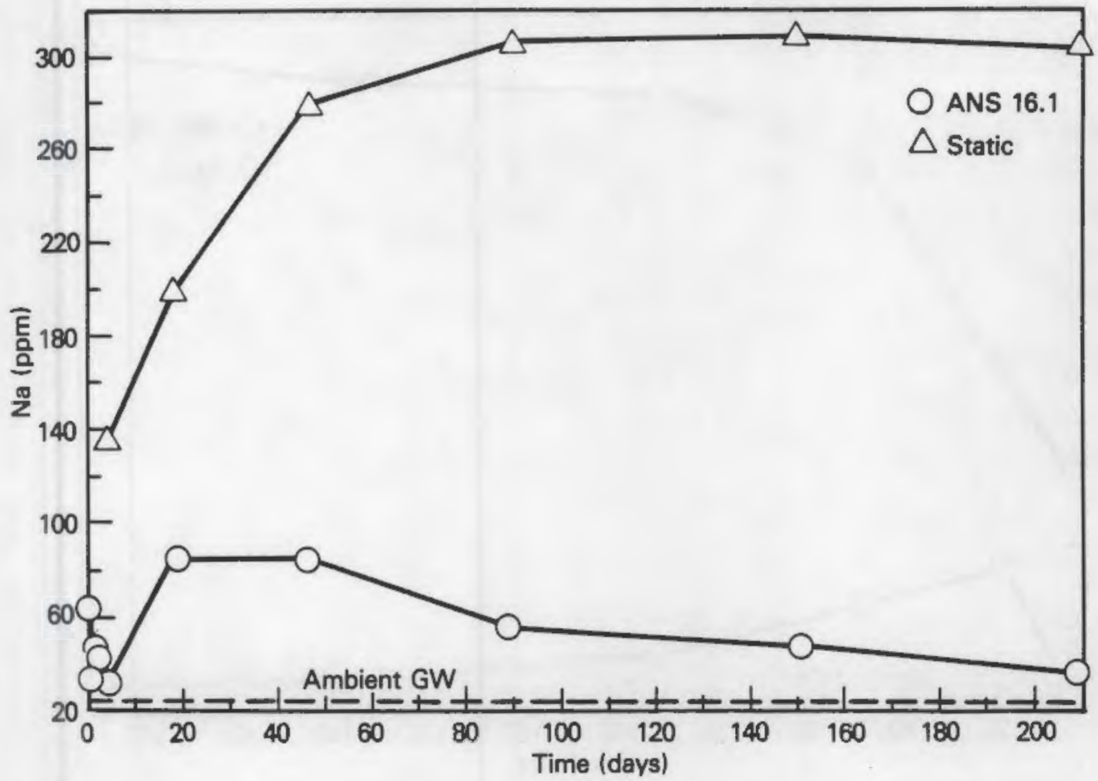

FIGURE 6.4. Na Concentration for ANS 16.1 and Static Leach Test Leachates from Intact Grout Cylinders

soluble at high pH), or 2) a thinner $CaCO_3$ rind on the surface of the grout cylinder in the static leach test, which allows more of the cylinder to leach. Whatever the mechanism, the greater Na leach rate in the static leach test versus that in the ANS 16.1 test contradicts the results expected from simple diffusion theory, which would predict that a static condition allows buildup of material in solution and thus should reduce the diffusive driving force. The same results were observed in the 60:40 PSW grout tests reported previously (Serne et al. 1987).

The K concentrations from the two leach tests show the same patterns as the Na data. In the ANS 16.1 test, the K concentrations in the leachates rise to values of 9 to 16 mg/L versus the ambient ground-water value of 8 mg/L. Later samples stabilize in the range of 8 to 10 mg/L. Mass balance calculations for the ANS 16.1 tests show a total of about 19.4 ± 5.8 and 58.7 ± 1.2 mg of K released from the grout for standard- and large-sized samples. In the static leach tests, K concentrations slowly increase and, after

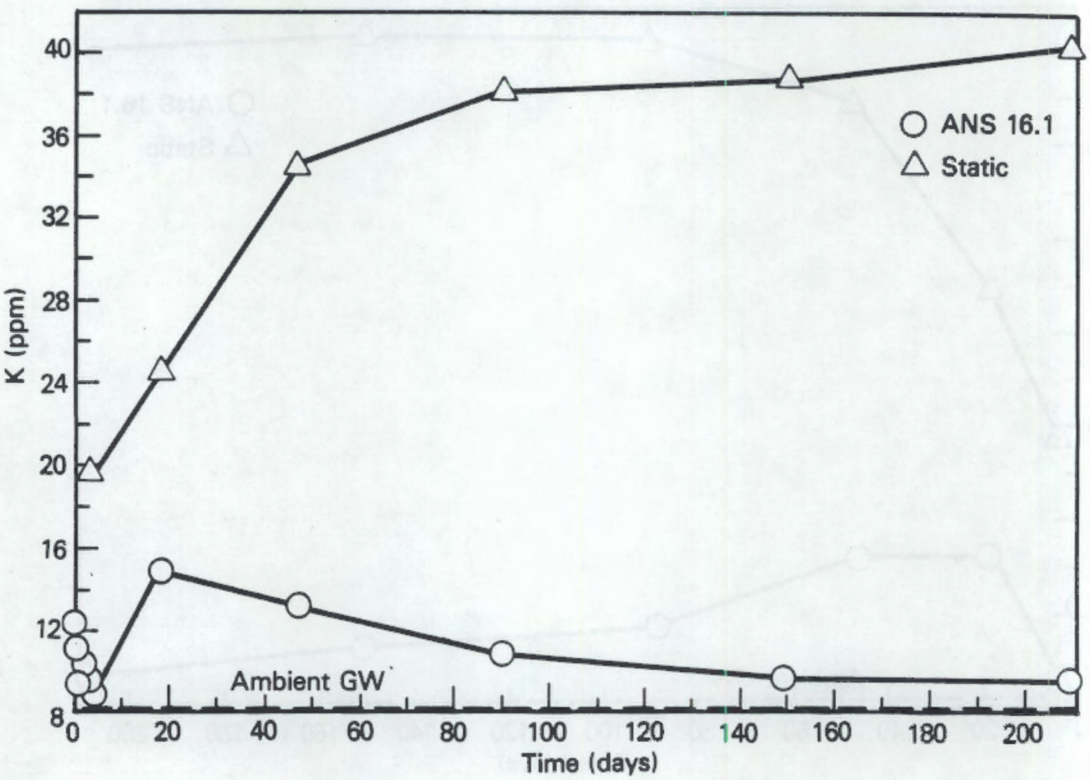

FIGURE 6.5. K Concentration for ANS 16.1 and Static Leach Test Leachates from Intact Grout Cylinders

210 days, show a value near 40 mg/L. Mass balance calculations for the static leach test show a release of 26.5 ± 2.6 mg of K, or 1.4 times more than the mass calculated for the ANS 16.1 test. The total K released to date is 19 ± 4%, 11 ± 5%, and 21 ± 3% of the K in the grout for the ANS 16.1 standard-sized grout, ANS 16.1 large-sized grout, and static leach tests, respectively.

After CaO, the two largest components of the grout are Al_2O_3 and SiO_2. In the ANS 16.1 leach test, Al concentrations were consistently below 0.2 mg/L and the Si concentrations were consistently between 11 to 15 mg/L, which is very close to the ambient ground-water value of 15 mg/L. In the static leach test, the Al concentration in the leachates slowly increases to 7 mg/L. The Si concentrations in the static leach test leachates show a slight release above the ambient ground-water value of 15 mg/L. MINTEQ predictions suggest that the leachates from the static tests are either oversaturated or in equilibrium with respect to diaspore, and undersaturated with respect to boehmite and gibbsite. The leachates from the ANS 16.1 tests may be in equilibrium with gibbsite [$Al(OH)_3$] or boehmite [γ-$AlO(OH)$]. Diaspore is less soluble than gibbsite and boehmite at high pH values. Thus, the Al concentrations in the high pH static leachates do not rise as high as might otherwise be predicted.

Although the grout contains a phosphate-rich liquid component, the leachates from both tests show PO_4 concentrations at or near the detection limit (<0.3 mg/L) for all samples. These low concentrations suggest that phosphorous concentrations in the leachates may be controlled by the solubility of a phosphate-bearing compound. The MINTEQ data base includes only two phosphate compounds, hydroxyapatite [$Ca_5(PO_4)_3OH$] and $MnHPO_4$. Other common phosphate-bearing compounds found in alkaline soils include fluorapatite [$Ca_5(PO_4)_3F$], brushite [$CaHPO_4 \cdot 2H_2O$], and β-$Ca_3(PO_4)_2$. All of these compounds could force the PO_4 concentrations below detection limits given the observed pH, calcium, and inferred low fluoride concentrations (Lindsay 1979). The MINTEQ calculations predict that the static test leachates are oversaturated with respect to hydroxyapatite and $MnHPO_4$, while the ANS 16.1 test leachates are in equilibrium with both of these compounds.

The sulfate concentrations in the ANS 16.1 leachates remain fairly stable at the ambient ground-water values of 70 mg/L. After 210 days of leaching, 16 ± 10 mg of sulfate leached from the standard-sized grouts and 18 ± 18 mg of sulfate leached from the large specimens. For the static tests, 3 ± 6 mg of sulfate leached from the grouts. These data suggest that sulfate leaching is very low or nonexistent. The MINTEQ computer code does not show that any common sulfate minerals are at equilibrium. Gypsum ($CaSO_4 \cdot 2H_2O$) is always significantly undersaturated. The static leachates also show fairly constant sulfate concentrations over time. Figure 6.6 shows the data for the two tests. Other potential SO_4 solubility-controlling phases include the cementitious phases, ettringite ($3CaO \cdot Al_2O_3 \cdot 3CaSO_4 \cdot 32H_2O$) and calcium monosulfoaluminate ($3CaO \cdot Al_2O_3 \cdot CaSO_4 \cdot 12H_2O$). However, MINTEQ calculations show that these phases are also undersaturated in the leachates. It seems likely that some sulfate-bearing solid phase is controlling the observed concentrations; otherwise, SO_4, being a major component of the waste liquid and anionic, should have exhibited measurable release.

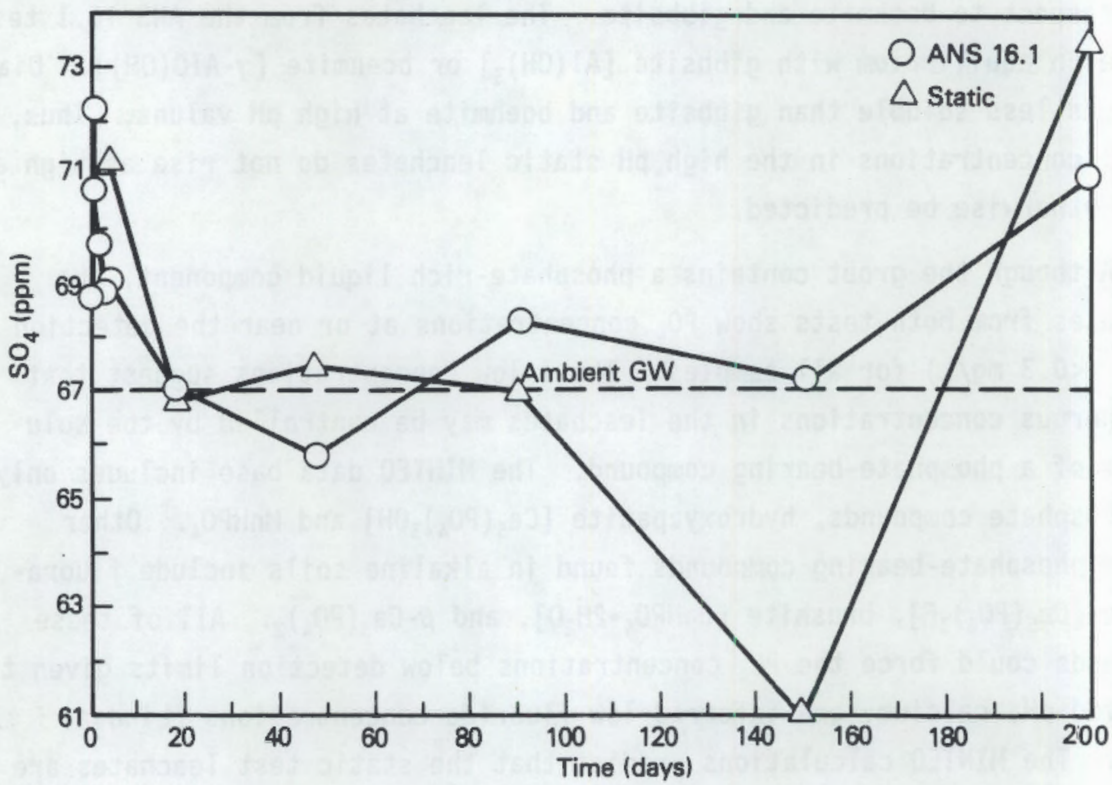

FIGURE 6.6. SO_4 Concentration for ANS 16.1 and Static Leach Test Leachates from Intact Grout Cylinders

The synthetic liquid waste contained approximately 500 mg/L nitrates from the addition of trace metal nitrate salts. The NO_3 should act as a readily leachable constituent as it is readily soluble and anionic, and thus not likely to adsorb on the clay additives or enter significantly into the cement hydration reactions. Tables A.1 through A.10 show that very little nitrate is leaching. The ANS 16.1 leach tests consistently showed nitrate concentrations below detection limits, whereas the nitrate levels from the static leach tests showed sporadic concentrations. A calculation of the inventory in each grout specimen shows that the small grouts would have only 13 mg nitrates. The nitrate fluctuations in the leachate likely occur because the source term is very low given the detection limit (0.5 to 1.0 mg/L) of nitrate using IC. Under static conditions, about 3.2 ± 1.3 mg of nitrate (24% of the total inventory) are leached from the synthetic grouts, and only 0.01 mg of nitrate are leached from the real grout, which likely does not contain nitrate.

The stable Sr concentrations in the ANS 16.1 test leachates vary from 0.03 to 0.23 mg/L and generally are related to effluent pH. The higher the pH, the lower the Sr concentration. In general, there is a net loss of Sr from the ground-water leachant throughout the test. The static tests show a range in leachate Sr concentrations between 0.04 and 0.49 mg/L. Even though the static leachates have very high pH values (>11.5), the Sr concentrations generally exceed values found in ANS 16.1 tests. Two of the four static test leachates examined with MINTEQ are in equilibrium with strontianite ($SrCO_3$). The ANS 16.1 leachates are undersaturated with respect to strontianite.

Leachates from both tests generally show no detectable releases of trace metals (i.e., Cd, Cr, Cu, Fe, Mn, Pb, Zn, and Zr). The one exception may be Cr released from the real waste under static leach test conditions. After 48 days, the leachate had Cr concentrations of 0.03 to 0.04 mg/L. Besides the radiotracers spiked into many of the synthetic grouts, all synthetic grouts contained the trace metals listed in Tables 4.4 and 4.5 as part of the simulated phosphate and sulfate liquid wastes. Another source of trace metals could be the dry solids blend, especially from the fly ash. Thus, it appears that no trace metals are readily leached from PSW grout. More quantitatively based discussions are presented later.

The organic carbon contents of leachates from the ANS 16.1 tests range between ambient ground-water values (<0.5) to 2.5 mg/L. The average ANS 16.1 leachate value is 0.9 mg/L, while the static leachates have an average TOC content of 2.9 mg/L. In general, the PSW grouts do not leach significant amounts of organic carbon. There is no apparent difference in the organic content leached from synthetic and real grouts.

The chemical analyses shown in Appendix A are quite similar to those for leachates observed in previous 60:40 PSW grout leach tests (Serne et al. 1987). Thus, the variation from 60:40 to 70:30 PSW does not appear to change the leachate chemistry. Further, there are no significant differences in the chemistry of ANS 16.1 leachates from the small-sized (35 mL) and large-sized (142 mL) grout cylinders. As the ANS 16.1 test requires that the solution volume used be 10 times the geometric surface area of the specimen, one would expect the leachate chemistry to remain the same. The data support this expectation. Finally, the data in Appendix A for actual PSW leachates are quite similar to that for the synthetic PSW grout leachates. As we do not see any significant changes in the chemical attributes of leachates, we expect that the leach rates for minor constituents from synthetic PSW grouts should accurately reflect the leaching characteristics of constituents in actual grouts of similar composition and produced with similar procedures.

Laboratory leaching studies on actual and synthetic grouts appear to yield similar results. Lokken et al. (1988) suggest that the leach rate of Na from samples of grout obtained from a large form of PSW grout are lower than leach rates of laboratory-prepared samples. Thus, the issue of whether leach tests of laboratory-prepared small specimens yield the same results as samples from actual grout production equipment is not resolved.

6.2 LEACH RATES OF SELECTED SPECIES

The leach data for the trace metals added to the synthetic PSW grout, selected major constituents in both synthetic and real grout, and selected radionuclides in the real grout were analyzed using the semi-infinite-solid mass transport diffusion model described in Section 3.0. The data on radioactivity found in the leachates, after correction for radioactive decay to the start of the experiments, are listed in Appendix B. The data for the cumulative fraction leached and incremental fraction leached at each sampling interval for the ANS 16.1 test are also in Appendix B.

The effective cumulative diffusion coefficients, D_e, are listed in Tables 6.2 and 6.3 for the above categories of constituents for both the ANS 16.1 and static leach tests in which Hanford ground water was the leachant. Table 6.2 reports on the synthetic PSW grout, while Table 6.3 reports on the real PSW grout. Appendix B also lists values of D_e obtained by separately evaluating each ANS 16.1 leach test interval. These values, called incremental D_e values, provide a useful check to see if any one data point is an outlier. The cumulative approach would propagate the effect of the outlier through all further calculations.

TABLE 6.2. D_e (Cumulative) Coefficients for Trace Constituents in Synthetic PSW Grouts (cm^2/s)

Species	Time (days)	ANS 16.1 Leach Test	Static Leach Test
^{14}C	4	$6.67 \pm 0.90 \times 10^{-13}$	$1.38 \pm 1.06 \times 10^{-13}$
	18	$3.22 \pm 1.28 \times 10^{-13}$	$1.84 \pm 0.36 \times 10^{-13}$
	48	$1.79 \pm 0.96 \times 10^{-13}$	$8.18 \pm 0.69 \times 10^{-13}$
	90	$1.21 \pm 0.76 \times 10^{-13}$	$5.23 \pm 0.06 \times 10^{-14}$
	151	$7.56 \pm 4.58 \times 10^{-14}$	$2.75 \pm 1.02 \times 10^{-14}$
	211	$5.64 \pm 3.17 \times 10^{-14}$	$2.72 \pm 0.93 \times 10^{-14}$
^{109}Cd	4	$<1.61 \pm 0.61 \times 10^{-9}$	$<4.72 \pm 4.96 \times 10^{-11}$
	18	$<5.08 \pm 1.53 \times 10^{-10}$	$<1.82 \pm 0.10 \times 10^{-11}$
	48	$<2.56 \pm 0.53 \times 10^{-10}$	$<9.28 \pm 1.72 \times 10^{-12}$
	90	$<1.68 \pm 0.16 \times 10^{-10}$	$<3.67 \pm 0.30 \times 10^{-12}$
	150	$<1.21 \pm 0.07 \times 10^{-10}$	--
^{203}Hg	4	$<3.64 \pm 3.08 \times 10^{-7}$	$<4.30 \pm 0.08 \times 10^{-9}$
	18	$<1.11 \pm 0.94 \times 10^{-7}$	$<9.04 \pm 0.18 \times 10^{-10}$
	48	$<5.42 \pm 4.62 \times 10^{-8}$	$<3.58 \pm 0.07 \times 10^{-10}$
	90	$<4.67 \pm 4.52 \times 10^{-8}$	$<1.91 \pm 0.04 \times 10^{-10}$
	150	$<3.37 \pm 3.25 \times 10^{-8}$	--
^{110m}Ag	4	$1.17 \pm 0.77 \times 10^{-9}$	$3.56 \pm 4.99 \times 10^{-11}$
	18	$3.24 \pm 1.03 \times 10^{-10}$	$2.24 \pm 1.87 \times 10^{-13}$
	48	$1.26 \pm 0.39 \times 10^{-10}$	$9.70 \pm 7.78 \times 10^{-14}$
	90	$7.58 \pm 1.32 \times 10^{-11}$	$5.64 \pm 4.34 \times 10^{-14}$
	150	$4.65 \pm 0.80 \times 10^{-11}$	--
^{75}Se	4	$7.60 \pm 9.90 \times 10^{-11}$	$8.06 \pm 11.36 \times 10^{-11}$
	18	$1.71 \pm 2.22 \times 10^{-11}$	$6.08 \pm 0.57 \times 10^{-11}$
	48	$6.48 \pm 8.38 \times 10^{-12}$	$3.73 \pm 1.56 \times 10^{-11}$
	90	$3.54 \pm 4.56 \times 10^{-12}$	$4.4B \pm 0.49 \times 10^{-11}$
	150	$2.13 \pm 2.74 \times 10^{-12}$	--

TABLE 6.2. (contd)

Species	Time (days)	ANS 16.1 Leach Test	Static Leach Test
^{125}I	4	$1.46 \pm 1.22 \times 10^{-9}$	$4.20 \pm 1.25 \times 10^{-9}$
	18	$4.30 \pm 4.38 \times 10^{-10}$	$2.34 \pm 0.22 \times 10^{-9}$
	48	$1.98 \pm 2.20 \times 10^{-10}$	$1.86 \pm 0.95 \times 10^{-9}$
	90	$1.14 \pm 1.23 \times 10^{-10}$	$2.68 \pm 0.38 \times 10^{-9}$
	150	$7.40 \pm 7.68 \times 10^{-11}$	$2.21 \pm 0.41 \times 10^{-9}$
	223	$6.06 \pm 5.71 \times 10^{-11}$	$5.30 \pm 0.58 \times 10^{-9}$
^{125}I	4	4.12×10^{-11}	
(large sample)	18	3.35×10^{-11}	
	48	2.06×10^{-11}	
	90	1.20×10^{-11}	
	50	7.91×10^{-12}	
	223	1.33×10^{-11}	
^{51}Cr	4	$<1.03 \pm 0.02 \times 10^{-6}$	$<2.94 \pm 1.06 \times 10^{-8}$
	18	$<3.14 \pm 0.01 \times 10^{-7}$	$<6.19 \pm 0.23 \times 10^{-9}$
	48	$<1.54 \pm 0.01 \times 10^{-7}$	$<2.45 \pm 0.08 \times 10^{-9}$
	90	$<1.05 \pm 0.01 \times 10^{-7}$	$<1.30 \pm 0.05 \times 10^{-9}$
	150	$<7.84 \pm 0.01 \times 10^{-8}$	$<7.84 \pm 0.29 \times 10^{-10}$
	223	$<1.26 \pm 0.80 \times 10^{-7}$	$<5.28 \pm 0.19 \times 10^{-10}$
^{51}Cr	4	$<1.33 \times 10^{-7}$	
(large sample)	18	$<4.02 \times 10^{-8}$	
	48	$<1.97 \times 10^{-8}$	
	90	$<1.33 \times 10^{-8}$	
	150	$<9.93 \times 10^{-9}$	
	223	$<8.79 \times 10^{-9}$	
^{210}Pb	4	$<3.60 \pm 0.03 \times 10^{-8}$	$<1.01 \pm 0.03 \times 10^{-9}$
	18	$<1.09 \pm 0.01 \times 10^{-8}$	$<2.12 \pm 0.08 \times 10^{-10}$
	48	$<5.34 \pm 0.04 \times 10^{-9}$	$<8.39 \pm 0.31 \times 10^{-11}$
	90	$<3.60 \pm 0.03 \times 10^{-9}$	$<4.48 \pm 0.16 \times 10^{-11}$
	150	$<2.66 \pm 0.02 \times 10^{-9}$	$<2.68 \pm 0.10 \times 10^{-11}$

TABLE 6.2. (contd)

Species	Time (days)	ANS 16.1 Leach Test	Static Leach Test
^{210}Pb	4	$<4.48 \times 10^{-9}$	
(large sample)	18	$<1.35 \times 10^{-9}$	
	48	$<6.63 \times 10^{-10}$	
	90	$<4.48 \times 10^{-10}$	
	150	$<3.32 \times 10^{-10}$	
^{125}I	4	$2.49 \pm 1.20 \times 10^{-9}$	5.15×10^{-9}
(A_o=10 x)	18	$8.99 \pm 3.57 \times 10^{-10}$	2.41×10^{-9}
	48	$4.40 \pm 1.46 \times 10^{-10}$	$1.32 \pm 1.05 \times 10^{-9}$
	90	$2.59 \pm 0.61 \times 10^{-10}$	$2.03 \pm 1.07 \times 10^{-9}$
	150	$1.68 \pm 0.38 \times 10^{-10}$	$1.66 \pm 0.88 \times 10^{-9}$
	223	$1.22 \pm 0.30 \times 10^{-10}$	$3.43 \pm 2.30 \times 10^{-9}$
^{125}I	4	2.72×10^{-10}	
(A_o=10 x)	18	9.79×10^{-11}	
(large sample)	48	4.59×10^{-11}	
	90	2.68×10^{-11}	
	150	1.78×10^{-11}	
	223	1.32×10^{-11}	
^{51}Cr	4	$<1.02 \pm 0.07 \times 10^{-8}$	$<2.75 \pm 0.07 \times 10^{-10}$
(A_o=10 x)	18	$<3.08 \pm 0.01 \times 10^{-9}$	$<5.78 \pm 0.15 \times 10^{-11}$
	48	$<1.50 \pm 0.01 \times 10^{-9}$	$<2.29 \pm 0.06 \times 10^{-11}$
	90	$<1.02 \pm 0.01 \times 10^{-9}$	$<1.22 \pm 0.03 \times 10^{-11}$
	150	$<7.55 \pm 0.04 \times 10^{-10}$	$<7.33 \pm 0.20 \times 10^{-12}$
	223	$<7.24 \pm 0.04 \times 10^{-10}$	$<4.93 \pm 0.13 \times 10^{-12}$
^{51}Cr	4	$<1.42 \times 10^{-9}$	
(A_o=10 x)	18	$<4.28 \times 10^{-10}$	
(large sample)	48	$<2.10 \times 10^{-10}$	
	90	$<1.42 \times 10^{-10}$	
	150	$<1.05 \times 10^{-10}$	
	223	$<8.54 \times 10^{-11}$	

TABLE 6.2. (contd)

Species	Time (days)	ANS 16.1 Leach Test	Static Leach Test
^{99}Tc	4	$3.30 \pm 1.75 \times 10^{-10}$	$2.81 \pm 0.79 \times 10^{-10}$
	18	$9.59 \pm 5.53 \times 10^{-11}$	$8.12 \pm 0.57 \times 10^{-11}$
	48	$5.34 \pm 4.09 \times 10^{-11}$	$7.10 \pm 3.83 \times 10^{-11}$
	90	$3.04 \pm 1.87 \times 10^{-11}$	$4.52 \pm 1.68 \times 10^{-11}$
	150	$1.86 \pm 1.17 \times 10^{-11}$	$3.48 \pm 1.13 \times 10^{-11}$
	208	$1.40 \pm 0.87 \times 10^{-11}$	$3.00 \pm 0.88 \times 10^{-11}$
^{99}Tc	4	8.76×10^{-10}	
(large sample)	18	4.24×10^{-10}	
	48	2.19×10^{-10}	
	90	1.36×10^{-10}	
	150	9.32×10^{-11}	
	208	7.32×10^{-11}	
^{99}Tc	4	$6.56 \pm 5.98 \times 10^{-10}$	$3.50 \pm 0.94 \times 10^{-10}$
(A_o=10 x)	18	$2.14 \pm 2.02 \times 10^{-10}$	$2.41 \pm 3.40 \times 10^{-10}$
	48	$1.05 \pm 1.03 \times 10^{-10}$	$4.79 \pm 6.73 \times 10^{-11}$
	90	$6.07 \pm 5.93 \times 10^{-11}$	$5.81 \pm 1.36 \times 10^{-11}$
	150	$3.81 \pm 3.64 \times 10^{-11}$	$4.44 \pm 1.03 \times 10^{-11}$
	208	$2.83 \pm 2.65 \times 10^{-11}$	$3.92 \pm 0.40 \times 10^{-11}$
^{99}Tc	4	6.85×10^{-10}	
(A_o=10 x)	18	3.77×10^{-10}	
(large sample)	48	2.10×10^{-10}	
	90	1.32×10^{-10}	
	150	8.90×10^{-11}	
	208	6.81×10^{-11}	
As	4	$<3.91 \times 10^{-9}$	$<1.09 \times 10^{-10}$
	18	$<1.17 \times 10^{-9}$	$<2.29 \times 10^{-11}$
	48	$<5.70 \times 10^{-10}$	$<9.08 \times 10^{-12}$
	90	$<3.83 \times 10^{-10}$	$<4.84 \times 10^{-12}$

TABLE 6.2. (contd)

Species	Time (days)	ANS 16.1 Leach Test	Static Leach Test
As (contd)	150	$<2.82 \times 10^{-10}$	$<2.90 \times 10^{-12}$
	208	$<2.29 \times 10^{-10}$	$<1.95 \times 10^{-12}$
U	4	$3.92 \pm 2.54 \times 10^{-12}$	$4.76 \pm 3.27 \times 10^{-16}$
	18	$3.23 \pm 1.81 \times 10^{-12}$	$1.60 \pm 1.10 \times 10^{-16}$
	48	$3.29 \pm 2.91 \times 10^{-12}$	$3.68 \pm 0.91 \times 10^{-18}$
	90	$1.33 \pm 0.50 \times 10^{-11}$	$2.74 \pm 0.65 \times 10^{-18}$
	150	$2.20 \pm 0.83 \times 10^{-11}$	$3.58 \pm 2.33 \times 10^{-14}$
	208	$4.50 \pm 1.57 \times 10^{-11}$	$9.04 \pm 0.63 \times 10^{-16}$
U (large sample)	4	3.53×10^{-11}	
	18	3.10×10^{-12}	
	48	4.40×10^{-12}	
	90	6.13×10^{-12}	
	150	2.46×10^{-11}	
	208	--	
U (A_o=10 x)	4	$6.72 \pm 0.32 \times 10^{-13}$	$8.29 \pm 10.34 \times 10^{-17}$
	18	$6.40 \pm 0.30 \times 10^{-14}$	$2.79 \pm 3.48 \times 10^{-17}$
	48	$3.65 \pm 0.17 \times 10^{-14}$	$2.78 \pm 0.22 \times 10^{-17}$
	90	$1.67 \pm 0.26 \times 10^{-13}$	$2.42 \pm 0.52 \times 10^{-18}$
	150	$2.40 \pm 0.67 \times 10^{-13}$	$5.27 \pm 3.46 \times 10^{-15}$
	208	$3.68 \pm 1.68 \times 10^{-13}$	$2.19 \pm 2.44 \times 10^{-15}$
Na	4	$8.76 \pm 2.55 \times 10^{-9}$	$8.10 \pm 0.95 \times 10^{-9}$
	18	$4.50 \pm 1.21 \times 10^{-9}$	$4.16 \pm 1.20 \times 10^{-9}$
	47	$3.13 \pm 1.31 \times 10^{-9}$	$4.20 \pm 0.23 \times 10^{-9}$
	90	$2.19 \pm 1.16 \times 10^{-9}$	$3.43 \pm 0.54 \times 10^{-9}$
	150	$1.65 \pm 0.83 \times 10^{-9}$	$2.66 \pm 0.10 \times 10^{-9}$
	210	$1.26 \pm 0.65 \times 10^{-9}$	$1.67 \pm 0.13 \times 10^{-9}$
Na (large sample)	4	8.61×10^{-9}	
	18	4.42×10^{-9}	
	47	2.46×10^{-9}	

TABLE 6.2. (contd)

Species	Time (days)	ANS 16.1 Leach Test	Static Leach Test
Na (contd)	90	1.60×10^{-9}	
	150	1.15×10^{-9}	
	210	9.28×10^{-10}	
K	4	$3.37 \pm 1.79 \times 10^{-9}$	$2.24 \pm 0.50 \times 10^{-9}$
	18	$1.57 \pm 0.93 \times 10^{-9}$	$1.15 \pm 0.37 \times 10^{-9}$
	47	$1.05 \pm 0.50 \times 10^{-9}$	$1.03 \pm 0.13 \times 10^{-9}$
	90	$6.77 \pm 3.43 \times 10^{-10}$	$8.73 \pm 1.31 \times 10^{-10}$
	150	$4.71 \pm 2.63 \times 10^{-10}$	$6.96 \pm 0.77 \times 10^{-10}$
	210	$3.60 \pm 2.15 \times 10^{-10}$	$4.82 \pm 0.62 \times 10^{-10}$
K	4	5.37×10^{-9}	
(large sample)	18	2.60×10^{-9}	
	47	1.41×10^{-9}	
	90	8.66×10^{-10}	
	150	5.67×10^{-10}	
	210	4.57×10^{-10}	
B	4	$2.23 \pm 1.05 \times 10^{-11}$	$2.21 \pm 0.61 \times 10^{-11}$
	18	$8.05 \pm 3.34 \times 10^{-12}$	$9.03 \pm 3.09 \times 10^{-12}$
	47	$4.05 \pm 0.93 \times 10^{-12}$	$6.64 \pm 2.71 \times 10^{-12}$
	90	$2.32 \pm 0.28 \times 10^{-12}$	$4.53 \pm 0.90 \times 10^{-12}$
	150	$1.21 \pm 0.41 \times 10^{-12}$	$3.48 \pm 0.28 \times 10^{-12}$
	210	$8.79 \pm 3.00 \times 10^{-13}$	$2.92 \pm 0.32 \times 10^{-12}$
B	4	9.93×10^{-12}	
(large sample)	18	4.43×10^{-12}	
	47	2.03×10^{-12}	
	90	1.24×10^{-12}	
	150	8.45×10^{-13}	
	210	6.17×10^{-13}	

TABLE 6.2. (contd)

Species	Time (days)	ANS 16.1 Leach Test	Static Leach Test
SO_4	4	$1.36 \pm 1.86 \times 10^{-9}$	$3.22 \pm 5.09 \times 10^{-11}$
	18	$2.89 \pm 3.98 \times 10^{-10}$	$5.85 \pm 5.93 \times 10^{-12}$
	47	$1.05 \pm 1.47 \times 10^{-10}$	$6.34 \pm 5.60 \times 10^{-13}$
	90	$6.59 \pm 8.43 \times 10^{-11}$	2.15×10^{-13}
	150	$3.79 \pm 4.36 \times 10^{-11}$	NEGATIVE[a]
	210	$3.34 \pm 3.54 \times 10^{-11}$	$7.45 \pm 7.05 \times 10^{-13}$
SO_4	4	1.37×10^{-10}	
(large sample)	18	5.68×10^{-11}	
	47	1.59×10^{-11}	
	90	1.49×10^{-11}	
	150	8.73×10^{-12}	
	210	9.96×10^{-12}	
NO_3	4	--	$1.31 \pm 1.60 \times 10^{-8}$
	18	--	$7.53 \pm 6.92 \times 10^{-10}$
	47	--	$8.48 \pm 7.17 \times 10^{-10}$
	90	--	$9.85 \pm 1.03 \times 10^{-10}$
	150	--	$8.09 \pm 1.40 \times 10^{-10}$
	210	--	$1.02 \pm 1.62 \times 10^{-10}$
Al	4	--	$8.80 \pm 3.05 \times 10^{-14}$
	18	--	$1.58 \pm 0.15 \times 10^{-13}$
	47	--	$1.50 \pm 0.30 \times 10^{-13}$
	90	--	$1.38 \pm 0.22 \times 10^{-13}$
	150	--	$1.02 \pm 0.72 \times 10^{-13}$
	210	--	$1.16 \pm 0.16 \times 10^{-13}$

(a) NEGATIVE: cumulative amount leached at this time is less than zero (i.e., net precipitation has occurred).

TABLE 6.3. D_e (Cumulative) Coefficients for Selected Constituents in Actual PSW Grouts (cm^2/s)

Species	Time (days)	ANS 16.1 Leach Test (Small Specimen)	ANS 16.1 Leach Test (Large Specimen)	Static Leach Test
^{60}Co	4	$<1.18 \times 15^{-12}$	$<1.51 \times 10^{-13}$	$<3.07 \times 10^{-14}$
	18	$<3.57 \times 10^{-13}$	$<4.57 \times 10^{-14}$	$<6.46 \times 10^{-15}$
	48	$<1.75 \times 10^{-13}$	$<2.24 \times 10^{-14}$	$<2.56 \times 10^{-15}$
	90	$<1.18 \times 10^{-13}$	$<1.51 \times 10^{-14}$	$<1.36 \times 10^{-15}$
	150	$<8.75 \times 10^{-14}$	$<1.12 \times 10^{-14}$	--
^{54}Mn	4	$<1.74 \times 10^{-10}$	$<2.16 \times 10^{-11}$	$<4.52 \times 10^{-12}$
	18	$<5.27 \times 10^{-11}$	$<6.53 \times 10^{-12}$	$<9.52 \times 10^{-13}$
	48	$<2.58 \times 10^{-11}$	$<3.20 \times 10^{-12}$	$<3.77 \times 10^{-13}$
	90	$<1.74 \times 10^{-11}$	$<2.16 \times 10^{-12}$	$<2.01 \times 10^{-13}$
	150	$<1.29 \times 10^{-11}$	$<1.60 \times 10^{-12}$	--
^{137}Cs	4	$<4.43 \times 10^{-12}$	$<6.31 \times 10^{-13}$	$<1.26 \times 10^{-13}$
	18	$<1.34 \times 10^{-12}$	$<1.91 \times 10^{-13}$	$<2.65 \times 10^{-14}$
	48	$<6.56 \times 10^{-13}$	$<9.34 \times 10^{-14}$	$<1.05 \times 10^{-14}$
	90	$<4.43 \times 10^{-13}$	$<6.31 \times 10^{-14}$	$<5.60 \times 10^{-15}$
	150	$<3.28 \times 10^{-13}$	$<4.67 \times 10^{-14}$	--
^{90}Sr	4	$<4.59 \times 10^{-16}$	$<6.55 \times 10^{-17}$	$<1.31 \times 10^{-17}$
	18	$<1.39 \times 10^{-16}$	$<1.98 \times 10^{-17}$	$<2.75 \times 10^{-18}$
	48	$<6.80 \times 10^{-17}$	$<9.70 \times 10^{-18}$	$<1.09 \times 10^{-18}$
	90	$<4.59 \times 10^{-17}$	$<6.55 \times 10^{-18}$	$<5.80 \times 10^{-19}$
	150	$<3.40 \times 10^{-17}$	$<4.85 \times 10^{-18}$	$<3.48 \times 10^{-19}$
	208	$<2.92 \times 10^{-17}$	$<3.95 \times 10^{-18}$	$<2.34 \times 10^{-19}$
U	4	$4.42 \pm 0.63 \times 10^{-11}$	3.41×10^{-11}	$1.73 \pm 0.10 \times 10^{-14}$
(50 mg/L	18	$4.20 \pm 0.57 \times 10^{-12}$	2.90×10^{-12}	$5.40 \pm 0.10 \times 10^{-15}$
spike)	48	$2.08 \pm 0.28 \times 10^{-12}$	1.67×10^{-12}	$3.24 \pm 0.08 \times 10^{-15}$
	90	$2.00 \pm 0.31 \times 10^{-12}$	1.72×10^{-12}	$1.08 \pm 0.03 \times 10^{-15}$
	150	$1.92 \pm 0.36 \times 10^{-12}$	1.73×10^{-12}	$7.48 \pm 0.07 \times 10^{-16}$
	208	$2.38 \pm 0.37 \times 10^{-12}$	2.39×10^{-12}	$8.22 \pm 0.07 \times 10^{-16}$

TABLE 6.3. (contd)

Species	Time (days)	ANS 16.1 Leach Test (Small Specimen)	ANS 16.1 Leach Test (Large Specimen)	Static Leach Test
Na	4	8.09×10^{-9}	9.53×10^{-9}	1.13×10^{-8}
	19	4.67×10^{-9}	4.76×10^{-9}	1.10×10^{-8}
	48	5.33×10^{-9}	3.71×10^{-9}	9.93×10^{-9}
	90	3.75×10^{-9}	2.42×10^{-9}	6.36×10^{-9}
	150	2.78×10^{-9}	1.66×10^{-9}	4.29×10^{-9}
	211	2.11×10^{-9}	1.28×10^{-9}	2.71×10^{-9}
K	4	3.06×10^{-9}	4.55×10^{-9}	3.94×10^{-9}
	19	1.83×10^{-9}	2.01×10^{-9}	1.84×10^{-9}
	48	1.80×10^{-9}	1.48×10^{-9}	3.01×10^{-9}
	90	1.23×10^{-9}	9.41×10^{-10}	1.95×10^{-9}
	150	8.79×10^{-10}	6.54×10^{-10}	1.29×10^{-9}
	211	7.02×10^{-10}	5.00×10^{-10}	9.16×10^{-10}
B	4	4.38×10^{-12}	1.92×10^{-11}	3.78×10^{-11}
	19	2.71×10^{-12}	6.29×10^{-12}	1.46×10^{-11}
	48	2.54×10^{-12}	3.75×10^{-12}	1.17×10^{-11}
	90	1.44×10^{-12}	2.00×10^{-12}	6.67×10^{-12}
	150	9.29×10^{-13}	1.22×10^{-12}	4.30×10^{-12}
	211	7.19×10^{-13}	8.85×10^{-13}	3.27×10^{-12}
SO_4	4	3.48×10^{-10}	1.00×10^{-10}	8.42×10^{-11}
	19	6.32×10^{-11}	1.19×10^{-11}	1.57×10^{-11}
	48	4.28×10^{-11}	$<10^{-12}$	9.36×10^{-12}
	90	1.55×10^{-11}	NEGATIVE[a]	3.40×10^{-12}
	150	9.89×10^{-12}	NEGATIVE	5.13×10^{-12}
	211	1.13×10^{-11}	6.68×10^{-14}	6.46×10^{-12}
Al	4	--	--	2.34×10^{-13}
	19	--	--	2.92×10^{-13}
	48	--	--	3.84×10^{-13}
	90	--	--	2.95×10^{-13}

TABLE 6.3. (contd)

Species	Time (days)	ANS 16.1 Leach Test (Small Specimen)	ANS 16.1 Leach Test (Large Specimen)	Static Leach Test
Al (contd)	150	--	--	2.22×10^{-13}
	211	--	--	1.71×10^{-13}
NO_3	4	--	--	0
	19	--	--	0
	48	--	--	9.42×10^{-12} (b)
	90	--	--	3.48×10^{-14}
	150	--	--	2.09×10^{-14}
	211	--	--	1.48×10^{-14}

(a) NEGATIVE: cumulative amount leached at this time is less than zero (i.e., net precipitation has occurred).
(b) The NO_3 inventory in actual grout was not determined; the same A_o as used in the synthetic grout was assumed.

If leaching were accurately described by the semi-infinite-solid diffusion model, the D_e values should be constant with time. Table 6.2 and Appendix B show that the cumulative D_e values for the ANS 16.1 leach test data decrease with time. Appendix B also shows that the incremental D_e values generally decrease with time, although certain samples show fluctuations.

In general, both the synthetic and real PSW grout show low leach rates for trace constituents. Many of the spiked trace metals and radionuclides were not detected in any leachates. None of the effluents contained measurable quantities of ^{109}Cd, ^{51}Cr, ^{210}Pb, ^{203}Hg, or As. The D_e values shown in Table 6.2 and Appendix B for these species are calculated based on assuming each leachate contained an amount equal to the detection limit. Thus, the values should be considered the upper limit and true values likely are lower. The detection limit values for the small grout cylinders are greater than for the large grout cylinders because the large grouts contain considerably more activity, yet the detection limit for counting leachates remains fixed. The cumulative amount leached, Σa_n, is equal in both cases, but the

A_o term is larger for the larger grout samples and thus the quotient is smaller, resulting in a smaller D_e. The static leach tests also show smaller D_e values because of minimal solution replacement, which increases the Σa_n term in Equations (3.1) and (3.2) for the ANS 16.1 leach tests. For the actual PSW grout, uranium was the only radionuclide detected in leachates.

For those trace species with detectable leach rates, the ^{125}I appears to leach fastest, then ^{99}Tc, ^{75}Se, and finally U, ^{14}C, and ^{110m}Ag. The iodine leach behavior shows that a tenfold increase in original inventory yields the same effective D_e as samples with the baseline inventory. This suggests that diffusion may be the mechanism that controls the leaching. The effective D_e of iodine in the two larger grout cylinders appears to be lower than values for the standard-sized samples. This suggests that additional testing at variable surface area-to-volume ratios should be performed to determine whether such small samples are biasing the measured leach rates. Iodine leaching under static leach test conditions is significantly faster than under ANS 16.1 leach test conditions. Iodine leaching from CRW grouts[(a)] also shows increased leaching under static leach test conditions. Aside from the carbonate-armouring hypothesis, the only other obvious difference is pH, but we know of no reason iodine should be pH sensitive.

The technetium leach data for a baseline inventory and a tenfold increased inventory show excellent agreement (all tests that differ only in an A_o term yield the same D_e value). This fact also suggests that diffusion processes through the grout control technetium leaching. The effective D_es for technetium from the large grout samples appear greater than for the smaller grouts, which is the opposite trend as found for iodine. We suggest that additional leach tests be performed using several sizes of grout to resolve the size issue.

The ^{75}Se leach data suggest that more Se leaches from the static tests; however, there is much scatter in the data because of small releases and a short half life for the tracer. The ^{110m}Ag leach data suggest that the high pH (static leach test conditions) significantly reduces silver leaching.

(a) 1989 draft report, Pacific Northwest Laboratory, Richland, Washington.

The uranium leach data for ANS 16.1 leach tests on synthetic PSW grouts show low leach rates. There does not appear to be any difference in leach rates versus sample size, but the ANS 16.1 data show that increasing the uranium inventory causes much lower leach rates. The data suggest that diffusion is not controlling the leach rate; rather, it appears that solubility processes may be controlling the release of uranium. The calculated D_e values for uranium for the ANS 16.1 leach tests suggest that the leach rate decreases for the first 48 days, and then increases steadily through 208 days. Such a trend is not typical for any other species measured to date.

Because of the atypical leaching trend versus time for uranium, we reconsidered our calculations. The data in Tables 6.2 and 6.3 for uranium were obtained assuming that the ground water does not contain any measurable uranium. The well water collected on 11/11/87 (see Table 4.10) was reanalyzed; four replicate analyses yielded a background value for uranium of 4.09 ± 0.24 µg/L. This value is within reason for ground waters in general (Hem 1970, p. 212) and Hanford well waters in particular (Cline et al. 1985). Of particular significance is the uranium concentrations in the grout leachates (see Tables A.4, A.5, A.6, A.9, A.10, and A.12), which never rise above 3 µg/L. Uranium is actually scavenged from the ground water in all tests. Thus, as was found for Ca and inorganic carbon, uranium shows a net precipitation. Therefore, the D_e values reported in Tables 6.2 and 6.3 are biased high. As the leach test proceeds, less uranium is removed from each influx of new solution, and the measured leachate concentrations appear to increase when in reality less removal is being observed. This process causes the apparent increase in leach rates at longer time periods.

As was found for CRW grouts and other cementitious waste forms (Habayeb 1985), ^{14}C leaches very slowly from the cementitious waste forms. All investigators suggest the same mechanism for this efficient sequestration. Cement pore solution environments readily promote the precipitation of alkali-earthen carbonates. The ^{14}C in the grout appears to be immobilized by such precipitation reactions.

The effective diffusion coefficients reported in Table 6.2 for Cd, Hg, Cr, and Pb are upper-limit values that assume leachates contain detection-limit concentrations. The D_e values for the static leach tests are significantly lower because there is minimal solution replenishment in these tests.

Table 6.2 also contains effective diffusion coefficients for the major constituents Na, K, B, SO_4, NO_3, and Al. For the ANS 16.1 leach test, only Na, K, and B consistently leached from all samples. Sodium leached faster than K and both leached significantly faster than sulfate and boron. For Na and K the observed D_e values remain the same when comparing the two sizes of samples. There is a large amount of scatter in the sulfate leach data, so it is difficult to judge whether the apparent lower D_e values for the large samples are real.

The calculated D_e values for static leach tests suggest that slightly more Na, K, and B are leached under the static leach test conditions than are leached under the ANS 16.1 leach test conditions. Those results were observed previously for the 60:40 PSW grouts (Serne et al. 1987).

The leach rate of nitrate from synthetic PSW grouts is quite variable and could be quantified only for the static leach tests, which allow more sensitivity for constituents present in very low initial inventories. The calculated D_e for nitrate is in the range of 10^{-10} to 10^{-9} cm^2/s. The major source of the nitrate was the inclusion of nitrate salts of trace metals. A D_e for nitrate of $1.2 \pm 0.5 \times 10^{-9}$ cm^2/s was found for the CRW grout, which contains very high levels of nitrate.

The real PSW grouts contained measurable quantities of ^{54}Mn, ^{60}Co, and uranium. We assumed ^{137}Cs and ^{90}Sr activities based on data presented in Table 4.4 of Sewart et al. (1987). Using total beta and gamma counting, none of the leachates from the experiments using real grout contained measurable amounts of radioactivity.

The real PSW grouts spiked with 50 mg/L uranium show low leach rates for the ANS 16.1 leach tests, with no significant differences between the two sizes of samples (see Table 6.3). The calculated D_e values for the ANS 16.1 leach tests on real grout are about 10 times larger than the D_e values for the synthetic grouts. The same trend was observed (i.e., decreasing leach rates for the first 48 days and increasing leach rates through 208 days). For the synthetic PSW grouts, the static leach tests show much lower uranium leach rates, but the rate does not increase later in the test as occurred for the ANS 16.1 leach test data collected on synthetic grouts. For the static leach tests, there is no significant difference in the calculated D_e values for uranium between synthetic and real grout. High pH conditions apparently keep uranium solution concentrations in the part-per-billion range or lower. As previously described, the test actually removes background concentrations of uranium from the ground water, so the leach data presented are biased high.

Table 6.3 also contains the leach data for major constituents Na, K, B, SO_4, Al, and NO_3^-. For the real PSW grout, Na and K leached faster than any other constituents. The data also suggest a slightly faster release of Na, K, and B under static conditions as was observed for synthetic grouts and previous work on 60:40 PSW formulations. There are no significant differences in leach rates for Na, K, or B between specimen sizes or between synthetic or real PSW grout.

The sulfate data for real PSW grout are as variable as the data for synthetic PSW grout. It is difficult to determine whether SO_4 actually shows a small net leaching or whether the data reflect imprecision in SO_4 analyses.

For the static leach test on real grout, very little nitrate was found in the leachate, perhaps because the inventory is much lower than it is in the synthetic grout. Accurate measurements of the NO_3^- concentration in actual liquid wastes were not obtained and no complete dissolution of actual grout was attempted. The calculated D_e value for NO_3^- assumed the same inventory in the real grout as was in the synthetic. We suspect that this assumption is erroneous and that the reported data are not accurate. Because real PSW grouts contain very low inventories of NO_3^-, useful leach data for NO_3^- are not likely to be obtained.

Two samples, PSWLA7-6 and PSW 10-4 (a large synthetic specimen spiked with ^{99}Tc and leached under ANS 16.1 leach test conditions, and a standard-sized specimen of real PSW grout leached under static leach test conditions) appear to show a small amount of stable Cr leaching. Assuming that all grout contained 0.01% Cr_2O_3 (see Table 4.9), we calculated effective diffusion coefficients for stable Cr. Sample PSWLA7-6 yielded a value of 1.3 x 10^{-11} cm^2/s, and sample PSW 10-4 yielded a value of 2.92 x 10^{-12} cm^2/s. These values corroborate that Cr is not readily leached from PSW grout. Recall that the ^{51}Cr data in Table 6.2 were limited by the tracer's short half life and yielded only detection limit values. The stable Cr data also suggest that the high pH conditions of the static leach test lowers Cr leach rates, perhaps by solubility processes.

6.3 APPLICATION TO PERFORMANCE ASSESSMENT CALCULATIONS

The D_e values generated in these laboratory studies are used directly to develop release (source-term) models for constituents in the grout. Previous performance assessment work (e.g., Sewart et al. 1987) has relied on conservative values when data were lacking. Generally, a default value of 1 x 10^{-9} cm^2/s was assigned when actual values did not exist. Numerous other leach tests on 60:40 synthetic PSW, synthetic CRW, and 70:30 synthetic and real PSW grouts and DSSF grout have been performed.

Table 6.4 lists the range of effective D_e values generated to date and our estimate of probable ranges to use for future performance assessment calculations. The proposed ranges are most defensible for PSW-like grouts but may be used for preliminary estimates for other grouts, with only a few exceptions.

Recently, an exhaustive list of radioisotopes that may be present in defense-related waste has created some interest in Sn, Pa, Nb, Ac, Sb, Pd, Mo, Rb, and Be. From chemical analogs we speculate that Ac would act similar to lanthanides, Pa similar to U, and Rb similar to Cs. The chemistry of Sn, Nb, Sb, Pd, Mo, and Be disposed in grout is considered too problematical for comment, other than anionic forms of Sb and Mo are known to exist in natural waters.

TABLE 6.4. Review of Available D_e Values for PSW and CRW Grouts (cm^2/s)

Species	PSW	CRW	Recommended for Performance Assessment
H	--	--	10^{-8} conservative estimate
B	$<10^{-12}$ to 5×10^{-12}	10^{-12} to 5×10^{-10}	10^{-10}
C	5×10^{-14}	2×10^{-13}	5×10^{-13}
NO_3	10^{-10} to 10^{-9}	$1.5 \pm 0.5 \times 10^{-9}$	2×10^{-9}
F	--	10^{-12} to 5×10^{-11}	grout dependent
Na	1 to 3×10^{-9}	$6 \pm 2 \times 10^{-9}$	5×10^{-9}
SO_4	10^{-12} to 10^{-11}	10^{-9} to 10^{-8}	grout dependent
K	4 to 9×10^{-10}	$1.3 \pm 0.4 \times 10^{-9}$	1×10^{-9}
Cr	10^{-12} to $<10^{-10}$	--	5×10^{-11}
Mn	10^{-13} to 10^{-11}	--	10^{-11}
Fe	--	--	10^{-11} analog of Mn
Co	10^{-13} to 10^{-11}	--	10^{-12}
Ni	--	--	10^{-10} conservative estimate
Cu	--	--	10^{-11} analog of Mn
Zn	--	--	10^{-10} analog of Cd
As	$<10^{-12}$ to $<10^{-10}$	--	10^{-11}
Se	10^{-12} to 5×10^{-11}	--	5×10^{-11}
Sr	10^{-13} to 10^{-12}	10^{-12} to 10^{-10}	5×10^{-11}
Zr	--	$<10^{-12}$	10^{-12} analog of U
Tc	4×10^{-11}	10^{-12} to 10^{-10}	10^{-10}
Ag	10^{-13} to 5×10^{-11}	--	5×10^{-11}
Cd	$<10^{-12}$ to $<10^{-10}$	--	10^{-10}
I	10^{-10} to 5×10^{-9}	3.4 to 34×10^{-9}	5×10^{-9}
Cs	10^{-14} to 10^{-12}	1 to 5×10^{-15}	10^{-13} (grout dependent)
Ba	--	--	5×10^{-11} analog of Sr
Hg	$<10^{-10}$ to $<10^{-8}$	--	5×10^{-11}
Pb	$<10^{-11}$ to $<10^{-10}$	--	5×10^{-11}
Lanthanides (Ce-Lu)	--	--	5×10^{-11} analog of Pb
Th	--	--	10^{-12} analog of U
U	10^{-15} to 10^{-11}	--	10^{-12}
Np	--	--	10^{-11} conservative estimate
Pu	--	10^{-16} to 10^{-15}	10^{-15}
Am	--	10^{-17} to 10^{-16}	10^{-15}
Cm	--	--	10^{-15} analog to Am

The available data on grout leaching, leachate adsorption, and defense liquid waste inventories, plus existing knowledge of grout and ground-water chemistry, suggest that ^{129}I and ^{99}Tc are problem radioisotopes and nitrate is a problem chemical. "Problem" is defined as a species that leaches more rapidly than most from the grout and has essentially no adsorption tendencies on Hanford sediments. Future performance assessment calculations for specific inventories and application of the D_e values listed in Table 6.4 may reveal additional species that merit emphasis. At present, any additional grout leach tests should continue to include studies of nitrate, iodine, and technetium.

7.0 CONCLUSIONS

This report presented leach data for selected radionuclides and regulated chemicals in PSW grout that could potentially contribute to contamination of the ground water below the grout disposal site. Prior to this study, conservative leach rates were assumed for these species. The actual leach data can now be used to refine performance assessment calculations and narrow the list of key species that require additional study.

The effective D_es listed in Tables 6.2 and 6.3 show trends similar to those from previous studies. Iodine, Na, and NO_3^- appear to leach fastest; Tc and K leach next fastest; the regulated trace metals leach at significantly slower rates; and finally, radionuclides such as ^{14}C, U, ^{60}Co, and ^{90}Sr leach very slowly.

Several key issues were partially addressed in this work. There is no significant difference in the leachate chemistry and calculated effective D_es for species from real and synthetic PSW grouts. We note in particular the similar concentrations of TOC in leachates from both types of grout. The similar leach rates of trace metals, which readily complex with chelating agents, from the two grout types further support our conclusion that organic chelates are not an important issue for PSW grout.

The comparisons of standard-sized (35 mL) with larger-sized (142 mL) grout specimens were not conclusive. For a few species (K, Na, and U) the calculated D_e values are indistinguishable, but for other species (B, I, and Tc) size appears to make a difference. The data for B and I suggest that D_e values are lower for larger-sized specimens; however, the data for Tc suggest the opposite (the large specimen yielded a larger D_e). For many of the trace metals, the larger size leads to lower D_e values when detection limits are observed. Thus, from a practical standpoint, for slow-leaching constituents present in low inventories greater sensitivity is achieved by leaching larger samples.

The comparison of leach tests where the original inventory was varied from a baseline value to about 10 times baseline is used to differentiate diffusion-controlled from solubility-controlled leaching. The data set for U is the only data set with variable inventory that provides conclusive results. Increasing the U content of the grout led to much lower D_e values. Regardless of the amount of U spiked into the grout, the concentration in the leachates was very low, implying a solubility control. The data for Tc and I show as much scatter in replicates of individual tests as the difference between tests at different inventories. Although not statistically meaningful, both species yield higher D_e values with the higher loadings. This trend is similar to that observed when increasing the loading of most major constituents--that is, increasing the waste loading generally has an adverse impact on waste form leachability. The limited scale-up and variable inventory studies would profit from continued study using greater ranges in specimen size and constituent inventory.

Particular attention was given to determining the leach rate of I, Tc, NO_3^-, U, and Cr because previous performance assessment calculations suggest that these species dominate as potential problem species. Also, I, NO_3^-, and U have been observed to migrate considerable distances from Hanford waste disposal sites used in the past (Eddy, Prater and Reiger 1983, Prater et al. 1984, Cline et al. 1985, and Delegard et al. 1986). We found that I and Tc leach relatively rapidly from PSW grout, and previous studies using CRW leachate (to be reported) suggest that these elements are not significantly retarded by Hanford sediment. PSW grout contains very little NO_3^- so it is difficult to accurately determine the NO_3^- leach rate. The static leach tests of synthetic grout suggest that NO_3^- leaches somewhat slower than I but faster than Tc. Leach rate data determined by spiking grouts with ^{51}Cr yielded detection limit values that suggest that Cr is not readily leachable. Calculations based on these data suggest effective D_es in the range of 3 x 10^{-12} to 2 x 10^{-11} cm^2/s. Data presented in Table 4.5 suggest that Cr present in either the sulfate or phosphate liquid waste precipitates upon neutralization to pH 12. Two plausible mechanisms to promote precipitation are formation of insoluble Cr oxides/hydroxides and mixed Fe/Cr hydrous oxides, or adsorption onto hydrous Fe oxides. From the available data we speculate that Cr will not readily leach from PSW grout or other Hanford grouts.

All the leach data for U show very low leach rates. In fact, the grout tests show that U in the natural ground water (4.09 μg/L) is actually effectively scavenged from solution. As was observed for Ca and inorganic C, there is net precipitation as opposed to any leaching. We expect similar trends for all Hanford grouts, especially during the early stages when fresh grout reacts with ground water.

Key species that continue to show the greatest leach rates and mobility in Hanford sediment/ground-water systems include I, Tc and NO_3^-.

8.0 REFERENCES

American Nuclear Society. 1986. Measurement of the Leachability of Solidified Low-Level Radioactive Wastes by a Short-Term Test Procedure. ANS 16.1, American Nuclear Society, Champaign, Illinois.

Arora, H., and R. Dayal. 1984. Solidification and Leaching of Boric Acid and Resin LWR Wastes. NUREG/CR-3909, Nuclear Regulatory Commission, Washington, D.C.

Bernard, A., J. C. Nomine, G. Cornec, A. Bonnet and L. Farges. 1982. "Long-Term Leaching Tests on Full-Scale Blocks of Radioactive Wastes." Nucl. Chem. Waste Manage. 3:161-168.

Clark, W. E. 1977. "The Isolation of Radioiodine with Portland Cement Part 1: Scoping Leach Studies." Nucl. Technol. 36:215-221.

Cline, C. S., J. T. Rieger, J. R. Raymond and P. A. Eddy. 1985. Ground-Water Monitoring at the Hanford Site, January - December 1984. PNL-5408, Pacific Northwest Laboratory, Richland, Washington.

Dayal, R., H. Arora and N. Morcos. 1983. Estimation of Cesium-137 Release from Waste/Cement Composites Using Data from Small-Scale Specimen. NUREG/CR-3382, Nuclear Regulatory Commission, Washington, D.C.

Dayal, R., D. C. Schweitzer and R. E. Davis. 1984. "Wet and Dry Cycle Leaching: Aspects of Research in the Unsaturated Zone." In NRC Nuclear Waste Geochemistry '83, eds. D. H. Alexander and G. F. Birchard, pp. 440-453. NUREG/CP-0052, Nuclear Regulatory Commission, Washington, D.C.

Delegard, C. H., R. T. Kimura, A. G. Law, R. C. Routson, and R. L. Weiss. 1986. Characterization and Anion Exchange Removal of Uranium from Hanford Ground Water. RHO-RE-SA-116P, Rockwell Hanford Operations, Richland, Washington.

Eddy, P. A., L. S. Prater and J. T. Rieger. 1983. Ground Water Surveillance at the Hanford Site for CY 1982. PNL-4659, Pacific Northwest Laboratory, Richland, Washington.

Felmy, A. R., D. Girvin and E. A. Jenne. 1984. MINTEQ: A Computer Program for Calculating Aqueous Geochemical Equilibria. NTIS PB-84-157148 (EPA-600/3-84-032), National Technical Information Service, Springfield, Virginia.

Godbee, H. W., O. U. Anders and R. M. Nielson, Jr. 1980. "Application of Mass Transport Theory to the Leaching of Radionuclides from Waste Solids." Nucl. Chem. Waste Manag. 1:29-35.

Greenberg, A. E., J. J. Connors, D. Jensen, and M. A. H. Franson, eds. 1981. Standard Methods for the Examination of Wastes and Wastewater. 15th ed., Method #403. American Public Health Association, Washington, D.C.

Habayeb, M. A. 1985. "Carbon-14 Releases From Solidified IRN-150 Moderator Resin Wastes." Nucl. Chem. Waste Manag. 5:351-357.

Hem, J. D. 1970. Study and Interpretation of the Chemical Characteristics of Natural Water. 2nd ed. U.S. Geological Survey Water Supply Paper 1473, pg. 212, U.S. Government Printing Office, Washington, D.C.

Kalb, P. D., and P. Columbo. 1984. "Full-Scale Leaching Study of Commercial Reactor Waste Forms." In Waste Management '84. Vol. 2, ed. R. G. Post, pp. 189-194. The University of Arizona Press, Tempe, Arizona.

Lindsay, W. L. 1979. Chemical Equilibria in Soils. John Wiley and Sons, New York, New York.

Lokken, R. O., M. A. Reimus, P. F. C. Martin and S. E. Geldart. 1988. Characterization of Simulated Low-Level Waste Grout Produced in a Pilot-Scale Test. PNL-6396, Pacific Northwest Laboratory, Richland, Washington.

Matsuzuru, H., and A. Ito. 1977. "Immobilization of Cesium-137 in Cement Waste Composites by Addition of Mineral Zeolites." Health Phys. 34:643-548.

Matsuzuru, H., and A. Ito. 1978. "Effects of Dimension of Specimen on Amounts of ^{137}Cs, ^{90}Sr and ^{60}Co Leached from Matrix of Hardened Cement Grout." J. Nucl. Sci. Technol. 15:296-301.

Matsuzuru, H., and N. Moriyama. 1982. "Leaching Radionuclides from a Cement Composite Incorporating Evaporatory Concentrates Generated at a Pressurized Water Reactor Nuclear Power Plant." Nucl. Sci. Eng. 80:14-25.

Moore, J. G., H. W. Godbee and A. H. Kibbey. 1977. "Leach 8ehavior of Hydrofracture Grout Incorporating Radioactive Wastes." Nucl. Technol. 32:39-59.

Moriyama, N., S. Dojiri and H. Matsuzuru. 1977. "Leaching of ^{137}Cs from the Ion Exchange Resin Incorporated in Polyethylene or Cement Composite." Health Phys. 32:549-552.

Moriyama, N., H. Matsuzuru, S. Dojiri and Y. Wadachi. 1975. Analytical Evaluation on the Leaching of Radionuclides from Waste Solids. JAERI-M 6302, Japan Atomic Energy Research Institute, Tokyo, Japan.

Nestor, C. W., Jr. 1980. Diffusion from Solid Cylinders. ORNL/CSD/TM-84, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Prater, L. S., J. T. Rieger, C. S. Cline, E. J. Jensen, T. L. Liikala and K. R. Oster. 1984. Ground Water Surveillance at the Hanford Site for CY 1983. PNL-5041, Pacific Northwest Laboratory, Richland, Washington.

Roy, D. M., and C. A. Langton. 1982. Longevity of Borehole and Shaft Sealing Materials: 2. Characterization of Cement-Based Ancient Building Materials. ONWI-202, Office of Nuclear Waste Isolation, Battelle Memorial Institute, Columbus, Ohio.

Roy, D. M., and C. A. Langton. 1983. Characterization of Cement-Based Ancient Building Materials in Support of Repository Seal Materials Studies. BMI/ONWI-523, Office of Nuclear Waste Isolation, Battelle Memorial Institute, Columbus, Ohio.

Sambell, R. A. J., C. Smitton and A. Elsden. 1982. "A Contribution Towards a Standard Leach Test for Immobilized Low and Medium Level Waste." Nucl. Chem. Waste Manage. 3:125-129.

Serne, R. J., W. J. Martin, S. B. McLaurine, S. P. Airhart, V. L. LeGore and R. L Treat. 1987. Laboratory Leach Tests of Phosphate/Sulfate Waste Grout and Leachate Adsorption Tests Using Hanford Sediment. PNL-6019, Pacific Northwest Laboratory, Richland, Washington.

Sewart, G. H., W. T. Farris, D. G. Huizenga, A. H. McMakin, G. P. Streile, and R. L. Treat. 1987. Long-term Performance Assessment of Grouted Phosphate/Sulfate Waste from N Reactor Operations. PNL-6152, Pacific Northwest Laboratory, Richland, Washington.

Stinton, D. P., E. W. McDaniel and H. O. Weeren. 1984. "Characterization of Hydrofracture Grouts for Radionuclide Migration." In Proceedings of the Second International Symposium on Ceramics in Nuclear Waste Management, pp. 448-455. International Atomic Energy Agency, Vienna, Austria.

U.S. DOE. 1987. Final Environmental Impact Statement: Disposal of Hanford Defense High-Level, Transuranic and Tank Wastes. DOE/EIS-0113, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

APPENDIX A

CHEMICAL COMPOSITIONS OF LEACHATES

TABLE A.1. Chemical Composition of Leachates from ANS 16.1 Leach Test: Sample PSWA5-1

SAMPLE #	------	WELL WATER	1	2	3	4	5	6	7	8	9	10	11
TIME	days	------	0.0833	0.29	1	2	3	4	18	47	90	150	210
pH		8.36	8.99	8.65	9.93	9.05	9.19	8.83	11.2	10.76	9.4	8.61	9.1
Eh	mv	351	336	265	334	421	420	412	284	332	326	371	358
Al	mg/l	<0.03	0.068	0.046	0.137	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Ba	mg/l	0.056	0.029	0.054	0.028	0.037	0.039	0.042	0.014	0.014	0.03	<0.002	0.048
Ca	mg/l	50.6	24.2	43.4	18.2	28.9	28.3	32.5	2.41	3.7	6.15	15.1	16.9
Cd	mg/l	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Cr	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cu	mg/l	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Fe	mg/l	<0.005	<0.006	<0.006	<0.006	<0.006	<0.006	0.03	0.009	<0.005	<0.005	<0.005	<0.005
K	mg/l	8	12.3	9.4	11.7	10.7	9.4	8.6	16	16	12.8	11.7	10
Mg	mg/l	13.4	11.2	13.6	10.3	11.9	11.7	12.4	0.982	1.84	8.72	10.2	11.1
Mn	mg/l	0.087	0.007	0.004	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Na	mg/l	25	57.3	31.4	53.2	45.5	38.1	34.1	91.7	108	71.8	56.2	43
P	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
as PO4	mg/l	<0.3	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31
Pb	mg/l	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Si	mg/l	15	14.1	15	13.6	14.8	14.5	14.7	11.4	12.5	13.5	15.1	13.6
Sr	mg/l	0.24	0.167	0.233	0.153	0.184	0.184	0.2	0.096	0.102	0.17	0.229	0.222
Zn	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Zr	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
F-	mg/l	<0.07	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.9	<0.06	<0.5
Cl-	mg/l	21	29	24	21	22	23	21	22	20	23	19.8	23.6
NO2-	mg/l	<0.3	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
NO3-	mg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	3.9	<0.5
SO4--	mg/l	67	71	75	73	77	79	75	66	66	70	64.4	71
HCO3-	mg/l	187.9	112.24	129.08	117.89	123.38	89.79	0.00	0.00	0.00	0.00	0.00	0.00
CO3--	mg/l	0	0.00	5.52	5.52	5.52	11.04	11.04	60.72	66.28	33.12	5.52	32.48
OH-	mg/l	0	0.00	28.58	28.58	28.58	57.17	57.17	314.41	343.20	171.50	28.58	188.18
B	mg/l	0.08	0.155	0.086	0.132	0.105	0.092	0.086	0.151	0.142	0.1	<0.02	0.081
as H3BO3	mg/l	0.41	0.86	0.46	0.68	0.54	0.48	0.45	0.78	0.74	0.52	0.00	0.42
TOC	mg/l	0.45	0.86	1.2	0.85	1.14	0.67	0.61	1.06	2.51	1.43	1.36	-
PO4---	mg/l	<0.4	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
CATIONS	meq/l	4.92	4.94	4.90	4.37	4.68	4.28	4.35	4.60	5.44	4.48	4.34	3.89
ANIONS	meq/l	5.06	4.14	4.54	4.23	4.43	4.14	4.27	4.66	6.36	3.96	3.99	3.77
TOT.ALK.*	mg/l	92.16	55.2	69	63.5	66.2	55.2	63.5	80.04	132.5	55.2	60.72	48.6
P.ALK	mg/l	0	0	2.76	2.76	2.76	5.52	5.52	49.68	99.36	16.56	2.76	32.36
IC	mg/l	34.1	19.65	30.12	17.67	16.48	24.07	25.37	12.4	15.69	20.04	23.88	-

(---) Data not available.
(*) Total Alkalinity as CO3--.

TABLE A.2. Chemical Composition of Leachates from ANS 16.1 Leach Test: Sample PSWA7-1

SAMPLE #	------	WELL WATER	1	2	3	4	5	6	7	8	9	10	11
TIME	days	------	0.0833	0.29	1	2	3	4	18	47	90	150	208
pH		8.36	10.81	8.97	9.17	9.00	8.76	8.62	10.81	9.13	8.42	8.34	8.33
Eh	mv	351	381	398	388	378	392	395	417	352	350	347	377
Al	mg/l	<0.03	0.082	0.128	0.062	0.059	0.054	<0.03	0.038	<0.03	<0.03	<0.03	<0.03
Ba	mg/l	0.056	0.012	0.049	0.02	0.039	0.043	0.048	0.016	0.029	0.047	0.044	0.05
Ca	mg/l	50.6	9.02	42.1	25.5	31.8	35.3	40.1	4.53	8.99	24.8	24.7	32.8
Cd	mg/l	<0.004	<0.004	<0.004	<0.004	<0.004	0.047	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Cr	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cu	mg/l	<0.004	<0.004	<0.004	<0.004	0.006	0.009	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Fe	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.012	0.022	<0.005
K	mg/l	8	15.8	8.9	9.6	10	10	8.6	14	12	8.9	8.71	8.11
Mg	mg/l	13.4	5.08	12.1	10.2	10.8	11.6	12	3.89	8.03	11.5	12.5	13.2
Mn	mg/l	0.007	<0.002	0.06	0.012	0.035	0.039	0.002	<0.002	<0.002	<0.002	0.007	<0.005
Na	mg/l	25	93.8	30.5	39.1	36.3	35.4	32.1	79.5	56.6	43.1	40.7	31
P	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.13	<0.1
as PO4	mg/l	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Pb	mg/l	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Si	mg/l	15	11	13.6	12.8	13.4	14.3	14.3	13.7	14.1	14.6	15	14.2
Sr	mg/l	0.24	0.107	.225	0.173	0.191	0.206	0.214	0.166	0.102	0.21	0.203	[illegible]
Zn	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	[illegible]
Zr	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
F-	mg/l	<0.07	<0.7	<0.6	<0.6	<0.6	<0.6	<0.6	<0.9	<0.5	0.6	0.58	0.496
Cl-	mg/l	21	22	22	22	23	22	23	23	22	25	22.1	23.1
NO2-	mg/l	<0.3	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
NO3-	mg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.3	0.5	4
SO4--	mg/l	67	75	67	69	71	69	69	66	66	71	68.9	70
HCO3-	mg/l	107.9	22.37	112.28	123.46	123.46	123.46	0.00	0.00	84.18	117.85	112.24	98.72
CO3--	mg/l	0	99.40	22.08	11.04	11.04	11.04	21.20	55.20	5.52	0.00	0.00	0.00
OH-	mg/l	0	0.00	0.00	0.00	0.00	0.00	56.37	10.95	0.00	0.00	0.00	0.00
B	mg/l	0.08	0.242	0.091	0.125	0.102	0.097	0.084	0.146	0.099	0.078	0.077	0.082
as H3BO3	mg/l	0.41	1.25	0.47	0.65	0.53	0.50	0.43	0.76	0.51	0.40	0.40	0.42
TOC	mg/l	0.45	1.38	0.68	0.45	0.62	0.68	0.79	0.94	0.82	0.44	-	-
PO4---	mg/l	<0.4	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
CATIONS	meq/l	4.92	5.35	4.65	4.06	4.31	4.51	4.61	4.36	3.88	4.20	4.26	4.28
ANIONS	meq/l	5.06	5.86	4.59	4.45	4.52	4.45	6.23	4.51	3.56	4.17	3.94	3.82
TOT.ALK.*	mg/l	92.16	110.4	77.3	71.76	71.76	71.76	124.2	74.52	46.92	57.96	55.2	48.55
P. ALK	mg/l	0	49.7	11.04	5.52	5.52	5.52	113.6	46.92	2.76	0	0	0
IC	mg/l	34.1	37.02	26.98	19.59	26.07	27.42	30.56	11.41	16.26	5.73	-	-

(---) Data not available.

(*) Total Alkalinity as CO3--.

TABLE A.3. Chemical Composition of Leachates from ANS 16.1 Leach Test: Sample PSWLA7-6

SAMPLE #	------	WELL WATER	1	2	3	4	5	6	7	8	9	10	11
TIME	days	------	0.0833	0.29	1	2	3	4	18	47	90	150	200
pH		8.36	9.46	9.16	9.41	9.46	9.07	8.01	10.61	9.07	8.46	8.18	7.95
Eh	mv	351	401	404	390	371	391	390	389	355	363	337	372
Al	mg/l	<0.03	0.204	0.113	0.113	0.1	0.044	0.032	0.061	0.032	<0.003	0.046	<0.003
Ba	mg/l	0.058	0.035	0.043	0.013	0.036	0.036	0.043	0.016	0.023	0.035	0.042	0.048
Ca	mg/l	50.6	32.3	36.5	15.3	27.2	26.4	33.2	5.28	7.43	16	20.9	21.6
Cd	mg/l	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Cr	mg/l	<0.02	<0.02	<0.02	0.044	0.05	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cu	mg/l	<0.004	<0.004	<0.004	0.006	0.009	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Fe	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.022	<0.005
K	mg/l	8	11.3	9.4	12.4	11.6	10.8	10.2	16.4	13	10.6	9.51	10
Mg	mg/l	13.4	12	12.7	10.7	11.2	11.3	12	6.17	6.81	8.09	8.38	9.52
Mn	mg/l	0.087	0.03	0.037	<0.002	0.024	0.019	0.046	<0.002	<0.002	<0.002	<0.002	0.032
Na	mg/l	25	51.4	38.4	54.6	44.8	40.9	35.7	85.1	61.2	49.8	47.5	39.7
P	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
as PO4	mg/l	<0.3	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.3	<0.3
Pb	mg/l	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Si	mg/l	15	14.1	14.6	14.2	14.1	14.5	14.7	13.4	12.7	13.5	13.6	13.5
Sr	mg/l	0.24	0.179	0.203	0.132	0.17	0.177	0.196	0.122	0.154	0.2	0.213	0.235
Zn	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.109	<0.02	<0.02	<0.02	<0.02
Zr	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
F-	mg/l	<0.07	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	0.448	<0.6	0.5	0.51	0.415
Cl-	mg/l	21	23	23	23	23	23	22	25.4	26	24	21.2	23.4
NO2-	mg/l	<0.3	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
NO3-	mg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.9	2
SO4--	mg/l	67	71	67	71	69	67	67	70.66	65	71	66.6	71
HCO3-	mg/l	187.9	56.12	157.18	112.28	89.83	117.85	64.18	0.00	95.40	78.61	100.55	98.72
CO3--	mg/l	0	66.20	0.00	22.08	33.12	5.52	82.80	193.20	11.04	11.04	0.00	0.00
OH-	mg/l	0	0.00	0.00	0.00	0.00	0.00	0.00	12.51	0.00	0.00	0.00	0.00
B	mg/l	0.08	0.122	0.099	0.13	0.107	0.095	0.087	0.147	0.1	0.1	0.096	0.082
as H3BO3	mg/l	0.41	0.63	0.51	0.67	0.55	0.49	0.45	0.76	0.52	0.52	0.50	0.42
TOC	mg/l	0.45	0.86	0.94	0.83	0.82	0.59	0.98	1.31	0.95	0.41	-	-
PO4---	mg/l	<0.4	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.03	<0.03	<0.03
CATIONS	meq/l	4.92	5.13	4.78	4.34	4.53	4.31	4.46	4.89	3.93	3.91	4.05	3.85
ANIONS	meq/l	5.06	5.26	4.62	4.71	4.66	4.16	6.16	9.39	4.02	3.84	3.78	3.81
TOT.ALK.*	mg/l	92.16	93.8	77.3	77.3	77.3	63.48	124.2	215.20	57.96	49.7	52.4	48.55
P.ALK	mg/l	0	33.1	0	11.04	16.56	2.76	41.4	118.68	5.52	5.52	0	0
IC	mg/l	34.1	21.72	25.89	17.66	20.46	23.71	26.91	16.39	18.61	4.22	-	-

(---) Data not available.
(*) Total Alkalinity as CO3--.

TABLE A.4. Chemical Composition of Leachates from ANS 16.1 Leach Test: Sample PSWA9-1

SAMPLE #	------	WELL WATER	1	2	3	4	5	6	7	8	9	10	11
TIME	days	------	0.0833	0.29	1	2	3	4	10	47	96	150	203
pH		8.36	10.22	9.12	9.22	9.03	8.59	8.53	10.12	9.10	8.64	8.2	8.10
Eh	mv	351	397	403	380	403	392	395	403	358	384	359	380
Al	mg/l	<0.03	0.43	0.12	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Ba	mg/l	0.056	0.019	0.047	0.016	0.039	0.044	0.05	0.018	0.025	0.034	0.04	0.05
Ca	mg/l	50.6	10.9	41	26.4	32.5	36.5	42.1	5.34	7.57	13.3	19.2	28.8
Cd	mg/l	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Cr	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cu	mg/l	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Fe	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.009	<0.005
K	mg/l	6	11.9	8.6	9.1	9.1	8.8	8.9	12.8	12	10.6	9.53	8.42
Mg	mg/l	13.4	9.68	11.9	10.2	11	12	12.6	6.92	5.81	7.95	11.8	13.3
Mn	mg/l	0.087	0.005	0.057	0.005	0.036	0.028	0.003	<0.002	<0.002	<0.002	0.005	<0.002
Na	mg/l	26	67.1	31	39.9	38.1	34.7	31.5	70.5	57.9	51.8	45.5	32.2
P	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
as PO4	mg/l	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Pb	mg/l	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Si	mg/l	15	12.5	13.6	13.1	13.6	14.8	14.8	14	13.7	13.9	14.9	14.4
Sr	mg/l	0.24	0.14	0.22	0.17	0.2	0.22	0.22	0.12	0.156	0.18	0.19	[illegible]
Zn	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.028	<0.02	<0.02	[illegible]
Zr	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
F-	mg/l	<0.07	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.5	0.5	0.54	<0.5
Cl-	mg/l	21	21	22	23	23	23	23	22	22	24	22.1	23.4
NO2-	mg/l	<0.3	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
NO3-	mg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	<0.5
SO4--	mg/l	67	73	64	69	67	64	69	68	66	71	68.9	71
HCO3-	mg/l	187.9	112.28	0.00	123.42	123.46	134.69	140.30	28.06	44.90	61.73	162.75	76.78
CO3--	mg/l	0	22.08	121.40	0.00	11.04	5.52	0.00	55.20	27.60	22.08	0.00	0.00
OH-	mg/l	0	0.00	3.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B	mg/l	0.08	0.19	0.1	0.11	0.1	0.09	0.09	0.125	0.13	0.11	0.082	0.079
as H3BO3	mg/l	0.41	0.98	0.52	0.57	0.52	0.47	0.47	0.65	0.67	0.57	0.42	0.41
TOC	mg/l	0.45	1.08	0.91	0.75	0.73	0.60	0.67	0.85	0.87	0.54	-	-
PO4---	mg/l	<0.4	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
CATIONS	meq/l	4.92	4.86	4.60	4.13	4.42	4.55	4.74	4.23	3.68	3.85	4.16	4.05
ANIONS	meq/l	5.06	4.69	6.18	4.11	4.44	4.38	4.39	4.34	3.65	3.93	4.76	3.40
TOT.ALK.*	mg/l	92.10	77.3	126.9	60.7	71.76	71.76	69	69	49.68	52.44	80.04	37.76
P. ALK	mg/l	0	11.04	66.2	0	5.52	2.76	0	27.6	13.8	11.04	0	0
IC	mg/l	34.1	18.87	27.92	21.95	26.38	28.34	31.33	16.39	14.25	4.09	-	-
U	PPB		0.15	-	0.4	0.23	0.23	0.23	0.19	0.13	2.56	2	1.71

(---) Data not available.
(*) Total Alkalinity as CO3--.

TABLE A.5. Chemical Composition of Leachates from ANS 16.1 Leach Test: Sample PSWA10-1

SAMPLE #	------	WELL WATER	1	2	3	4	5	6	7	8	9	10	11
TIME	days	------	0.0833	0.29	1	2	3	4	19	48	90	150	211
pH		8.36	9.96	9.2	9.88	9.18	8.37	8.87	10.44	-	11.12	9.19	8.18
Eh	mv	351	413	429	412	344	366	382	357	-	315	343	359
Al	mg/l	<0.03	0.191	0.205	0.208	0.052	<0.03	<0.03	<0.03	<0.03	<0.03	-	<0.03
Ba	mg/l	0.056	0.028	0.047	0.032	0.036	0.042	0.046	0.003	0.012	0.031	-	0.046
Ca	mg/l	50.6	26.2	43.6	28.1	32.1	32.2	36.2	1.79	1.7	7.52	-	16.3
Cd	mg/l	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004
Cr	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02
Cu	mg/l	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004
Fe	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0062	-	<0.005
K	mg/l	8	11.8	9.4	10.6	9.9	9.4	8.6	16	19.4	12.1	-	10.3
Mg	mg/l	13.4	11.5	17.4	9.87	10.4	11.8	12.2	2.24	0.07	8.12	-	9.58
Mn	mg/l	0.007	0.013	0.054	0.028	0.048	0.033	0.044	<0.002	<0.002	<0.002	-	<0.002
Na	mg/l	25	56.1	36.3	45.1	40	38	32.9	89.5	120	63.4	-	36.6
P	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	-	<0.1
as PO4	mg/l	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	-	<0.3
Pb	mg/l	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	-	<0.06
Si	mg/l	15	13.7	13.9	12.5	12.8	14.1	14.1	13.9	12.9	13.1	-	13.8
Sr	mg/l	0.24	0.161	0.216	0.186	0.178	0.199	0.208	0.033	0.09	0.179	-	0.228
Zn	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02
Zr	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	-	<0.008
F-	mg/l	<0.07	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.5	<0.7	0.513	-	0.52
Cl-	mg/l	21	22	22	22	22	23	22	22	23	21	-	23.7
NO2-	mg/l	<0.3	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	-	<0.03
NO3-	mg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5
SO4--	mg/l	67	73	71	69	69	68	66	66	71	64	-	70.9
HCO3-	mg/l	187.9	0.00	134.69	56.12	134.69	0.00	151.52	0.00	0.00	134.69	-	98.72
CO3--	mg/l	0	11.04	16.56	44.16	0.00	33.12	11.04	55.20	88.28	115.92	-	32.36
OH-	mg/l	0	70.38	0.00	0.00	0.00	21.90	0.00	18.77	15.65	0.00	-	0.00
B	mg/l	0.00	0.168	0.111	0.126	0.099	0.094	0.082	0.141	0.16	0.088	-	0.091
as H3BO3	mg/l	0.46	0.96	0.63	0.71	0.57	0.54	0.47	0.81	0.91	0.50	-	0.52
TOC	mg/l	0.45	1.45	0.7	0.64	0.58	0.72	0.77	1.45	1.19	1.39	-	-
PO4---	mg/l	<0.4	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.03	-	<0.03
CATIONS	meq/l	4.92	5.00	5.43	4.45	4.45	4.48	4.47	4.57	6.20	4.11	-	3.46
ANIONS	meq/l	5.06	6.65	4.86	4.45	4.27	4.46	4.85	4.94	5.99	6.03	-	4.87
TOT.ALK.*	mg/l	92.16	135.24	82.8	71.76	66.24	71.76	85.56	88.32	115.9	182.16	-	80.91
P. ALK	mg/l	0	129.72	8.28	22.08	0	55.2	5.52	60.72	71.76	57.96	-	16.18
IC	mg/l	34.1	20.13	23.43	17	23.42	26.08	20.29	20.13	12.55	13.36	-	-
U	PPB		-	1.41	2.07	1.07	2.15	0.48	1.6	1.6	1.17	-	2

(---) Data not available.
(*) Total Alkalinity as CO3--.

TABLE A.6. Chemical Composition of Leachates from ANS 16.1 Leach Test: Sample PSWLA10-6

SAMPLE #	------	WELL WATER	1	2	3	4	5	6	7	8	9	10	11
TIME	days	------	0.0833	0.29	1	2	3	4	19	48	96	150	211
pH		8.38	9.55	9.31	9.97	9.49	8.68	9.08	10.52	-	10.69	8.4	8.24
Eh	mv	351	414	425	419	354	378	386	379	-	365	358	373
Al	mg/l	<0.03	0.089	0.17	0.22	0.073	<0.03	<0.03	0.044	<0.03	0.042	-	<0.03
Ba	mg/l	0.058	0.036	0.034	0.031	0.031	0.037	0.044	0.014	<0.002	0.04	-	0.051
Ca	mg/l	50.6	32.8	28	23.3	21.9	27.2	32.6	4.89	1.61	13.8	-	21.7
Cd	mg/l	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004
Cr	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02
Cu	mg/l	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004
Fe	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.006	<0.005	<0.005	<0.005	0.013	-	<0.005
K	mg/l	8	11.2	10.7	12.1	11.7	8.7	8.8	14.8	16	10.6	-	9.3
Mg	mg/l	13.4	12.2	11.9	10.3	10.7	11.8	12.5	6.14	3.32	10.3	-	11.8
Mn	mg/l	0.007	0.015	0.012	0.017	0.013	0.022	0.033	<0.022	<0.002	<0.002	-	<0.002
Na	mg/l	25	48.7	41.2	52.5	45.2	39.9	38.2	86.4	95.6	51.1	-	38.6
P	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.13	-	<0.1
as PO4	mg/l	<0.3	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31	0.31	-	<0.31
Pb	mg/l	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	-	<0.06
Si	mg/l	15	14.6	14.2	13.5	13.5	13.6	14.4	13.4	11.5	13.5	-	13.8
Sr	mg/l	0.24	0.185	0.179	0.156	0.154	0.181	0.201	0.11	0.033	0.202	-	[illegible]
Zn	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	.2
Zr	mg/l	<0.006	<0.006	<0.008	<0.006	<0.006	<0.008	<0.008	<0.008	<0.006	<0.008	-	<0.008
F-	mg/l	<0.07	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.7	0.578	-	0.517
Cl-	mg/l	21	22	18	22	22	21	22	23	20	21	-	24.1
NO2-	mg/l	<0.3	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	-	<0.03
NO3-	mg/l	<0.5	6	<0.5	2	<0.5	2.3	<0.5	<0.6	2.5	<0.5	-	<0.5
SO4--	mg/l	67	70	68	73	65	66	68	65	61	63	-	72.4
HCO3-	mg/l	187.9	101.02	89.79	72.98	78.57	123.46	123.46	0.00	0.00	50.51	-	197.48
CO3--	mg/l	0	49.68	16.56	33.12	27.60	5.52	5.52	91.84	99.40	132.48	-	21.58
OH-	mg/l	0	0.00	0.00	0.00	0.00	0.00	0.00	5.26	3.12	0.00	-	0.00
B	mg/l	0.08	0.143	0.124	0.145	0.111	0.083	0.081	0.132	0.14	0.06	-	0.084
as H3BO3	mg/l	0.41	0.74	0.64	0.75	0.57	0.43	0.42	0.68	0.72	0.41	-	0.43
TOC	mg/l	0.45	1.16	0.63	0.51	0.58	0.47	0.61	0.56	1.9	-	-	-
PO4---	mg/l	<0.4	<0.5	<0.5	<0.5	<0.5	<0.6	<0.5	<0.5	<0.5	<0.5	-	<0.5
CATIONS	meq/l	4.92	5.05	4.35	4.61	4.24	4.29	4.48	4.88	4.92	4.04	-	3.89
ANIONS	meq/l	5.06	5.49	3.95	4.47	4.18	4.21	4.25	5.37	5.37	7.19	-	6.17
TOT.ALK.*	mg/l	92.16	99.36	60.72	69	66.24	66.24	66.24	101.12	104.9	157.32	-	118.7
P.ALK	mg/l	0	24.84	8.28	16.56	13.8	2.76	2.76	55.2	55.2	66.24	-	10.79
IC	mg/l	34.1	22.14	23.48	17.44	16.63	27.42	27.61	17.06	21.23	-	-	-
U	PPB		1.63	1.65	1.5	1.69	1.63	1.63	0.9	1.01	2.77	-	2.7

(---) Data not available.
(*) Total Alkalinity as CO3--.

TABLE A.7. Chemical Composition of Leachates from Static Leach Test: Sample PSWS5-4

SAMPLE #	------	WELL WATER	1	2	3	4	5	6
TIME	days	------	4	18	47	90	150	223
pH		8.36	11.83	11.9	11.78	11.8	11.94	11.85
Eh	mv	351	384	197	319	309	338	375
Al	mg/l	<0.03	0.832	2.69	3.46	4.48	1.7	6.29
Ba	mg/l	0.056	0.02	0.042	0.052	0.066	0.059	0.058
Ca	mg/l	50.6	1.71	7.77	17.9	21.6	23.3	13
Cd	mg/l	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Cr	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cu	mg/l	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Fe	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
K	mg/l	8	19.6	26.8	38	39.4	41	41.5
Mg	mg/l	13.4	<0.06	<0.06	0.112	<0.06	<0.05	<0.05
Mn	mg/l	0.087	<0.002	<0.002	<0.002	<0.002	<0.005	<0.005
Na	mg/l	25	139	208	254	327	313	313
P	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
as PO4	mg/l	<0.3	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31
Pb	mg/l	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Si	mg/l	15	9.78	10.2	9.51	11.1	10.5	12.4
Sr	mg/l	0.24	0.116	0.237	0.331	0.44	0.49	0.461
Zn	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.005	<0.005
Zr	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.1	<0.1
F-	mg/l	<0.07	<0.7	<0.7	<1.2	<1	<0.7	<0.3
Cl-	mg/l	21	23	22	18	19	17.9	21.6
NO2-	mg/l	<0.3	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
NO3-	mg/l	<0.5	<0.5	<0.5	3.2	3.5	3.9	5
SO4--	mg/l	87	75	69	56	61	55.3	69
HCO3-	mg/l	187.9	0.00	0.00	0.00	0.00	0.00	0.00
CO3--	mg/l	0	82.80	187.68	44.12	138.00	88.32	107.96
OH-	mg/l	0	39.10	78.20	218.98	172.04	209.58	213.94
B	mg/l	0.08	0.295	0.375	0.399	0.51	0.562	0.604
as H3BO3	mg/l	0.41	1.53	1.94	2.07	2.64	2.91	3.13
TOC	mg/l	0.45	2.32	2.31	3.1	-	4.78	-
PO4---	mg/l	<0.4	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
CATIONS	meq/l	4.92	6.83	10.12	12.72	16.31	15.83	15.33
ANIONS	meq/l	5.06	7.27	12.91	16.08	16.58	16.99	18.31
TOT.ALK.*	mg/l	92.16	151.8	325.68	430.56	441.6	458.16	486.5
P. ALK	mg/l	0	110.4	231.64	408.5	372.6	414	431.52
IC	mg/l	34.1	26.38	7.67	6.52	-	5.64	-

(---) Data not available.
(*) Total Alkalinity as CO3--.

TABLE A.8. Chemical Composition of Leachates from Static Leach Test: Sample PSWS7-4

SAMPLE #	------	WELL WATER	1	2	3	4	5	6
TIME	days	------	4	18	47	98	150	208
pH		8.36	11.91	11.86	11.91	11.78	11.69	11.42
Eh	mv	351	361	417	361	299	313	329
Al	mg/l	<0.03	0.86	2.41	3.83	4.8	5.97	6.86
Ba	mg/l	0.056	0.017	0.025	0.037	0.033	0.024	0.014
Ca	mg/l	50.6	5.74	8.3	12.4	10.5	6.5	1.11
Cd	mg/l	<0.004	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cr	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cu	mg/l	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Fe	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
K	mg/l	8	20	23.4	33	36.1	39.6	39.6
Mg	mg/l	13.4	0.46	<0.06	<0.06	<0.06	<0.06	<0.06
Mn	mg/l	0.007	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Na	mg/l	26	137	173	271	288	323	299
P	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
as PO4	mg/l	<0.3	<0.31	<0.31	<0.31	<0.31	<0.3	<0.3
Pb	mg/l	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Si	mg/l	15	11.4	11.2	13.4	14.5	16.3	18.7
Sr	mg/l	0.24	0.105	0.168	0.259	0.26	0.213	0.154
Zn	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Zr	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
F-	mg/l	<0.07	<0.6	<0.7	<0.8	<0.6	0.4	<0.8
Cl-	mg/l	21	22	22	21	22	18.8	22.3
NO2-	mg/l	<0.3	<0.03	<0.3	<0.3	<0.3	<0.3	<0.3
NO3-	mg/l	<0.5	41	1.8	2.4	3	3.2	4
SO4--	mg/l	67	69	64	70	66	66.9	72
HCO3-	mg/l	107.9	0.00	0.00	0.00	0.00	0.00	0.00
CO3--	mg/l	0	27.60	55.20	331.20	83.52	44.20	215.76
OH-	mg/l	0	90.72	93.84	82.56	154.63	190.80	183.40
B	mg/l	0.08	0.327	0.32	0.417	0.44	0.492	0.522
as H3BO3	mg/l	0.41	1.89	1.86	2.16	2.28	2.55	2.70
TOC	mg/l	0.45	3.05	2.88	2.92	0.94	-	-
PO4---	mg/l	<0.4	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
CATIONS	meq/l	4.92	6.79	8.54	13.25	13.97	15.39	14.07
ANIONS	meq/l	5.06	8.98	9.34	16.81	13.92	14.57	20.17
TOT.ALK.*	mg/l	92.16	187.7	220.8	441.6	358.4	380.9	539.4
P. ALK	mg/l	0	173.9	193.2	276	314.64	358.8	431.52
IC	mg/l	34.1	9.82	6.42	4.93	4.51	-	-

(---) Data not available.

(*) Total Alkalinity as CO3--.

TABLE A.9. Chemical Composition of Leachates from Static Leach Test: Sample PSWS9-4

SAMPLE #	------	WELL WATER	1	2	3	4	5	6
TIME	days	------	4	18	47	90	150	208
pH		8.36	11.64	11.79	11.62	11.67	11.81	11.78
Eh	mv	351	369	396	313	309	325	312
Al	mg/l	<0.03	1.06	2.41	4	5	5.93	6.49
Ba	mg/l	0.056	0.01	0.013	0.015	0.014	0.011	0.01
Ca	mg/l	50.6	3.47	4.01	4.52	4.04	4.52	3.82
Cd	mg/l	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Cr	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.002
Cu	mg/l	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Fe	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
K	mg/l	6	17.2	20.6	31	33.4	36.1	36
Mg	mg/l	13.4	0.299	<0.06	<0.06	<0.06	<0.06	<0.06
Mn	mg/l	0.087	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Na	mg/l	25	122	166	250	261	292	269
P	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
as PO4	mg/l	<0.3	<0.31	<0.31	<0.31	<0.31	<0.31	<0.31
Pb	mg/l	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Si	mg/l	15	10.7	12.9	17.8	19.8	21.3	22.4
Sr	mg/l	0.24	0.072	0.108	0.14	0.14	0.141	0.142
Zn	mg/l	<0.02	<0.02	<0.02	0.027	<0.02	<0.02	<0.02
Zr	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
F-	mg/l	<0.07	<0.7	<0.7	<0.8	<0.6	0.45	<0.07
Cl-	mg/l	21	21	19	21	22	20.2	22.1
NO2-	mg/l	<0.3	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
NO3-	mg/l	<0.5	2.3	1.8	0.7	3	3.2	4
SO4--	mg/l	67	67	61	70	69	66.7	74
HCO3-	mg/l	187.9	0.00	0.00	0.00	0.00	0.00	0.00
CO3--	mg/l	0	28.80	82.80	82.80	198.72	22.00	107.88
OH-	mg/l	0	124.44	86.02	101.66	98.53	193.97	183.40
B	mg/l	0.08	0.277	0.303	0.425	0.43	0.493	0.507
as H3BO3	mg/l	0.41	1.43	1.57	2.20	2.23	2.55	2.83
TOC	mg/l	0.45	2.93	3.32	-	1.44	-	-
PO4---	mg/l	<0.4	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
CATIONS	meq/l	4.92	5.94	7.52	11.89	12.41	13.85	12.81
ANIONS	meq/l	5.06	10.31	9.85	10.80	14.53	14.18	16.61
TOT.ALK.*	mg/l	92.16	248.4	234.6	262.2	372.6	384.3	431.52
P. ALK.	mg/l	0	234	193.2	220.8	273.24	353.3	377.58
IC	mg/l	34.1	13.43	9.83	-	4.53	-	-
U	PPB		0.04	0.04	0.01	0.25	0.65	0.13

(---) Data not available.
(*) Total Alkalinity as CO3--.

TABLE A.10. Chemical Composition of Leachates from Static Leach Test: Sample PSWSIO-4

SAMPLE #	------	WELL WATER	1	2	3	4	5	6
TIME	days	------	4	18	46	90	150	211
pH		8.36	11.73	11.42	-	11.84	11.81	12.22
Eh	mv	351	337	360	-	305	317	280
Al	mg/l	<0.03	1.39	3.29	5.69	6.42	-	7.1
Ba	mg/l	0.056	0.007	0.007	0.045	0.043	-	0.036
Ca	mg/l	50.6	4.03	0.130	18.9	16.3	-	11.4
Cd	mg/l	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004
Cr	mg/l	<0.02	<0.02	<0.02	0.03	0.029	-	0.036
Cu	mg/l	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004
Fe	mg/l	<0.005	<0.005	<0.005	<0.005	0.008	-	<0.005
K	mg/l	8	21.5	27	44.2	44.4	-	46.2
Mg	mg/l	13.4	<0.06	<0.06	<0.06	<0.06	-	<0.06
Mn	mg/l	0.087	<0.002	<0.002	<0.002	<0.002	-	<0.002
Na	mg/l	26	143	254	346	352	-	330
P	mg/l	<0.1	<0.1	0.83	<0.1	0.13	-	<0.1
as PO4	mg/l	<0.3	<0.3	2.54	<0.3	<0.3	-	<0.3
Pb	mg/l	<0.06	<0.06	<0.06	<0.05	<0.05	-	<0.05
Si	mg/l	16	9.23	9.09	12	12.4	-	13.9
Sr	mg/l	0.24	0.123	0.04	0.37	0.366	-	0.346
Zn	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02
Zr	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	-	<0.008
F-	mg/l	<0.07	<0.9	<0.8	<0.7	0.344	-	<0.7
Cl-	mg/l	21	22	21	21	20	-	21
NO2-	mg/l	<0.3	<0.03	<0.03	<0.03	<0.03	-	<0.03
NO3-	mg/l	<0.5	<0.5	0.7	<0.5	<0.5	-	0.5
SO4--	mg/l	67	74	73	74	72	-	79
HCO3-	mg/l	187.9	0.00	0.00	0.00	0.00	-	0.00
CO3--	mg/l	0	38.64	82.80	55.20	496.80	-	32.20
OH-	mg/l	0	20.33	117.30	200.20	187.68	-	282.93
B	mg/l	0.08	0.348	0.448	0.61	0.628	-	0.669
as H3BO3	mg/l	0.41	1.80	2.32	3.16	3.25	-	3.46
TOC	mg/l	0.45	3.71	-	3.57	-	-	-
PO4---	mg/l	<0.4	<0.05	<0.05	<0.05	<0.05	-	<0.05
CATIONS	meq/l	4.92	6.97	11.74	17.08	17.26	-	16.08
ANIONS	meq/l	5.06	4.65	11.87	15.75	29.68	-	18.79
TOT.ALK.*	mg/l	92.18	74.52	289.8	408.5	828	-	496.2
P. ALK.	mg/l	0	55.2	246.4	380.9	579.6	-	480.1
IC	mg/l	34.1	3.34	-	29.57	-	-	-
U	PPB		0.42	-	0.22	0.23	-	0.35

(---) Data not available.
(*) Total Alkalinity as CO3--.

TABLE A.11. Arsenic Concentrations for Batch #2 of PSW Grouts

ANS SAMPLE #	DAYS	As(ppb)
A2-1-1	0.83	< 5
A2-1-2	0.29	< 6
A2-1-3	1	< 5
A2-1-4	2	< 5
A2-1-5	3	< 5
A2-1-6	4	< 3
A2-1-7	18	<20
A2-1-8	48	<20
A2-1-9	90	<20
A2-1-10	150	<20
A2-1-11	223	<20

STATIC SAMPLE #	DAYS	As(ppb)
A2-4-1	4	< 3
A2-4-2	18	< 3
A2-4-3	48	<20
A2-4-4	90	<20
A2-4-5	150	<20
A2-4-6	223	<20

TABLE A.12. Uranium Concentrations For PSW Grout Samples

SAMPLE ID	U. CONC. (μg/L)	SAMPLE ID	U. CONC. (μg/L)
A8-1-1	0.02	A8-3-10	1.50
A8-1-2	0.09	A8-3-11	1.38
A8-1-3	0.12	S8-4-1	0.05
A8-1-4	0.09	S8-4-2	0.01
A8-1-5	0.09	S8-4-3	0.01
A8-1-6	0.10	S8-4-4	2.61
A8-1-7	0.15	S8-4-5	0.14
A8-1-8	0.10	S8-4-6	0.14
A8-1-9	2.51	S8-5-1	0.03
A8-1-10	2.00	S8-5-1	0.14
A8-1-11	3.28	S8-5-2	0.01
A8-2-1	0.05	S8-5-3	0.01
A8-2-2	0.21	S8-5-4	1.58
A8-2-3	0.20	S8-5-5	0.20
A8-2-4	0.20	S8-5-6	0.43
A8-2-5	0.21	LA8-6-1	0.22
A8-2-6	0.26	LA8-6-2	0.07
A8-2-7	0.03	LA8-6-3	0.20
A8-2-8	1.03	LA8-6-4	0.19
A8-2-9	2.38	LA8-6-5	0.19
A8-2-10	2.38	LA8-6-6	0.14
A8-2-11	2.33	LA8-6-7	0.11
A8-3-1	0.14	LA8-6-8	0.80
A8-3-2	0.27	LA8-6-9	0.84
A8-3-3	0.24	A9-1-1	0.15
A8-3-4	0.11	A9-1-2	0.20
A8-3-5	0.24	A9-1-3	0.23
A8-3-6	0.21	A9-1-4	0.23
A8-3-7	0.09	A9-1-5	0.23
A8-3-8	0.09	A9-1-6	0.23
A8-3-9	2.13	A9-1-7	0.19

TABLE A.12. (contd)

SAMPLE ID	U. CONC. (μg/L)	SAMPLE ID	U. CONC. (μg/L)
A9-1-8	0.13	S9-5-1	0.01
A9-1-9	2.56	S9-5-2	0.04
A9-1-10	2.00	S9-5-3	0.01
A9-1-11	1.70	S9-5-4	1.69
A9-2-1	0.17	S9-5-4	0.31
A9-2-2	0.25	S9-5-5	0.16
A9-2-3	0.18	S9-5-6	0.25
A9-2-4	0.21	A10-1-1	1.66
A9-2-5	0.24	A10-1-2	2.00
A9-2-6	0.22	A10-1-3	1.41
A9-2-7	0.20	A10-1-4	2.07
A9-2-8	0.13	A10-1-5	1.87
A9-2-9	2.42	A10-1-6	2.15
A9-2-10	2.00	A10-1-7	0.48
A9-2-11	1.67	A10-1-8	0.15
A9-3-1	0.20	A10-1-9	2.18
A9-3-2	0.15	A10-1-10	2.00
A9-3-4	0.21	A10-1-11	1.77
A9-3-5	0.26	A10-2-1	1.60
A9-3-6	0.23	A10-2-2	1.60
A9-3-7	0.20	A10-2-3	1.17
A9-3-8	0.13	A10-2-4	1.82
A9-3-9	2.39	A10-2-5	1.82
A9-3-10	1.07	A10-2-6	2.07
A9-3-11	0.08	A10-2-7	2.75
S9-4-1	0.04	A10-2-8	0.16
S9-4-2	0.04	A10-2-9	2.63
S9-4-3	0.01	A10-2-10	2.63
S9-4-4	0.60	A10-4-11	1.55
S9-4-5	0.65	S10-4-1	0.44
S9-4-6	0.13	S10-4-2	0.42

TABLE A.12. (contd)

SAMPLE ID	U. CONC. (μg/L)	SAMPLE ID	U. CONC. (μg/L)
S10-4-3	0.22	A11-1-6	0.14
S10-4-4	0.35	A11-1-7	0.09
S10-4-5	0.23	A11-1-9	1.73
S10-4-6	0.35	A11-1-11	2.50
S10-5-1	0.42	A11-2-1	0.12
S10-5-2	0.42	A11-2-2	0.13
S10-5-3	0.25	A11-2-3	0.09
S10-5-4	0.23	A11-2-3	0.36
S10-5-5	0.23	A11-2-4	0.14
S10-5-6	0.23	A11-2-5	0.11
LA10-6-1	1.83	A11-2-6	0.13
LA10-6-2	1.65	A11-2-7	0.08
LA10-6-3	1.50	A11-2-9	1.77
LA10-6-4	1.69	A11-2-11	3.92
LA10-6-5	1.63	S11-4-1	0.02
LA10-6-6	1.63	S11-4-2	0.01
LA10-6-7	0.90	S11-4-3	0.18
LA10-6-8	1.01	S11-4-4	0.13
LA10-6-9	2.77	S11-4-6	0.27
LA10-6-10	2.70	S11-5-1	0.02
LA10-6-11	2.70	S11-5-2	0.03
A11-1-1	0.11	S11-5-3	0.14
A11-1-2	0.18	S11-5-4	0.27
A11-1-4	0.12	S11-5-6	0.55
A11-1-5	0.12		

APPENDIX B

CUMULATIVE FRACTION LEACHED AND EFFECTIVE DIFFUSION COEFFICIENT DATA

TABLE B.1-1a. Carbon-14 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 1-1)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	1-1-1	0.00	0.00	0.08	2.60E-04	2.60E-04	2.57E-12	2.57E-12
PSW	1-1-2	0.00	0.00	0.29	5.65E-05	3.16E-04	1.61E-13	1.09E-12
PSW	1-1-3	0.00	0.01	1.00	5.00E-05	3.66E-04	3.71E-14	4.24E-13
PSW	1-1-4	0.00	0.01	2.00	1.63E-04	5.30E-04	4.93E-13	4.44E-13
PSW	1-1-5	0.00	0.01	3.00	4.26E-05	5.72E-04	5.69E-14	3.45E-13
PSW	1-1-6	0.01	0.01	4.00	3.89E-04	9.62E-04	6.66E-12	7.31E-13
PSW	1-1-7	0.01	0.02	18.00	5.69E-04	1.53E-03	2.04E-13	4.12E-13
PSW	1-1-8	0.01	0.03	48.00	4.07E-04	1.94E-03	7.25E-14	2.47E-13
PSW	1-1-9	0.00	0.03	90.00	2.96E-04	2.23E-03	1.44E-14	1.75E-13
PSW	1-1-10	0.00	0.03	151.00	4.27E-05	2.28E-03	7.36E-16	1.08E-13
PSW	1-1-11	0.00	0.03	211.00	1.80E-05	2.29E-03	2.04E-16	7.89E-14

TABLE B.1-1b. Carbon-14 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 1-2)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	1-2-1	0.01	0.01	0.08	4.31E-04	4.31E-04	6.85E-12	6.85E-12
PSW	1-2-2	0.00	0.01	0.29	4.50E-05	4.76E-04	9.86E-14	2.39E-12
PSW	1-2-3	0.00	0.01	1.00	1.92E-04	6.68E-04	5.28E-13	1.36E-12
PSW	1-2-4	0.00	0.01	2.00	1.30E-04	7.98E-04	3.02E-13	9.74E-13
PSW	1-2-5	0.00	0.01	3.00	4.50E-05	8.43E-04	6.12E-14	7.24E-13
PSW	1-2-6	0.00	0.01	4.00	4.50E-05	8.88E-04	8.61E-14	6.03E-13
PSW	1-2-7	0.00	0.02	18.00	2.77E-04	1.17E-03	4.67E-14	2.31E-13
PSW	1-2-8	0.00	0.02	48.00	1.56E-04	1.32E-03	1.04E-14	1.11E-13
PSW	1-2-9	0.00	0.02	90.00	9.02E-05	1.41E-03	1.29E-15	6.77E-14
PSW	1-2-10	0.00	0.02	150.00	4.35E-05	1.46E-03	7.60E-16	4.32E-14
PSW	1-2-11	0.00	0.02	211.00	7.85E-05	1.53E-03	3.44E-15	3.40E-14

TABLE B.1-2a. Carbon-14 Fraction Leached for Static Leach Test: Whole Grout in Hanford Ground Water (PSW 1-4)

	SAMPLE ID	uCi LEACHED	TIME DAYS	cum An/Ao	D cum.
PSW	1-4-1	0.01	4.00	9.12E-04	6.36E-13
PSW	1-4-2	0.02	19.00	1.14E-03	2.09E-13
PSW	1-4-3	0.02	48.00	1.17E-03	8.67E-14
PSW	1-4-4	0.02	90.00	1.24E-03	5.19E-14
PSW	1-4-5	0.02	150.00	1.30E-03	3.47E-14
PSW	1-4-6	0.02	211.00	1.53E-03	3.38E-14

<u>TABLE B.1-2b</u>. Carbon-14 Fraction Leached for Static Leach Test: Whole Grout in Hanford Ground Water (PSW 1-5)

SAMPLE ID	uCi LEACHED	TIME DAYS	cum An/Ao	D cum.
1-5-1	0.01	4.00	5.19E-04	2.13E-13
1-5-2	0.01	19.00	9.75E-04	1.58E-13
1-5-3	0.01	48.00	1.08E-03	7.69E-14
1-5-4	0.02	96.00	1.23E-03	5.28E-14
1-5-5	0.01	150.00	9.80E-04	2.03E-14
1-5-6	0.02	211.00	1.17E-03	2.07E-14

TABLE B.2-1a. Mercury-203 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 2-1)

SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
2-1-1	5.24E-03	5.24E-03	8.30E-02	1.47E-01	1.47E-01	7.69E-07	7.69E-07
2-1-2	5.28E-03	1.05E-02	2.90E-01	1.48E-01	2.95E-01	1.03E-06	8.87E-07
2-1-3	5.29E-03	1.58E-02	1.00E+00	1.48E-01	4.44E-01	3.06E-07	5.81E-07
2-1-4	5.29E-03	2.11E-02	2.00E+00	1.48E-01	5.92E-01	3.79E-07	5.18E-07
2-1-5	5.29E-03	2.64E-02	3.00E+00	1.48E-01	7.40E-01	6.44E-07	5.40E-07
2-1-6	5.28E-03	3.17E-02	4.00E+00	1.48E-01	8.88E-01	8.98E-07	5.82E-07
2-1-7	5.33E-03	3.70E-02	1.80E+01	1.50E-01	1.04E+00	1.31E-08	1.77E-07
2-1-8	5.37E-03	4.24E-02	4.80E+01	1.51E-01	1.19E+00	9.30E-09	8.69E-08
2-1-9	1.26E-02	5.49E-02	8.90E+01	3.52E-01	1.54E+00	5.81E-08	7.87E-08
2-1-10	5.59E-03	6.05E-02	1.50E+02	1.57E-01	1.70E+00	9.19E-09	5.67E-08

TABLE B.2-1b. Mercury-203 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 2-2)

SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
2-2-1	2.65E-03	2.65E-03	8.30E-02	7.31E-02	7.31E-02	1.90E-07	1.90E-07
2-2-2	2.95E-03	5.60E-03	2.90E-01	8.13E-02	1.54E-01	3.11E-07	2.43E-07
2-2-3	2.65E-03	8.25E-03	1.00E+00	7.30E-02	2.27E-01	7.40E-08	1.53E-07
2-2-4	2.65E-03	1.09E-02	2.00E+00	7.30E-02	3.00E-01	9.19E-08	1.33E-07
2-2-5	2.65E-03	1.36E-02	3.00E+00	7.31E-02	3.74E-01	1.56E-07	1.37E-07
2-2-6	2.65E-03	1.62E-02	4.00E+00	7.31E-02	4.47E-01	2.20E-07	1.47E-07
2-2-7	2.65E-03	1.89E-02	1.80E+01	7.31E-02	5.20E-01	3.13E-09	4.43E-08
2-2-8	2.65E-03	2.15E-02	4.80E+01	7.31E-02	5.93E-01	2.19E-09	2.16E-08
2-2-9	2.65E-03	2.42E-02	8.90E+01	7.31E-02	6.66E-01	2.51E-09	1.47E-08
2-2-10	2.65E-03	2.68E-02	1.50E+02	7.31E-02	7.39E-01	1.99E-09	1.07E-08

TABLE B.2-2a. Mercury-203 Fraction Leached for Static Leach Test: Whole Grout in Hanford Ground Water (PSW 2-4)

SAMPLE ID	uCi LEACHED	TIME DAYS	cum An/Ao	D cum.
2-4-1	2.6458E-03	4.00	7.55E-02	4.36E-09
2-4-2	2.6458E-03	19.00	7.55E-02	9.17E-10
2-4-3	2.6458E-03	48.00	7.55E-02	3.63E-10
2-4-4	2.6458E-03	90.00	7.55E-02	1.94E-10

TABLE B.2-2b. Mercury-203 Fraction Leached for Static Leach Test: Whole Grout in Hanford Ground Water (PSW 2-5)

SAMPLE ID	uCi LEACHED	TIME DAYS	cum An/Ao	D cum.
2-5-1	2.6458E-03	4.00	7.57E-02	4.24E-09
2-5-2	2.6458E-03	19.00	7.57E-02	8.92E-10
2-5-3	2.6458E-03	48.00	7.57E-02	3.53E-10
2-5-4	2.6458E-03	90.00	7.57E-02	1.88E-10

TABLE B.3-1a. Cadmium-109 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 2-1)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	2-1-1	0.01	0.01	0.08	7.05E-03	7.05E-03	1.77E-09	1.77E-09
PSW	2-1-2	0.01	0.02	0.29	1.16E-02	1.86E-02	6.31E-09	3.53E-09
PSW	2-1-3	0.01	0.03	1.00	9.49E-03	2.81E-02	1.25E-09	2.33E-09
PSW	2-1-4	0.01	0.04	2.00	8.08E-03	3.62E-02	1.12E-09	1.94E-09
PSW	2-1-5	0.01	0.05	3.00	7.57E-03	4.38E-02	1.68E-09	1.89E-09
PSW	2-1-6	0.01	0.06	4.00	8.81E-03	5.26E-02	3.19E-09	2.04E-09
PSW	2-1-7	0.01	0.07	18.00	8.72E-03	6.13E-02	4.47E-11	6.17E-10
PSW	2-1-8	0.01	0.08	48.00	7.81E-03	6.91E-02	2.50E-11	2.94E-10
PSW	2-1-9	0.01	0.09	89.00	4.52E-03	7.36E-02	9.63E-12	1.80E-10
PSW	2-1-10	0.01	0.09	150.00	6.22E-03	7.99E-02	1.44E-11	1.26E-10

TABLE B.3-1b. Cadmium-109 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 2-2)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	2-2-1	0.01	0.01	0.08	7.64E-03	7.64E-03	2.08E-09	2.08E-09
PSW	2-2-2	0.01	0.01	0.29	4.43E-03	1.21E-02	9.26E-10	1.49E-09
PSW	2-2-3	0.01	0.02	1.00	8.58E-03	2.07E-02	1.02E-09	1.28E-09
PSW	2-2-4	0.01	0.03	2.00	6.61E-03	2.73E-02	7.53E-10	1.10E-09
PSW	2-2-5	0.01	0.04	3.00	6.69E-03	3.40E-02	1.31E-09	1.14E-09
PSW	2-2-6	0.01	0.05	4.00	5.99E-03	4.00E-02	1.47E-09	1.18E-09
PSW	2-2-7	0.01	0.06	18.00	9.45E-03	4.94E-02	5.25E-11	4.00E-10
PSW	2-2-8	0.01	0.07	48.00	1.02E-02	5.96E-02	4.29E-11	2.19E-10
PSW	2-2-9	0.01	0.08	69.00	9.22E-03	6.89E-02	4.00E-11	1.57E-10
PSW	2-2-10	0.01	0.09	150.00	7.78E-03	7.66E-02	2.26E-11	1.16E-10

TABLE B.3-2a. Cadmium-109 Fraction Leached for Static Leach Test: Whole Grout in Hanford Ground Water (PSW 2-4)

	SAMPLE ID	uCi LEACHED	TIME DAYS	cum An/Ao	D cum.
PSW	2-4-1	0.00	4.00	4.00E-03	1.22E-11
PSW	2-4-2	0.01	19.00	1.08E-02	1.89E-11
PSW	2-4-3	0.01	48.00	1.28E-02	1.05E-11
PSW	2-4-4	0.01	90.00	1.01E-02	3.46E-12

TABLE B.3-2b. Cadmium-109 Fraction Leached for Static Leach Test: Whole Grout in Hanford Ground Water (PSW 2-5)

	SAMPLE ID	uCi LEACHED	TIME DAYS	cum An/Ao	D cum.
PSW	2-5-1	0.01	4.00	1.06E-02	8.23E-11
PSW	2-5-2	0.01	19.00	1.06E-02	1.75E-11
PSW	2-5-3	0.01	48.00	1.15E-02	8.07E-12
PSW	2-5-4	0.01	90.00	1.09E-02	3.88E-12

TABLE B.4-1a. Selenium-75 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 3-1)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	3-1-1	0.00	0.00	0.08	2.83E-06	2.83E-06	2.76E-16	2.76E-16
PSW	3-1-2	0.00	0.00	0.29	2.86E-06	5.69E-06	3.70E-16	3.18E-16
PSW	3-1-3	0.00	0.00	1.00	1.38E-03	1.39E-03	2.56E-11	5.51E-12
PSW	3-1-4	0.00	0.00	2.00	8.89E-05	1.48E-03	1.31E-13	3.12E-12
PSW	3-1-5	0.00	0.00	3.00	3.47E-06	1.48E-03	3.40E-16	2.09E-12
PSW	3-1-6	0.00	0.00	4.00	7.00E-04	2.18E-03	1.95E-11	3.39E-12
PSW	3-1-7	0.00	0.00	18.00	3.48E-06	2.19E-03	6.86E-18	7.57E-13
PSW	3-1-8	0.00	0.00	48.00	2.90E-06	2.19E-03	3.33E-18	2.85E-13
PSW	3-1-9	0.00	0.00	150.00	3.13E-06	2.19E-03	9.86E-19	9.13E-14
PSW	3-1-10	0.00	0.00	223.00	3.45E-06	2.20E-03	4.70E-18	6.16E-14

TABLE B.4-1b. Selenium-75 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 3-2)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	3-2-1	0.01	0.01	0.08	9.99E-03	9.99E-03	3.68E-09	3.68E-09
PSW	3-2-2	0.00	0.01	0.29	9.60E-04	1.09E-02	4.49E-11	1.26E-09
PSW	3-2-3	0.00	0.01	1.00	9.85E-04	1.19E-02	1.39E-11	4.35E-10
PSW	3-2-4	0.00	0.01	2.00	3.14E-06	1.19E-02	1.75E-16	2.18E-10
PSW	3-2-5	0.00	0.01	3.00	3.15E-06	1.19E-02	3.01E-16	1.45E-10
PSW	3-2-6	0.00	0.01	4.00	3.15E-06	1.19E-02	4.23E-16	1.09E-10
PSW	3-2-7	0.00	0.01	18.00	3.30E-06	1.19E-02	6.63E-18	2.42E-11
PSW	3-2-8	0.00	0.01	48.00	3.23E-06	1.19E-02	4.42E-18	9.10E-12
PSW	3-2-9	0.00	0.01	89.00	3.23E-06	1.20E-02	5.07E-18	4.91E-12
PSW	3-2-10	0.00	0.01	150.00	3.58E-06	1.20E-02	4.95E-18	2.91E-12

TABLE B.4-2a. Selenium-75 Fraction Leached for Static Leach Test: Whole Grout in Hanford Ground Water (PSW 3-4)

	SAMPLE ID	uCi LEACHED	TIME DAYS	cum An/Ao	D cum.
PSW	3-4-1	0.00	4.00	5.81E-04	2.49E-13
PSW	3-4-2	0.02	19.00	1.75E-02	4.78E-11
PSW	3-4-3	0.02	48.00	1.90E-02	2.22E-11
PSW	3-4-4	0.04	90.00	3.26E-02	3.48E-11

TABLE B.4-2b. Selenium-75 Fraction Leached for Static Leach Test: Whole Grout in Hanford Ground Water (PSW 3-5)

	SAMPLE ID	uCi LEACHED	TIME DAYS	cum An/Ao	D cum.
PSW	3-5-1	0.01	4.00	1.33E-02	1.31E-10
PSW	3-5-2	0.02	19.00	1.89E-02	5.56E-11
PSW	3-5-3	0.03	46.00	2.53E-02	3.93E-11
PSW	3-5-4	0.04	90.00	3.46E-02	3.92E-11

TABLE B.5-1a. Silver-110m Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 3-1)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	3-1-1	1.0899E-03	1.0899E-03	0.08	7.40E-04	7.40E-04	1.88E-11	1.88E-11
PSW	3-1-2	1.0930E-03	2.1829E-03	0.29	7.42E-04	1.48E-03	2.51E-11	2.18E-11
PSW	3-1-3	3.0921E-02	3.3104E-02	1.00	2.10E-02	2.25E-02	5.91E-09	1.44E-09
PSW	3-1-4	1.6743E-02	4.9847E-02	2.00	1.14E-02	3.39E-02	2.15E-09	1.83E-09
PSW	3-1-5	1.7657E-02	6.7503E-02	3.00	1.20E-02	4.59E-02	4.08E-09	2.00E-09
PSW	3-1-6	4.8791E-03	7.2382E-02	4.00	3.31E-03	4.92E-02	4.36E-10	1.72E-09
PSW	3-1-7	1.2044E-03	7.3587E-02	18.00	8.18E-04	5.00E-02	3.79E-13	3.98E-10
PSW	3-1-8	1.1024E-03	7.4689E-02	48.00	7.49E-04	5.07E-02	2.22E-13	1.53E-10
PSW	3-1-9	1.2048E-03	7.5894E-02	89.00	8.18E-04	5.16E-02	3.04E-13	8.51E-11
PSW	3-1-10	1.1879E-03	7.7082E-02	150.00	8.07E-04	5.24E-02	2.35E-13	5.21E-11

TABLE B.5-1b. Silver-110m Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 3-2)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	3-2-1	1.0753E-03	1.0753E-03	0.08	6.90E-04	6.90E-04	1.75E-11	1.75E-11
PSW	3-2-2	1.8677E-02	1.9752E-02	0.29	1.20E-02	1.27E-02	7.00E-09	1.69E-09
PSW	3-2-3	1.1483E-03	2.0900E-02	1.00	7.36E-04	1.34E-02	7.79E-12	5.49E-10
PSW	3-2-4	1.0860E-03	2.1986E-02	2.00	6.96E-04	1.41E-02	8.65E-12	3.04E-10
PSW	3-2-5	1.0887E-03	2.3075E-02	3.00	6.98E-04	1.48E-02	1.48E-11	2.23E-10
PSW	3-2-6	2.1459E-02	4.4534E-02	4.00	1.38E-02	2.86E-02	8.07E-09	6.24E-10
PSW	3-2-7	1.5445E-02	5.9979E-02	18.00	9.91E-03	3.85E-02	5.97E-11	2.51E-10
PSW	3-2-8	1.0945E-03	6.1073E-02	48.00	7.02E-04	3.92E-02	2.09E-13	9.77E-11
PSW	3-2-9	7.5190E-03	6.8592E-02	89.00	4.82E-03	4.40E-02	1.13E-11	8.65E-11
PSW	3-2-10	1.1513E-03	6.9744E-02	150.00	7.38E-04	4.47E-02	2.11E-13	4.08E-11

TABLE B.5-2a. Silver-110m Fraction Leached for Static Leach Test: Whole Grout in Hanford Ground Water (PSW 3-4)

	SAMPLE ID	uCi LEACHED	TIME DAYS	cum An/Ao	D cum.
PSW	3-4-1	1.5225E-02	4.00	9.80E-03	7.09E-11
PSW	3-4-2	2.3515E-03	19.00	1.51E-03	3.58E-13
PSW	3-4-3	2.4414E-03	48.00	1.57E-03	1.52E-13
PSW	3-4-4	2.5313E-03	90.00	1.63E-03	8.71E-14

TABLE B.5-2b. Silver-110m Fraction Leached for Static Leach Test: Whole Grout in Hanford Ground Water (PSW 3-5)

	SAMPLE ID	uCi LEACHED	TIME DAYS	cum An/Ao	D cum.
PSW	3-5-1	1.0760E-03	4.00	6.93E-04	3.87E-13
PSW	3-5-2	1.1690E-03	19.00	7.53E-04	9.13E-14
PSW	3-5-3	1.2589E-03	48.00	8.11E-04	4.19E-14
PSW	3-5-4	1.3480E-03	90.00	8.69E-04	2.57E-14

TABLE B.6-1a. Iodine-125 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 4-1)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	4-1-1	0.00	0.00	0.08	2.98E-04	2.98E-04	3.17E-12	3.17E-12
PSW	4-1-2	0.00	0.00	0.29	2.98E-04	5.97E-04	4.19E-12	3.62E-12
PSW	4-1-3	0.01	0.01	1.00	1.87E-02	1.93E-02	4.83E-09	1.10E-09
PSW	4-1-4	0.00	0.01	2.00	7.36E-04	2.00E-02	9.33E-12	5.90E-10
PSW	4-1-5	0.00	0.01	3.00	5.78E-04	2.06E-02	9.76E-12	4.17E-10
PSW	4-1-6	0.00	0.01	4.00	5.78E-04	2.12E-02	1.37E-11	3.30E-10
PSW	4-1-7	0.00	0.01	18.00	5.78E-04	2.17E-02	1.96E-13	7.75E-11
PSW	4-1-8	0.00	0.01	48.00	1.14E-03	2.29E-02	5.34E-13	3.22E-11
PSW	4-1-9	0.00	0.02	90.00	2.39E-03	2.53E-02	2.58E-12	2.09E-11
PSW	4-1-10	0.00	0.02	150.00	2.65E-03	2.79E-02	2.73E-12	1.53E-11
PSW	4-1-11	0.00	0.02	223.00	7.12E-03	3.50E-02	2.00E-11	1.63E-11

LI = +11.2±1.2

TABLE B.6-1b. Iodine-125 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 4-2)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	4-2-1	0.01	0.01	0.08	2.21E-02	2.21E-02	1.74E-08	1.74E-08
PSW	4-2-2	0.00	0.01	0.29	2.97E-04	2.24E-02	4.14E-12	5.12E-09
PSW	4-2-3	0.01	0.03	1.00	1.75E-02	3.99E-02	4.24E-09	4.70E-09
PSW	4-2-4	0.00	0.03	2.00	5.75E-04	4.05E-02	5.69E-12	2.42E-09
PSW	4-2-5	0.00	0.03	3.00	5.64E-04	4.10E-02	9.29E-12	1.66E-09
PSW	4-2-6	0.00	0.03	4.00	5.75E-04	4.16E-02	1.36E-11	1.28E-09
PSW	4-2-7	0.00	0.03	18.00	5.57E-04	4.22E-02	1.82E-13	2.92E-10
PSW	4-2-8	0.00	0.03	46.00	1.08E-03	4.33E-02	4.78E-13	1.15E-10
PSW	4-2-9	0.00	0.03	90.00	2.34E-03	4.56E-02	2.47E-12	6.82E-11
PSW	4-2-10	0.00	0.03	150.00	2.64E-03	4.82E-02	2.70E-12	4.58E-11
PSW	4-2-11	0.00	0.04	223.00	7.09E-03	5.53E-02	2.06E-11	4.05E-11

LI = 10.8±1.7

TABLE B.6-1c. Iodine-125 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 4-3)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	4-3-1	0.02	0.02	0.08	2.43E-02	2.43E-02	2.18E-08	2.18E-08
PSW	4-3-2	0.00	0.02	0.29	3.76E-03	2.81E-02	6.90E-10	8.31E-09
PSW	4-3-3	0.01	0.03	1.00	1.79E-02	4.60E-02	4.61E-09	6.47E-09
PSW	4-3-4	0.01	0.04	2.00	9.96E-03	5.60E-02	1.77E-09	4.79E-09
PSW	4-3-5	0.00	0.04	3.00	1.92E-03	5.79E-02	1.12E-10	3.41E-09
PSW	4-3-6	0.00	0.04	4.00	2.32E-03	6.02E-02	2.29E-10	2.77E-09
PSW	4-3-7	0.01	0.05	18.00	1.34E-02	7.36E-02	1.09E-10	9.21E-10
PSW	4-3-8	0.01	0.05	48.00	1.03E-02	8.39E-02	4.48E-11	4.48E-10
PSW	4-3-9	0.00	0.06	90.00	2.36E-03	8.63E-02	2.60E-12	2.53E-10
PSW	4-3-10	0.00	0.06	150.00	2.62E-03	8.89E-02	2.75E-12	1.61E-10
PSW	4-3-11	0.00	0.06	223.00	6.72E-03	9.56E-02	1.92E-11	1.25E-10

LI = 9.5±1.2

TABLE B.6-1d. Iodine-125 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 4-6)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	4-6-1	0.00	0.00	0.08	6.64E-05	6.64E-05	3.91E-13	3.91E-13
PSW	4-6-2	0.00	0.00	0.29	7.96E-04	8.61E-04	7.41E-11	1.86E-11
PSW	4-6-3	0.01	0.01	1.00	2.09E-03	2.95E-03	1.51E-10	6.41E-11
PSW	4-6-4	0.00	0.01	2.00	1.13E-03	4.09E-03	5.53E-11	6.15E-11
PSW	4-6-5	0.00	0.01	3.00	4.19E-04	4.50E-03	1.28E-11	4.98E-11
PSW	4-6-6	0.00	0.01	4.00	2.24E-04	4.73E-03	5.17E-12	4.12E-11
PSW	4-6-7	0.01	0.03	18.00	4.32E-03	9.05E-03	2.74E-11	3.35E-11
PSW	4-6-8	0.01	0.03	48.00	2.53E-03	1.16E-02	8.53E-12	2.06E-11
PSW	4-6-9	0.00	0.04	90.00	5.21E-04	1.21E-02	3.05E-13	1.20E-11
PSW	4-6-10	0.00	0.04	150.00	5.91E-04	1.27E-02	3.37E-13	7.91E-12
PSW	4-6-11	0.02	0.06	223.00	7.38E-03	2.01E-02	5.58E-11	1.33E-11

LI = 11.0±1.0

TABLE B.6-2a. Iodine-125 Fraction Leached for Static Leach Test: Whole Grout in Hanford Ground Water (PSW 4-4)

	SAMPLE ID	uCi LEACHED	TIME DAYS	cum An/Ao	D cum.
PSW	4-4-1	0.04	4.00	6.47E-02	3.32E-09
PSW	4-4-2	0.08	19.00	1.22E-01	2.49E-09
PSW	4-4-3	0.13	48.00	1.96E-01	2.53E-09
PSW	4-4-4	0.19	90.00	2.90E-01	2.95E-09
PSW	4-4-5	0.22	150.00	3.44E-01	2.50E-09
PSW	4-4-6	0.41	223.00	6.34E-01	5.71E-09

TABLE B.6-2b. Iodine-125 Fraction Leached for Static Leach Test: Whole Grout in Hanford Ground Water (PSW 4-5)

SAMPLE ID	uCi LEACHED	TIME DAYS	cum An/Ao	D cum.
4-5-1	0.05	4.00	7.98E-02	5.03E-09
4-5-2	0.08	19.00	1.14E-01	2.16E-09
4-5-3	0.09	48.00	1.34E-01	1.16E-09
4-5-4	0.17	90.00	2.62E-01	2.41E-09
4-5-5	0.20	150.00	3.02E-01	1.92E-09
4-5-6	0.39	223.00	5.87E-01	4.69E-09

TABLE B.7-1a. Chromium-51 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 4-1)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	4-1-1	0.06	0.06	0.08	1.97E-01	1.97E-01	1.38E-06	1.38E-06
PSW	4-1-2	0.06	0.11	0.29	1.97E-01	3.93E-01	1.82E-06	1.58E-06
PSW	4-1-3	0.06	0.17	1.00	1.97E-01	5.90E-01	5.38E-07	1.03E-06
PSW	4-1-4	0.06	0.22	2.00	1.97E-01	7.87E-01	6.68E-07	9.15E-07
PSW	4-1-5	0.06	0.28	3.00	1.97E-01	9.84E-01	1.13E-06	9.54E-07
PSW	4-1-6	0.06	0.33	4.00	1.97E-01	1.18E+00	1.60E-06	1.03E-06
PSW	4-1-7	0.06	0.39	18.00	1.97E-01	1.38E+00	2.28E-08	3.12E-07
PSW	4-1-8	0.06	0.45	48.00	1.97E-01	1.58E+00	1.59E-08	1.53E-07
PSW	4-1-9	0.06	0.51	90.00	2.11E-01	1.79E+00	2.02E-08	1.05E-07
PSW	4-1-10	0.06	0.56	150.00	2.09E-01	2.00E+00	1.69E-08	7.84E-08
PSW	4-1-11	0.08	0.65	223.00	2.97E-01	2.29E+00	3.61E-08	6.96E-08

TABLE B.7-1b. Chromium-51 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 4-2)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	4-2-1	0.06	0.06	0.08	1.98E-01	1.98E-01	1.39E-06	1.39E-06
PSW	4-2-2	0.06	0.11	0.29	1.98E-01	3.95E-01	1.84E-06	1.59E-06
PSW	4-2-3	0.06	0.17	1.00	1.98E-01	5.93E-01	5.43E-07	1.04E-06
PSW	4-2-4	0.06	0.23	2.00	1.98E-01	7.91E-01	6.74E-07	9.25E-07
PSW	4-2-5	0.06	0.28	3.00	1.98E-01	9.90E-01	1.15E-06	9.64E-07
PSW	4-2-6	0.06	0.34	4.00	1.99E-01	1.19E+00	1.62E-06	1.04E-06
PSW	4-2-7	0.06	0.39	18.00	1.99E-01	1.39E+00	2.34E-08	3.16E-07
PSW	4-2-8	0.06	0.45	48.00	1.99E-01	1.59E+00	1.63E-08	1.55E-07
PSW	4-2-9	0.06	0.51	90.00	2.03E-01	1.79E+00	1.87E-08	1.05E-07
PSW	4-2-10	0.06	0.57	150.00	2.06E-01	2.00E+00	1.84E-08	7.85E-08
PSW	4-2-11	0.49	1.06	223.00	1.72E+00	3.72E+00	1.22E-06	1.83E-07
	Cr-51							

TABLE B.7-1c. Chromium-51 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 4-6)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	4-6-1	0.06	0.06	0.08	4.47E-02	4.47E-02	1.77E-07	1.77E-07
PSW	4-6-2	0.06	0.11	0.29	4.47E-02	8.94E-02	2.35E-07	2.03E-07
PSW	4-6-3	0.06	0.17	1.00	4.47E-02	1.34E-01	6.91E-08	1.32E-07
PSW	4-6-4	0.06	0.23	2.00	4.47E-02	1.79E-01	8.58E-08	1.18E-07
PSW	4-6-5	0.06	0.28	3.00	4.48E-02	2.24E-01	1.46E-07	1.23E-07
PSW	4-6-6	0.06	0.34	4.00	4.49E-02	2.69E-01	2.07E-07	1.33E-07
PSW	4-6-7	0.06	0.40	18.00	4.49E-02	3.13E-01	2.95E-09	4.02E-08
PSW	4-6-8	0.06	0.46	48.00	4.49E-02	3.58E-01	2.06E-09	1.97E-08
PSW	4-6-9	0.06	0.51	90.00	4.49E-02	4.03E-01	2.27E-09	1.33E-08
PSW	4-6-10	0.06	0.57	150.00	4.65E-02	4.50E-01	2.09E-09	9.93E-09
PSW	4-6-11	0.08	0.66	223.00	6.61E-02	5.16E-01	4.46E-09	8.79E-09

TABLE B.7-2a. Chromium-51 Fraction Leached for Static Leach Test: Whole Grout in Hanford Ground Water (PSW 4-4)

	SAMPLE ID	uCi LEACHED	TIME DAYS	cum An/Ao	D cum.
PSW	4-4-1	5.5018E-02	4.00	1.95E-01	3.02E-08
PSW	4-4-2	5.5018E-02	19.00	1.95E-01	6.35E-09
PSW	4-4-3	5.5018E-02	48.00	1.95E-01	2.51E-09
PSW	4-4-4	5.5018E-02	90.00	1.95E-01	1.34E-09
PSW	4-4-5	5.5018E-02	150.00	1.95E-01	8.05E-10
PSW	4-4-6	5.5018E-02	223.00	1.95E-01	5.41E-10

TABLE B.7-2b. Chromium-51 Fraction Leached for Static Leach Test: Whole Grout in Hanford Ground Water (PSW 4-5)

	SAMPLE ID	uCi LEACHED	TIME DAYS	cum An/Ao	D cum.
PSW	4-5-1	5.5018E-02	4.00	1.90E-01	2.87E-08
PSW	4-5-2	5.5018E-02	19.00	1.90E-01	6.03E-09
PSW	4-5-3	5.5018E-02	48.00	1.90E-01	2.39E-09
PSW	4-5-4	5.5018E-02	90.00	1.90E-01	1.27E-09
PSW	4-5-5	5.5018E-02	150.00	1.90E-01	7.64E-10
PSW	4-5-6	5.5018E-02	223.00	1.90E-01	5.14E-10

TABLE B.8-1a. Lead-210 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 4-1)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	4-1-1	0.04	0.04	0.08	3.69E-02	3.69E-02	4.85E-08	4.85E-08
PSW	4-1-2	0.04	0.07	0.29	3.69E-02	7.38E-02	6.42E-08	5.55E-08
PSW	4-1-3	0.04	0.11	1.00	3.69E-02	1.11E-01	1.89E-08	3.62E-08
PSW	4-1-4	0.04	0.15	2.00	3.69E-02	1.48E-01	2.35E-08	3.22E-08
PSW	4-1-5	0.04	0.19	3.00	3.69E-02	1.85E-01	3.99E-08	3.36E-08
PSW	4-1-6	0.04	0.22	4.00	3.69E-02	2.22E-01	5.61E-08	3.62E-08
PSW	4-1-7	0.04	0.26	18.00	3.69E-02	2.58E-01	8.01E-10	1.10E-08
PSW	4-1-8	0.04	0.30	48.00	3.69E-02	2.95E-01	5.58E-10	5.37E-09
PSW	4-1-9	0.04	0.33	90.00	3.69E-02	3.32E-01	6.15E-10	3.62E-09
PSW	4-1-10	0.04	0.37	150.00	3.69E-02	3.69E-01	5.29E-10	2.68E-09
PSW	4-1-11	0.04	0.41	223.00	3.69E-02	4.06E-01	5.59E-10	2.19E-09

TABLE B.8-1b. Lead-210 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 4-2)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	4-2-1	0.04	0.04	0.08	3.67E-02	3.67E-02	4.80E-08	4.80E-08
PSW	4-2-2	0.04	0.07	0.29	3.67E-02	7.34E-02	6.35E-08	5.49E-08
PSW	4-2-3	0.04	0.11	1.00	3.67E-02	1.10E-01	1.87E-08	3.58E-08
PSW	4-2-4	0.04	0.15	2.00	3.67E-02	1.47E-01	2.32E-08	3.19E-08
PSW	4-2-5	0.04	0.19	3.00	3.67E-02	1.84E-01	3.94E-08	3.32E-08
PSW	4-2-6	0.04	0.22	4.00	3.67E-02	2.20E-01	5.55E-08	3.58E-08
PSW	4-2-7	0.04	0.26	18.00	3.67E-02	2.57E-01	7.92E-10	1.08E-08
PSW	4-2-8	0.04	0.30	48.00	3.67E-02	2.94E-01	5.52E-10	5.31E-09
PSW	4-2-9	0.04	0.33	90.00	3.67E-02	3.30E-01	6.08E-10	3.56E-09
PSW	4-2-10	0.04	0.37	150.00	3.67E-02	3.67E-01	5.23E-10	2.65E-09
PSW	4-2-11	0.05	0.42	223.00	5.00E-02	4.17E-01	1.02E-09	2.31E-09

TABLE B.8-1c. Lead-210 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 4-6)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	4-6-1	0.04	0.04	0.08	8.22E-03	8.22E-03	5.99E-09	5.99E-09
PSW	4-6-2	0.04	0.07	0.29	8.22E-03	1.64E-02	7.93E-09	6.86E-09
PSW	4-6-3	0.04	0.11	1.00	8.22E-03	2.47E-02	2.34E-09	4.48E-09
PSW	4-6-4	0.04	0.15	2.00	8.22E-03	3.29E-02	2.90E-09	3.98E-09
PSW	4-6-5	0.04	0.19	3.00	8.22E-03	4.11E-02	4.92E-09	4.14E-09
PSW	4-6-6	0.04	0.22	4.00	8.22E-03	4.93E-02	6.93E-09	4.48E-09
PSW	4-6-7	0.04	0.26	18.00	8.22E-03	5.75E-02	9.89E-11	1.35E-09
PSW	4-6-8	0.04	0.30	48.00	8.22E-03	6.58E-02	6.90E-11	6.63E-10
PSW	4-6-9	0.04	0.33	90.00	8.22E-03	7.40E-02	7.60E-11	4.48E-10
PSW	4-6-10	0.04	0.37	150.00	8.22E-03	8.22E-02	6.53E-11	3.32E-10

TABLE B.8-2a. Lead-210 Fraction Leached for Static Leach Test: Whole Grout in Hanford Ground Water (PSW 4-5)

	SAMPLE ID	uCi LEACHED	TIME DAYS	cum An/Ao	D cum.
PSW	4-5-1	3.6089E-02	4.00	3.52E-02	9.81E-10
PSW	4-5-2	3.6089E-02	19.00	3.52E-02	2.06E-10
PSW	4-5-3	3.6089E-02	48.00	3.52E-02	8.17E-11
PSW	4-5-4	3.6089E-02	90.00	3.52E-02	4.36E-11
PSW	4-5-5	3.6089E-02	150.00	3.52E-02	2.61E-11

TABLE B.8-2b. Lead-210 Fraction Leached for Static Leach Test: Whole Grout in Hanford Ground Water (PSW 4-4)

	SAMPLE ID	uCi LEACHED	TIME DAYS	cum An/Ao	D cum.
PSW	4-4-1	3.6089E-02	4.00	3.61E-02	1.03E-09
PSW	4-4-2	3.6089E-02	19.00	3.61E-02	2.17E-10
PSW	4-4-3	3.6089E-02	48.00	3.61E-02	8.61E-11
PSW	4-4-4	3.6089E-02	90.00	3.61E-02	4.59E-11
PSW	4-4-5	3.6089E-02	150.00	3.61E-02	2.75E-11

TABLE B.9-1a. Iodine-125 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 5-1)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	5-1-1	0.17	0.17	0.08	2.77E-02	2.77E-02	2.76E-08	2.76E-08
PSW	5-1-2	0.03	0.20	0.29	4.37E-03	3.21E-02	9.09E-10	1.06E-08
PSW	5-1-3	0.00	0.20	1.00	7.76E-05	3.22E-02	8.44E-14	3.09E-09
PSW	5-1-4	0.00	0.21	2.00	5.67E-04	3.27E-02	5.60E-12	1.60E-09
PSW	5-1-5	0.05	0.25	3.00	7.36E-03	4.01E-02	1.60E-09	1.60E-09
PSW	5-1-6	0.02	0.27	4.00	2.64E-03	4.27E-02	2.90E-10	1.36E-09
PSW	5-1-7	0.13	0.40	18.00	2.10E-02	6.38E-02	2.63E-10	8.75E-10
PSW	5-1-8	0.09	0.49	48.00	1.41E-02	7.78E-02	8.19E-11	3.77E-10
PSW	5-1-9	0.05	0.54	90.00	7.59E-03	8.54E-02	2.63E-11	2.42E-10
PSW	5-1-10	0.05	0.58	150.00	7.28E-03	9.27E-02	2.08E-11	1.71E-10
PSW	5-1-11	0.06	0.64	223.00	8.87E-03	1.02E-01	3.25E-11	1.38E-10

LI = 9.9±1.8

TABLE B.9-1b. Iodine-125 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 5-2)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	5-2-1	0.25	0.25	0.08	4.00E-02	4.00E-02	5.74E-08	5.74E-08
PSW	5-2-2	0.04	0.29	0.29	6.38E-03	4.63E-02	1.94E-09	2.21E-08
PSW	5-2-3	0.12	0.41	1.00	1.89E-02	6.52E-02	5.01E-09	1.27E-08
PSW	5-2-4	0.03	0.43	2.00	3.98E-03	6.92E-02	2.76E-10	7.15E-09
PSW	5-2-5	0.00	0.44	3.00	5.93E-05	6.93E-02	1.04E-13	4.78E-09
PSW	5-2-6	0.01	0.44	4.00	1.49E-03	7.08E-02	9.22E-11	3.74E-09
PSW	5-2-7	0.11	0.56	18.00	1.82E-02	8.90E-02	1.97E-10	1.31E-09
PSW	5-2-8	0.06	0.62	48.00	9.78E-03	9.88E-02	3.94E-11	6.07E-10
PSW	5-2-9	0.00	0.62	90.00	4.43E-04	9.92E-02	6.98E-14	3.28E-10
PSW	5-2-10	0.01	0.64	150.00	2.24E-03	1.01E-01	1.96E-12	2.05E-10
PSW	5-2-11	0.00	0.64	223.00	7.27E-04	1.02E-01	2.19E-13	1.40E-10

LI = 10.0±2.0

TABLE B.9-1c. Iodine-125 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 5-3)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	5-3-1	0.17	0.17	0.08	2.68E-02	2.68E-02	2.57E-08	2.57E-08
PSW	5-3-2	0.03	0.20	0.29	4.61E-03	3.14E-02	1.01E-09	1.01E-08
PSW	5-3-3	0.09	0.29	1.00	1.39E-02	4.53E-02	2.73E-09	6.13E-09
PSW	5-3-4	0.04	0.33	2.00	6.14E-03	5.14E-02	6.56E-10	3.95E-09
PSW	5-3-5	0.02	0.34	3.00	2.78E-03	5.42E-02	2.26E-10	2.92E-09
PSW	5-3-6	0.01	0.36	4.00	2.02E-03	5.62E-02	1.70E-10	2.36E-09
PSW	5-3-7	0.06	0.41	18.00	9.24E-03	6.55E-02	5.07E-11	7.11E-10
PSW	5-3-8	0.05	0.46	48.00	7.95E-03	7.34E-02	2.62E-11	3.35E-10
PSW	5-3-9	0.04	0.50	90.00	5.81E-03	7.92E-02	1.54E-11	2.08E-10
PSW	5-3-10	0.01	0.51	150.00	1.17E-03	8.04E-02	5.33E-13	1.29E-10
PSW	5-3-11	0.00	0.51	223.00	8.45E-05	8.05E-02	1.72E-15	8.66E-11

LI = 9.5±1.0

TABLE B.9-1d. Iodine-125 Fraction Leached for ANS 16.1 Leach Test: Whole, Large Grout in Hanford Ground Water (PSW 5-6)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	5-6-1	0.15	0.15	0.08	4.78E-03	4.78E-03	2.03E-09	2.03E-09
PSW	5-6-2	0.03	0.18	0.29	1.01E-03	5.79E-03	1.20E-10	8.52E-10
PSW	5-6-3	0.12	0.30	1.00	3.79E-03	9.59E-03	4.98E-10	6.77E-10
PSW	5-6-4	0.04	0.34	2.00	1.17E-03	1.08E-02	5.91E-11	4.28E-10
PSW	5-6-5	0.03	0.37	3.00	6.28E-04	1.16E-02	5.00E-11	3.30E-10
PSW	5-6-6	0.02	0.38	4.00	5.75E-04	1.22E-02	3.40E-11	2.72E-10
PSW	5-6-7	0.10	0.49	18.00	3.30E-03	1.55E-02	1.60E-11	9.79E-11
PSW	5-6-8	0.06	0.54	48.00	1.83E-03	1.73E-02	3.41E-12	4.59E-11
PSW	5-6-9	0.02	0.57	90.00	7.07E-04	1.80E-02	5.87E-13	2.68E-11
PSW	5-6-10	0.03	0.60	150.00	1.02E-03	1.90E-02	9.66E-13	1.78E-11
PSW	5-6-11	0.03	0.63	223.00	1.00E-03	2.00E-02	1.03E-12	1.32E-11

LI = 10.4±1.1

TABLE B.9-2a. Iodine-125 Fraction Leached for Static Leach Test: Whole Grout in Hanford Ground Water (PSW 5-4)

	SAMPLE ID	uCi LEACHED	TIME DAYS	cum An/Ao	D cum.
PSW	5-4-1	0.00	4.00	5.53E-05	2.34E-15
PSW	5-4-2	0.00	19.00	5.99E-05	5.78E-16
PSW	5-4-3	0.82	48.00	9.49E-02	5.74E-10
PSW	5-4-4	1.26	90.00	1.93E-01	1.27E-09
PSW	5-4-5	1.47	150.00	2.25E-01	1.03E-09
PSW	5-4-6	2.37	223.00	3.64E-01	1.81E-09

TABLE B.9-2b. Iodine-125 Fraction Leached for Static Leach Test: Whole Grout in Hanford Ground Water (PSW 5-5)

	SAMPLE ID	uCi LEACHED	TIME DAYS	cum An/Ao	D cum.
PSW	5-5-1	0.53	4.00	8.36E-02	5.15E-09
PSW	5-5-2	0.78	19.00	1.25E-01	2.41E-09
PSW	5-5-3	1.15	48.00	1.83E-01	2.06E-09
PSW	5-5-4	1.83	90.00	2.92E-01	2.79E-09
PSW	5-5-5	2.14	150.00	3.40E-01	2.28E-09
PSW	5-5-6	3.88	223.00	6.18E-01	5.06E-09

TABLE B.10-1a. Chromium-51 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 5-1)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	5-1-1	0.06	0.06	0.08	1.94E-02	1.94E-02	1.36E-08	1.36E-08
PSW	5-1-2	0.06	0.11	0.29	1.94E-02	3.89E-02	1.80E-08	1.56E-08
PSW	5-1-3	0.06	0.17	1.00	1.94E-02	5.83E-02	5.30E-09	1.01E-08
PSW	5-1-4	0.06	0.22	2.00	1.94E-02	7.77E-02	6.57E-09	9.02E-09
PSW	5-1-5	0.06	0.28	3.00	1.94E-02	9.72E-02	1.12E-08	9.40E-09
PSW	5-1-6	0.06	0.33	4.00	1.94E-02	1.17E-01	1.57E-08	1.01E-08
PSW	5-1-7	0.06	0.39	18.00	1.94E-02	1.36E-01	2.24E-10	3.07E-09
PSW	5-1-8	0.06	0.44	48.00	1.94E-02	1.55E-01	1.57E-10	1.50E-09
PSW	5-1-9	0.06	0.50	90.00	1.95E-02	1.75E-01	1.73E-10	1.02E-09
PSW	5-1-10	0.06	0.55	150.00	1.96E-02	1.95E-01	1.50E-10	7.53E-10
PSW	5-1-11	0.11	0.66	223.00	3.76E-02	2.32E-01	5.86E-10	7.21E-10

TABLE B.10-1b. Chromium-51 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 5-2)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	5-2-1	0.06	0.06	0.08	1.95E-02	1.95E-02	1.37E-08	1.37E-08
PSW	5-2-2	0.06	0.11	0.29	1.95E-02	3.90E-02	1.81E-08	1.56E-08
PSW	5-2-3	0.06	0.17	1.00	1.95E-02	5.85E-02	5.33E-09	1.02E-08
PSW	5-2-4	0.06	0.22	2.00	1.95E-02	7.80E-02	6.61E-09	9.07E-09
PSW	5-2-5	0.06	0.28	3.00	1.95E-02	9.75E-02	1.12E-08	9.45E-09
PSW	5-2-6	0.06	0.33	4.00	1.95E-02	1.17E-01	1.58E-08	1.02E-08
PSW	5-2-7	0.06	0.39	18.00	1.95E-02	1.36E-01	2.25E-10	3.09E-09
PSW	5-2-8	0.06	0.44	48.00	1.95E-02	1.56E-01	1.57E-10	1.51E-09
PSW	5-2-9	0.06	0.50	90.00	1.96E-02	1.76E-01	1.75E-10	1.02E-09
PSW	5-2-10	0.06	0.55	150.00	1.98E-02	1.95E-01	1.51E-10	7.58E-10
PSW	5-2-11	0.11	0.66	223.00	3.78E-02	2.33E-01	5.90E-10	7.26E-10

TABLE B.10-1c. Chromium-51 Fraction Leached for ANS 16.1 Leach Test: Whole, Large Grout in Hanford Ground Water (PSW 5-6)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	5-6-1	0.06	0.06	0.08	4.62E-03	4.62E-03	1.89E-09	1.89E-09
PSW	5-6-2	0.06	0.11	0.29	4.62E-03	9.24E-03	2.51E-09	2.17E-09
PSW	5-6-3	0.06	0.17	1.00	4.62E-03	1.39E-02	7.38E-10	1.41E-09
PSW	5-6-4	0.06	0.22	2.00	4.62E-03	1.85E-02	9.17E-10	1.26E-09
PSW	5-6-5	0.06	0.28	3.00	4.62E-03	2.31E-02	1.56E-09	1.31E-09
PSW	5-6-6	0.06	0.33	4.00	4.62E-03	2.77E-02	2.19E-09	1.42E-09
PSW	5-6-7	0.06	0.39	18.00	4.62E-03	3.23E-02	3.13E-11	4.28E-10
PSW	5-6-8	0.06	0.44	48.00	4.62E-03	3.70E-02	2.18E-11	2.10E-10
PSW	5-6-9	0.06	0.50	90.00	4.62E-03	4.16E-02	2.40E-11	1.42E-10
PSW	5-6-10	0.06	0.55	150.00	4.64E-03	4.62E-02	2.06E-11	1.05E-10
PSW	5-6-11	0.06	0.61	223.00	4.60E-03	5.08E-02	2.16E-11	8.54E-11

TABLE B.10-2a. Chromium-51 Fraction Leached for Static Leach Test: Whole Grout in Hanford Ground Water (PSW 5-4)

	SAMPLE ID	uCi LEACHED	TIME DAYS	cum An/Ao	D cum.
PSW	5-4-1	0.06	4.00	1.88E-02	2.70E-10
PSW	5-4-2	0.06	19.00	1.88E-02	5.88E-11
PSW	5-4-3	0.06	48.00	1.88E-02	2.25E-11
PSW	5-4-4	0.06	90.00	1.88E-02	1.20E-11
PSW	5-4-5	0.06	150.00	1.88E-02	7.19E-12
PSW	5-4-6	0.06	223.00	1.88E-02	4.84E-12

TABLE B.10-2b. Chromium-51 Fraction Leached for Static Leach Test: Whole Grout in Hanford Ground Water (PSW 5-5)

	SAMPLE ID	uCi LEACHED	TIME DAYS	cum An/Ao	D cum.
PSW	5-5-1	0.06	4.00	1.95E-02	2.80E-10
PSW	5-5-2	0.06	19.00	1.95E-02	5.89E-11
PSW	5-5-3	0.06	48.00	1.95E-02	2.33E-11
PSW	5-5-4	0.06	90.00	1.95E-02	1.24E-11
PSW	5-5-5	0.06	150.00	1.95E-02	7.47E-12
PSW	5-5-6	0.06	223.00	1.95E-02	5.02E-12

TABLE B.11-a. Sodium Fraction Leached from ANS 16.1 Leach Test: Whole, Small Grout in Hanford Ground Water (PSW A5-1)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum. (<0.2)
PSWA 5-1-1	1.94E+01	3.12E-02	3.12E-02	8.33E-02	3.57E-08	3.57E-08
PSWA 5-1-2	3.84E+00	6.18E-03	3.74E-02	2.90E-01	1.87E-09	1.47E-08
PSWA 5-1-3	1.69E+01	2.72E-02	6.46E-02	1.00E+00	1.07E-08	1.28E-08
PSWA 5-1-4	1.23E+01	1.98E-02	8.44E-02	2.00E+00	6.99E-09	1.09E-08
PSWA 5-1-5	7.86E+00	1.27E-02	9.71E-02	3.00E+00	4.85E-09	9.61E-09
PSWA 5-1-6	5.46E+00	8.79E-03	1.06E-01	4.00E+00	3.29E-09	8.67E-09
PSWA 5-1-7	4.00E+01	6.44E-02	1.70E-01	1.80E+01	2.52E-09	4.93E-09
PSWA 5-1-8	4.98E+01	8.02E-02	2.50E-01	4.70E+01	2.88E-09	4.46E-09
PSWA 5-1-9	2.81E+01	4.52E-02	2.96E-01	9.00E+01	9.03E-10	3.50E-09
PSWA 5-1-10	1.87E+01	3.01E-02	3.26E-01	1.50E+02	3.64E-10	2.60E-09
PSWA 5-1-11	1.08E+01	1.74E-02	3.43E-01	2.10E+02	1.84E-10	1.99E-09

TABLE B.11-b. Potassium Fraction Leached from ANS 16.1 Leach Test: Whole, Small Grout in Hanford Ground Water (PSW A5-1)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum. (<0.2)
PSWA 5-1-1	2.58E+00	2.15E-02	2.15E-02	8.33E-02	1.69E-08	1.69E-08
PSWA 5-1-2	8.40E-01	6.99E-03	2.85E-02	2.90E-01	2.39E-09	8.54E-09
PSWA 5-1-3	2.22E+00	1.85E-02	4.69E-02	1.00E+00	4.90E-09	6.73E-09
PSWA 5-1-4	1.62E+00	1.35E-02	6.04E-02	2.00E+00	3.24E-09	5.58E-09
PSWA 5-1-5	8.40E-01	6.99E-03	6.74E-02	3.00E+00	1.48E-09	4.83E-09
PSWA 5-1-6	3.60E-01	3.00E-03	7.04E-02	4.00E+00	3.82E-10	3.79E-09
PSWA 5-1-7	4.80E+00	3.99E-02	1.10E-01	1.80E+01	9.70E-10	2.07E-09
PSWA 5-1-8	4.80E+00	3.99E-02	1.50E-01	4.70E+01	7.14E-10	1.47E-09
PSWA 5-1-9	2.88E+00	2.40E-02	1.74E-01	9.00E+01	2.54E-10	1.03E-09
PSWA 5-1-10	2.22E+00	1.85E-02	1.93E-01	1.50E+02	1.37E-10	7.57E-10
PSWA 5-1-11	1.20E+00	9.98E-03	2.03E-01	2.10E+02	6.05E-11	5.98E-10

TABLE B.11-c. Boron (as H_3BO_3) Fraction Leached from ANS 16.1 Leach Test: Whole, Small Grout in Hanford Ground Water (PSW 2-1)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum. (<0.2)
PSWA 5-1-1	2.34E-01	1.76E-03	1.76E-03	8.33E-02	1.14E-10	1.14E-10
PSWA 5-1-2	3.00E-02	2.26E-04	1.99E-03	2.90E-01	2.50E-12	4.18E-11
PSWA 5-1-3	1.62E-01	1.22E-03	3.21E-03	1.00E+00	2.14E-11	3.15E-11
PSWA 5-1-4	7.80E-02	5.88E-04	3.80E-03	2.00E+00	6.16E-12	2.21E-11
PSWA 5-1-5	4.20E-02	3.17E-04	4.12E-03	3.00E+00	3.03E-12	1.73E-11
PSWA 5-1-6	2.40E-02	1.81E-04	4.30E-03	4.00E+00	1.39E-12	1.41E-11
PSWA 5-1-7	2.22E-01	1.67E-03	5.97E-03	1.80E+01	1.70E-12	6.05E-12
PSWA 5-1-8	1.98E-01	1.49E-03	7.46E-03	4.70E+01	9.98E-13	3.62E-12
PSWA 5-1-9	6.60E-02	4.97E-04	7.96E-03	9.00E+01	1.09E-13	2.15E-12
PSWA 5-1-10	-2.46E-01	-1.85E-03	6.11E-03	1.50E+02	1.38E-12	7.60E-13
PSWA 5-1-11	6.00E-03	4.52E-05	6.15E-03	2.10E+02	1.24E-15	5.51E-13

TABLE B.11-d. Sulfate (SO_4) Fraction Leached From ANS 16.1 Leach Test: Whole, Small Grout in Hanford Ground Water (PSW A5-1)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum. (<0.2)
PSWA 5-1-1	2.40E+00	5.63E-03	5.63E-03	8.33E-02	1.16E-09	1.16E-09
PSWA 5-1-2	4.80E+00	1.13E-02	1.69E-02	2.90E-01	6.22E-09	3.01E-09
PSWA 5-1-3	3.60E+00	8.45E-03	2.54E-02	1.00E+00	1.03E-09	1.97E-09
PSWA 5-1-4	6.00E+00	1.41E-02	3.94E-02	2.00E+00	3.54E-09	2.38E-09
PSWA 5-1-5	7.20E+00	1.69E-02	5.63E-02	3.00E+00	8.65E-09	3.24E-09
PSWA 5-1-6	4.80E+00	1.13E-02	6.76E-02	4.00E+00	5.41E-09	3.49E-09
PSWA 5-1-7	-6.00E-01	-1.41E-03	6.62E-02	1.80E+01	1.21E-12	7.44E-10
PSWA 5-1-8	-6.00E-01	-1.41E-03	6.48E-02	4.70E+01	6.86E-13	2.73E-10
PSWA 5-1-9	1.80E+00	4.23E-03	6.90E-02	9.00E+01	7.89E-12	1.62E-10
PSWA 5-1-10	-1.56E+00	-3.66E-03	6.54E-02	1.50E+02	5.38E-12	8.71E-11
PSWA 5-1-11	2.40E+00	5.63E-03	7.10E-02	2.10E+02	1.93E-11	7.34E-11

TABLE B.12-a. Sodium Fraction Leached from Static Leach Test: Whole, Small Grout in Ground Water (PSW S5-4)

SAMPLE	mg LEACHED	cum. An/Ao	TIME days	D cum. ((0.2)
PSWS 5-4-1	6.84E+01	1.07E-01	4.00E+00	8.69E-09
PSWS 5-4-2	1.16E+02	1.80E-01	1.80E+01	5.50E-09
PSWS 5-4-3	1.52E+02	2.37E-01	4.80E+01	4.02E-09
PSWS 5-4-4	2.08E+02	3.23E-01	9.00E+01	4.04E-09
PSWS 5-4-5	2.14E+02	3.34E-01	1.50E+02	2.60E-09
PSWS 5-4-6	2.14E+02	3.34E-01	2.23E+02	1.75E-09

TABLE B.12-b. Potassium Fraction Leached from Static Leach Test: Whole, Small Grout in Ground Water (PSW S5-4)

SAMPLE	mg LEACHED	cum. An/Ao	TIME days	D cum. ((0.2)
PSWS 5-4-1	6.96E+00	5.61E-02	4.00E+00	2.40E-09
PSWS 5-4-2	1.19E+01	9.55E-02	1.80E+01	1.55E-09
PSWS 5-4-3	1.47E+01	1.19E-01	4.80E+01	8.95E-10
PSWS 5-4-4	2.15E+01	1.73E-01	9.00E+01	1.01E-09
PSWS 5-4-5	2.40E+01	1.93E-01	1.50E+02	7.61E-10
PSWS 5-4-6	2.43E+01	1.96E-01	2.23E+02	5.25E-10

TABLE B.12-c. Aluminum Fraction Leached from Static Leach Test: Whole, Small Grout in Ground Water (PSW S5-4)

SAMPLE	mg LEACHED	cum. An/Ao	TIME days	D cum. ((0.2)
PSWS 5-4-1	4.81E-01	2.97E-04	4.00E+00	6.72E-14
PSWS 5-4-2	1.64E+00	1.01E-03	1.80E+01	1.73E-13
PSWS 5-4-3	2.23E+00	1.37E-03	4.80E+01	1.20E-13
PSWS 5-4-4	3.01E+00	1.86E-03	9.00E+01	1.17E-13
PSWS 5-4-5	1.57E+00	9.67E-04	1.50E+02	1.91E-14
PSWS 5-4-6	4.32E+00	2.66E-03	2.23E+02	9.73E-14

TABLE B.12-d. Nitrate (NO_3) Fraction Leached from Static Leach Test: Whole, Small Grout in Ground Water (PSW S5-4)

SAMPLE	mg LEACHED	cum. An/Ao	TIME days	D cum. ((0.2)
PSWS 5-4-1	0.00E+00	0.00E+00	4.00E+00	0.00E+00
PSWS 5-4-2	0.00E+00	0.00E+00	1.80E+01	0.00E+00
PSWS 5-4-3	1.62E+00	1.49E-01	4.80E+01	1.42E-09
PSWS 5-4-4	1.94E+00	1.78E-01	9.00E+01	1.08E-09
PSWS 5-4-5	2.33E+00	2.14E-01	1.50E+02	9.64E-10
PSWS 5-4-6	2.98E+00	2.75E-01	2.23E+02	1.21E-09

TABLE B.12-e. Sulfate (SO_4) Fraction Leached from Static Leach Test: Whole, Small Grout in Ground Water (PSW S5-4)

SAMPLE	mg LEACHED	cum. An/Ao	TIME days	D cum. (<0.2)
PSWS 5-4-1	4.80E+00	1.09E-02	4.00E+00	9.09E-11
PSWS 5-4-2	1.60E+00	3.64E-03	1.80E+01	2.25E-12
PSWS 5-4-3	-6.10E+00	-1.39E-02	4.80E+01	1.22E-11
PSWS 5-4-4	-3.65E+00	-8.29E-03	9.00E+01	2.34E-12
PSWS 5-4-5	-7.37E+00	-1.67E-02	1.50E+02	5.72E-12
PSWS 5-4-6	8.50E-01	1.93E-03	2.23E+02	5.12E-14

TABLE B.12-f. Boron (as H_3BO_3) Fraction Leached from Static Leach Test: Whole, Small Grout in Ground Water (PSW S5-4)

SAMPLE	mg LEACHED	cum. An/Ao	TIME days	D cum. (<0.2)
PSWS 5-4-1	6.72E-01	4.90E-03	4.00E+00	1.90E-11
PSWS 5-4-2	9.74E-01	7.11E-03	1.80E+01	8.88E-12
PSWS 5-4-3	1.13E+00	8.23E-03	4.80E+01	4.47E-12
PSWS 5-4-4	1.57E+00	1.15E-02	9.00E+01	4.62E-12
PSWS 5-4-5	1.83E+00	1.33E-02	1.50E+02	3.76E-12
PSWS 5-4-6	2.09E+00	1.52E-02	2.23E+02	3.29E-12

TABLE B.13-1a. Technetium-99 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 6-1)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	6-1-1	0.02	0.02	0.08	1.06E-02	1.06E-02	4.27E-09	4.27E-09
PSW	6-1-2	0.00	0.03	0.29	1.22E-03	1.18E-02	7.50E-11	1.52E-09
PSW	6-1-3	0.01	0.03	1.00	2.38E-03	1.42E-02	8.45E-11	6.38E-10
PSW	6-1-4	0.00	0.03	2.00	7.50E-04	1.49E-02	1.04E-11	3.53E-10
PSW	6-1-5	0.00	0.03	3.00	2.59E-04	1.52E-02	2.10E-12	2.43E-10
PSW	6-1-6	0.00	0.04	4.00	9.47E-04	1.61E-02	3.96E-11	2.06E-10
PSW	6-1-7	0.00	0.04	18.00	1.83E-03	1.80E-02	2.11E-12	5.68E-11
PSW	6-1-8	0.00	0.04	47.00	1.12E-03	1.91E-02	5.84E-13	2.45E-11
PSW	6-1-9	0.01	0.05	90.00	3.01E-03	2.21E-02	4.13E-12	1.72E-11
PSW	6-1-10	0.00	0.05	150.00	1.27E-04	2.22E-02	6.72E-15	1.04E-11
PSW	6-1-11	0.00	0.05	206.00	4.82E-04	2.27E-02	1.55E-13	7.85E-12

LI = 10.6±1.2

TABLE B.13-1b. Technetium-99 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 6-2)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	6-2-1	0.04	0.04	0.08	1.85E-02	1.85E-02	1.30E-08	1.30E-08
PSW	6-2-2	0.00	0.04	0.29	3.74E-04	1.89E-02	7.04E-12	3.88E-09
PSW	6-2-3	0.00	0.04	1.00	1.44E-03	2.03E-02	3.09E-11	1.30E-09
PSW	6-2-4	0.00	0.05	2.00	1.54E-03	2.18E-02	4.37E-11	7.55E-10
PSW	6-2-5	0.00	0.05	3.00	1.81E-03	2.36E-02	8.07E-11	6.00E-10
PSW	6-2-6	0.00	0.05	4.00	5.03E-04	2.40E-02	1.11E-11	4.54E-10
PSW	6-2-7	0.01	0.06	18.00	3.77E-03	2.77E-02	6.93E-12	1.35E-10
PSW	6-2-8	0.02	0.08	47.00	7.27E-03	3.50E-02	2.45E-11	8.24E-11
PSW	6-2-9	0.00	0.08	90.00	2.10E-04	3.52E-02	2.01E-14	4.36E-11
PSW	6-2-10	0.00	0.08	150.00	5.33E-04	3.57E-02	1.18E-13	2.69E-11
PSW	6-2-11	0.00	0.08	208.00	7.26E-04	3.65E-02	3.52E-13	2.02E-11

LI = 10.7±1.5

TABLE B.13-1c. Technetium-99 Fraction Leached for ANS 16.1 Leach Test: Whole, Large Grout in Hanford Ground Water (PSW 6-6)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	6-6-1	0.09	0.09	0.08	9.83E-03	9.83E-03	6.77E-09	6.77E-09
PSW	6-6-2	0.02	0.12	0.29	2.52E-03	1.24E-02	7.63E-10	3.96E-09
PSW	6-6-3	0.04	0.16	1.00	4.24E-03	1.66E-02	6.34E-10	2.07E-09
PSW	6-6-4	0.02	0.18	2.00	1.89E-03	1.85E-02	1.57E-10	1.29E-09
PSW	6-6-5	0.02	0.19	3.00	1.74E-03	2.02E-02	2.25E-10	1.03E-09
PSW	6-6-6	0.01	0.20	4.00	1.36E-03	2.16E-02	1.95E-10	8.76E-10
PSW	6-6-7	0.10	0.30	18.00	1.02E-02	3.18E-02	1.57E-10	4.24E-10
PSW	6-6-8	0.05	0.35	47.00	5.14E-03	3.70E-02	2.92E-11	2.19E-10
PSW	6-6-9	0.03	0.38	90.00	3.42E-03	4.04E-02	1.27E-11	1.36E-10
PSW	6-6-10	0.03	0.41	150.00	2.71E-03	4.31E-02	7.25E-12	9.32E-11
PSW	6-6-11	0.02	0.43	206.00	1.86E-03	4.50E-02	5.50E-12	7.32E-11

LI = 9.6±0.8

TABLE B.13-2a. Technetium-99 Fraction Leached for Static Leach Test: Whole Grout in Hanford Ground Water (PSW 6-4)

	SAMPLE ID	uCi LEACHED	TIME DAYS	cum An/Ao	D cum.
PSW	6-4-1	0.04	4.00	1.66E-02	2.25E-10
PSW	6-4-2	0.05	18.00	2.06E-02	7.72E-11
PSW	6-4-3	0.06	47.00	2.51E-02	4.39E-11
PSW	6-4-4	0.07	96.00	3.03E-02	3.33E-11
PSW	6-4-5	0.08	150.00	3.50E-02	2.68E-11
PSW	6-4-6	0.09	208.00	3.89E-02	2.38E-11

TABLE B.13-2b. Technetium-99 Fraction Leached for Static Leach Test: Whole Grout in Hanford Ground Water (PSW 6-5)

	SAMPLE ID	uCi LEACHED	TIME DAYS	cum An/Ao	D cum.
PSW	6-5-1	0.04	4.00	2.03E-02	3.37E-10
PSW	6-5-2	0.05	18.00	2.16E-02	8.52E-11
PSW	6-5-3	0.08	47.00	3.75E-02	9.80E-11
PSW	6-5-4	0.08	96.00	3.96E-02	5.71E-11
PSW	6-5-5	0.09	150.00	4.43E-02	4.28E-11
PSW	6-5-6	0.10	208.00	4.80E-02	3.63E-11

TABLE B.14-1a. Technetium-99 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 7-1)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	7-1-1	0.14	0.14	0.08	3.07E-02	3.07E-02	3.71E-08	3.71E-08
PSW	7-1-2	0.00	0.14	0.29	8.11E-05	3.08E-02	1.95E-13	1.07E-08
PSW	7-1-3	0.01	0.16	1.00	3.24E-03	3.40E-02	1.62E-10	3.78E-09
PSW	7-1-4	0.01	0.17	2.00	2.50E-03	3.65E-02	1.19E-10	2.18E-09
PSW	7-1-5	0.01	0.18	3.00	2.35E-03	3.88E-02	1.79E-10	1.65E-09
PSW	7-1-6	0.01	0.18	4.00	1.63E-03	4.05E-02	1.21E-10	1.34E-09
PSW	7-1-7	0.04	0.23	18.00	9.08E-03	4.95E-02	5.35E-11	4.48E-10
PSW	7-1-8	0.03	0.26	47.00	7.10E-03	5.66E-02	2.42E-11	2.23E-10
PSW	7-1-9	0.01	0.27	90.00	2.71E-03	5.94E-02	3.48E-12	1.28E-10
PSW	7-1-10	0.00	0.28	150.00	8.64E-04	6.02E-02	3.21E-13	7.91E-11
PSW	7-1-11	0.00	0.28	208.00	5.18E-04	6.07E-02	1.88E-13	5.60E-11

LI = 10.2±1.4

TABLE B.14-1b. Technetium-99 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 7-2)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	7-2-1	0.08	0.08	0.08	1.68E-02	1.68E-02	1.01E-08	1.01E-08
PSW	7-2-2	0.00	0.08	0.29	8.03E-04	1.76E-02	3.04E-11	3.17E-09
PSW	7-2-3	0.01	0.09	1.00	1.50E-03	1.91E-02	3.10E-11	1.08E-09
PSW	7-2-4	0.01	0.10	2.00	1.86E-03	2.10E-02	5.96E-11	6.50E-10
PSW	7-2-5	0.01	0.11	3.00	1.13E-03	2.21E-02	3.74E-11	4.82E-10
PSW	7-2-6	0.00	0.11	4.00	8.79E-04	2.30E-02	3.18E-11	3.90E-10
PSW	7-2-7	0.02	0.13	18.00	4.55E-03	2.75E-02	1.21E-11	1.24E-10
PSW	7-2-8	0.02	0.15	47.00	3.52E-03	3.11E-02	5.35E-12	6.06E-11
PSW	7-2-9	0.01	0.16	90.00	2.85E-03	3.39E-02	3.47E-12	3.77E-11
PSW	7-2-10	0.01	0.17	150.00	1.94E-03	3.59E-02	1.46E-12	2.53E-11
PSW	7-2-11	0.01	0.18	208.00	1.14E-03	3.70E-02	8.15E-13	1.94E-11

LI = 10.4±1.0

TABLE B.14-1c. Technetium-99 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 7-3)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	7-3-1	0.04	0.04	0.08	9.32E-03	9.32E-03	3.20E-09	3.20E-09
PSW	7-3-2	0.01	0.05	0.29	1.71E-03	1.10E-02	1.42E-10	1.28E-09
PSW	7-3-3	0.02	0.07	1.00	3.28E-03	1.43E-02	1.55E-10	6.26E-10
PSW	7-3-4	0.01	0.07	2.00	1.64E-03	1.60E-02	4.82E-11	3.89E-10
PSW	7-3-5	0.01	0.08	3.00	1.08E-03	1.70E-02	3.51E-11	2.96E-10
PSW	7-3-6	0.00	0.08	4.00	5.81E-04	1.76E-02	1.44E-11	2.37E-10
PSW	7-3-7	0.01	0.10	18.00	3.07E-03	2.07E-02	5.73E-12	7.27E-11
PSW	7-3-8	0.01	0.10	47.00	1.15E-03	2.18E-02	5.96E-13	3.10E-11
PSW	7-3-9	0.00	0.10	90.00	6.15E-05	2.19E-02	1.67E-15	1.63E-11
PSW	7-3-10	0.00	0.10	150.00	5.97E-05	2.20E-02	1.43E-15	9.83E-12
PSW	7-3-11	0.00	0.10	208.00	3.91E-04	2.23E-02	9.89E-14	7.34E-12

LI = 10.9±1.8

TABLE B.14-1d. Technetium-99 Fraction Leached for ANS 16.1 Leach Test: Whole, Large Grout in Hanford Ground Water (PSW 7-6)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	7-6-1	0.11	0.11	0.08	4.97E-03	4.97E-03	2.34E-09	2.34E-09
PSW	7-6-2	0.00	0.11	0.29	3.41E-05	5.00E-03	1.46E-13	6.78E-10
PSW	7-6-3	0.12	0.23	1.00	5.74E-03	1.07E-02	1.21E-09	9.07E-10
PSW	7-6-4	0.07	0.30	2.00	3.14E-03	1.39E-02	4.53E-10	7.57E-10
PSW	7-6-5	0.06	0.36	3.00	2.89E-03	1.68E-02	6.50E-10	7.37E-10
PSW	7-6-6	0.04	0.40	4.00	1.89E-03	1.87E-02	3.93E-10	6.85E-10
PSW	7-6-7	0.23	0.63	18.00	1.07E-02	2.94E-02	1.80E-10	3.77E-10
PSW	7-6-8	0.13	0.76	47.00	6.00E-03	3.54E-02	4.15E-11	2.10E-10
PSW	7-6-9	0.08	0.83	90.00	3.51E-03	3.89E-02	1.40E-11	1.32E-10
PSW	7-6-10	0.05	0.88	150.00	2.31E-03	4.12E-02	5.50E-12	8.90E-11
PSW	7-6-11	0.03	0.91	206.00	1.23E-03	4.24E-02	2.52E-12	6.81E-11

LI = 9.9±1.3

TABLE B.14-2a. Technetium-99 Fraction Leached for Static Leach Test: Whole Grout in Hanford Ground Water (PSW 7-4)

	SAMPLE ID	uCi LEACHED	TIME DAYS	cum An/Ao	D cum.
PSW	7-4-1	0.09	4.00	1.66E-02	2.83E-10
PSW	7-4-2	0.25	18.00	5.15E-02	4.82E-10
PSW	7-4-3	0.18	47.00	3.70E-02	9.55E-11
PSW	7-4-4	0.21	90.00	4.31E-02	6.77E-11
PSW	7-4-5	0.24	150.00	4.87E-02	5.17E-11
PSW	7-4-6	0.25	208.00	5.17E-02	4.20E-11

TABLE B.14-2b. Technetium-99 Fraction Leached for Static Leach Test: Whole Grout in Hanford Ground Water (PSW 7-5)

	SAMPLE ID	uCi LEACHED	TIME DAYS	cum An/Ao	D cum.
PSW	7-5-1	0.11	4.00	2.25E-02	4.16E-10
PSW	7-5-2	0.01	19.06	1.93E-03	6.44E-13
PSW	7-5-3	0.01	46.00	1.94E-03	2.58E-13
PSW	7-5-4	0.18	90.00	3.65E-02	4.86E-11
PSW	7-5-5	0.20	150.00	4.12E-02	3.71E-11
PSW	7-5-6	0.24	210.00	4.83E-02	3.64E-11

TABLE B.15-a. Sodium Fraction Leached for ANS 16.1 Leach Test: Whole, Small Grout in Hanford Ground Water (PSW A7-1)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum. (<0.2)
PSWA 7-1-1	4.13E+01	6.92E-02	6.92E-02	8.33E-02	1.88E-07	1.88E-07
PSWA 7-1-2	3.30E+00	5.54E-03	7.48E-02	2.90E-01	1.61E-09	6.31E-08
PSWA 7-1-3	8.46E+00	1.42E-02	8.90E-02	1.00E+00	3.09E-09	2.59E-08
PSWA 7-1-4	6.78E+00	1.14E-02	1.00E-01	2.00E+00	2.47E-09	1.65E-08
PSWA 7-1-5	6.24E+00	1.05E-02	1.11E-01	3.00E+00	3.55E-09	1.34E-08
PSWA 7-1-6	4.26E+00	7.15E-03	1.18E-01	4.00E+00	2.33E-09	1.14E-08
PSWA 7-1-7	3.27E+01	5.49E-02	1.73E-01	1.80E+01	1.96E-09	5.43E-09
PSWA 7-1-8	1.90E+01	3.18E-02	2.05E-01	4.70E+01	4.85E-10	3.08E-09
PSWA 7-1-9	1.09E+01	1.82E-02	2.23E-01	9.00E+01	1.57E-10	1.78E-09
PSWA 7-1-10	9.42E+00	1.58E-02	2.39E-01	1.50E+02	1.07E-10	1.29E-09
PSWA 7-1-11	3.60E+00	6.04E-03	2.45E-01	2.08E+02	2.52E-11	1.01E-09

TABLE B.15-b. Potassium Fraction Leached for ANS 16.1 Leach Test: Whole, Small Grout in Hanford Ground Water (PSW A7-1)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum. (<0.2)
PSWA 7-1-1	4.68E+00	4.06E-02	4.06E-02	8.33E-02	6.46E-08	6.46E-08
PSWA 7-1-2	5.40E-01	4.68E-03	4.52E-02	2.90E-01	1.15E-09	2.31E-08
PSWA 7-1-3	9.60E-01	8.32E-03	5.36E-02	1.00E+00	1.06E-09	9.39E-09
PSWA 7-1-4	1.20E+00	1.04E-02	6.40E-02	2.00E+00	2.06E-09	6.70E-09
PSWA 7-1-5	1.20E+00	1.04E-02	7.44E-02	3.00E+00	3.51E-09	6.03E-09
PSWA 7-1-6	3.60E-01	3.12E-03	7.75E-02	4.00E+00	4.44E-10	4.91E-09
PSWA 7-1-7	3.60E+00	3.12E-02	1.09E-01	1.80E+01	8.34E-10	2.15E-09
PSWA 7-1-8	2.40E+00	2.08E-02	1.30E-01	4.70E+01	2.07E-10	1.17E-09
PSWA 7-1-9	5.40E-01	4.68E-03	1.34E-01	9.00E+01	1.04E-11	6.55E-10
PSWA 7-1-10	4.26E-01	3.69E-03	1.38E-01	1.50E+02	5.86E-12	4.15E-10
PSWA 7-1-11	6.60E-02	5.72E-04	1.38E-01	2.08E+02	2.26E-13	3.02E-10

TABLE B.15-c. Boron (H_3BO_3) Fraction Leached for ANS 16.1 Leach Test: Whole, Small Grout in Hanford Ground Water (PSW A7-1)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum. (<0.2)
PSWA 7-1-1	5.04E-01	3.96E-03	3.96E-03	8.33E-02	6.15E-10	6.15E-10
PSWA 7-1-2	3.60E-02	2.83E-04	4.24E-03	2.90E-01	4.19E-12	2.03E-10
PSWA 7-1-3	1.44E-01	1.13E-03	5.37E-03	1.00E+00	1.96E-11	9.44E-11
PSWA 7-1-4	7.20E-02	5.65E-04	5.94E-03	2.00E+00	6.10E-12	5.77E-11
PSWA 7-1-5	5.40E-02	4.24E-04	6.36E-03	3.00E+00	5.83E-12	4.41E-11
PSWA 7-1-6	1.20E-02	9.42E-05	6.46E-03	4.00E+00	4.05E-13	3.41E-11
PSWA 7-1-7	2.10E-01	1.65E-03	8.10E-03	1.80E+01	1.77E-12	1.19E-11
PSWA 7-1-8	6.00E-02	4.71E-04	8.58E-03	4.70E+01	1.06E-13	5.12E-12
PSWA 7-1-9	-6.00E-03	-4.71E-05	8.53E-03	9.00E+01	1.05E-15	2.64E-12
PSWA 7-1-10	-6.00E-03	-4.71E-05	8.48E-03	1.50E+02	9.53E-16	1.57E-12
PSWA 7-1-11	6.00E-03	4.71E-05	8.53E-03	2.08E+02	1.54E-15	1.14E-12

TABLE B.15-d. Sulfate (SO_4) Fraction Leached for ANS 16.1 Leach Test: Whole, Small Grout in Hanford Ground Water (PSW A7-1)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum. (<0.2)
PSWA 7-1-1	4.80E+00	1.17E-02	1.17E-02	8.33E-02	5.41E-09	5.41E-09
PSWA 7-1-2	0.00E+00	0.00E+00	1.17E-02	2.90E-01	0.00E+00	1.56E-09
PSWA 7-1-3	1.20E+00	2.93E-03	1.47E-02	1.00E+00	1.32E-10	7.05E-10
PSWA 7-1-4	2.40E+00	5.87E-03	2.05E-02	2.00E+00	6.57E-10	6.91E-10
PSWA 7-1-5	1.20E+00	2.93E-03	2.35E-02	3.00E+00	2.79E-10	6.01E-10
PSWA 7-1-6	1.20E+00	2.93E-03	2.64E-02	4.00E+00	3.93E-10	5.71E-10
PSWA 7-1-7	-6.00E-01	-1.47E-03	2.49E-02	1.80E+01	1.40E-12	1.13E-10
PSWA 7-1-8	-6.00E-01	-1.47E-03	2.35E-02	4.70E+01	1.03E-12	3.84E-11
PSWA 7-1-9	2.40E+00	5.87E-03	2.93E-02	9.00E+01	1.63E-11	3.13E-11
PSWA 7-1-10	1.14E+00	2.79E-03	3.21E-02	1.50E+02	3.34E-12	2.25E-11
PSWA 7-1-11	1.80E+00	4.40E-03	3.65E-02	2.08E+02	1.34E-11	2.10E-11

TABLE B.16-a. Sodium Fraction Leached for ANS 16.1 Leach Test: Whole, Large Grout in Hanford Ground Water (LA PSW7-6)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum.
PSWLA 7-6-1	4.22E+01	1.51E-02	1.51E-02	8.33E-02	2.15E-08	2.15E-08
PSWLA 7-6-2	2.14E+01	7.66E-03	2.28E-02	2.90E-01	7.39E-09	1.40E-08
PSWLA 7-6-3	4.74E+01	1.69E-02	3.97E-02	1.00E+00	1.06E-08	1.24E-08
PSWLA 7-6-4	3.17E+01	1.13E-02	5.10E-02	2.00E+00	5.87E-09	1.02E-08
PSWLA 7-6-5	2.54E+01	9.09E-03	6.01E-02	3.00E+00	6.43E-09	9.46E-09
PSWLA 7-6-6	1.71E+01	6.12E-03	6.62E-02	4.00E+00	4.10E-09	8.61E-09
PSWLA 7-6-7	9.62E+01	3.44E-02	1.01E-01	1.80E+01	1.85E-09	4.42E-09
PSWLA 7-6-8	5.79E+01	2.07E-02	1.21E-01	4.70E+01	4.93E-10	2.46E-09
PSWLA 7-6-9	3.97E+01	1.42E-02	1.35E-01	9.00E+01	2.28E-10	1.60E-09
PSWLA 7-6-10	3.60E+01	1.29E-02	1.48E-01	1.50E+02	1.71E-10	1.15E-09
PSWLA 7-6-11	2.35E+01	8.40E-03	1.57E-01	2.08E+02	1.17E-10	9.28E-10

TABLE B.16-b. Potassium Fraction Leached for ANS 16.1 Leach Test: Whole, Large Grout in Hanford Ground Water (LA PSW7-6)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum.
PSWLA 7-6-1	5.28E+00	9.75E-03	9.75E-03	8.33E-02	8.97E-09	8.97E-09
PSWLA 7-6-2	2.24E+00	4.14E-03	1.39E-02	2.90E-01	2.15E-09	5.23E-09
PSWLA 7-6-3	7.04E+00	1.30E-02	2.69E-02	1.00E+00	6.24E-09	5.68E-09
PSWLA 7-6-4	5.76E+00	1.06E-02	3.75E-02	2.00E+00	5.18E-09	5.53E-09
PSWLA 7-6-5	4.48E+00	8.27E-03	4.58E-02	3.00E+00	5.32E-09	5.49E-09
PSWLA 7-6-6	3.52E+00	6.50E-03	5.23E-02	4.00E+00	4.63E-09	5.37E-09
PSWLA 7-6-7	1.34E+01	2.48E-02	7.71E-02	1.80E+01	9.63E-10	2.60E-09
PSWLA 7-6-8	8.00E+00	1.48E-02	9.19E-02	4.70E+01	2.51E-10	1.41E-09
PSWLA 7-6-9	4.16E+00	7.68E-03	9.96E-02	9.00E+01	8.70E-11	8.66E-10
PSWLA 7-6-10	2.42E+00	4.46E-03	1.04E-01	1.50E+02	2.05E-11	5.67E-10
PSWLA 7-6-11	3.20E+00	5.91E-03	1.10E-01	2.08E+02	5.80E-11	4.57E-10

TABLE B.16-c. Boron (as H_3BO_3) Fraction Leached for ANS 16.1 Leach Test: Whole, Large Grout in Hanford Ground Water (LA PSW7-6)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum.
PSWLA 7-6-1	3.52E-01	5.89E-04	5.89E-04	8.33E-02	3.27E-11	3.27E-11
PSWLA 7-6-2	1.60E-01	2.68E-04	8.56E-04	2.90E-01	9.02E-12	1.99E-11
PSWLA 7-6-3	4.16E-01	6.96E-04	1.55E-03	1.00E+00	1.79E-11	1.89E-11
PSWLA 7-6-4	2.24E-01	3.75E-04	1.93E-03	2.00E+00	6.43E-12	1.46E-11
PSWLA 7-6-5	1.28E-01	2.14E-04	2.14E-03	3.00E+00	3.57E-12	1.20E-11
PSWLA 7-6-6	6.40E-02	1.07E-04	2.25E-03	4.00E+00	1.26E-12	9.93E-12
PSWLA 7-6-7	5.60E-01	9.37E-04	3.18E-03	1.80E+01	1.37E-12	4.43E-12
PSWLA 7-6-8	1.76E-01	2.94E-04	3.48E-03	4.70E+01	9.98E-14	2.03E-12
PSWLA 7-6-9	1.76E-01	2.94E-04	3.77E-03	9.00E+01	9.84E-14	1.24E-12
PSWLA 7-6-10	1.44E-01	2.41E-04	4.01E-03	1.50E+02	5.99E-14	8.45E-13
PSWLA 7-6-11	1.60E-02	2.68E-05	4.04E-03	2.08E+02	1.19E-15	6.17E-13

TABLE B-16.d. Sulfate (SO_4) Fraction Leached for ANS 16.1 Leach Test: Whole, Large Grout in Hanford Ground Water (LA PSW7-6)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum.
PSWLA 7-6-1	6.40E+00	3.33E-03	3.33E-03	8.33E-02	1.05E-09	1.05E-09
PSWLA 7-6-2	0.00E+00	0.00E+00	3.33E-03	2.90E-01	0.00E+00	3.01E-10
PSWLA 7-6-3	6.40E+00	3.33E-03	6.67E-03	1.00E+00	4.10E-10	3.50E-10
PSWLA 7-6-4	3.20E+00	1.67E-03	8.33E-03	2.00E+00	1.27E-10	2.73E-10
PSWLA 7-6-5	0.00E+00	0.00E+00	8.33E-03	3.00E+00	0.00E+00	1.82E-10
PSWLA 7-6-6	0.00E+00	0.00E+00	8.33E-03	4.00E+00	0.00E+00	1.37E-10
PSWLA 7-6-7	5.89E+00	3.07E-03	1.14E-02	1.80E+01	1.47E-11	5.68E-11
PSWLA 7-6-8	-3.20E+00	-1.67E-03	9.74E-03	4.70E+01	3.20E-12	1.59E-11
PSWLA 7-6-9	6.40E+00	3.33E-03	1.31E-02	9.00E+01	1.26E-11	1.49E-11
PSWLA 7-6-10	-3.20E-01	-1.67E-04	1.29E-02	1.50E+02	2.87E-14	8.73E-12
PSWLA 7-6-11	6.40E+00	3.33E-03	1.62E-02	2.08E+02	1.85E-11	9.98E-12

TABLE B.17-a. Sodium Fraction Leached for Static Leach Test: Whole, Small Grout in Ground Water (PSW S7-4)

SAMPLE	mg LEACHED	cum. An/Ao	TIME days	D cum. (<0.2)
PSWS 7-4-1	6.72E+01	1.06E-01	4.00E+00	6.61E-09
PSWS 7-4-2	9.44E+01	1.49E-01	1.80E+01	3.78E-09
PSWS 7-4-3	1.61E+02	2.54E-01	4.70E+01	4.46E-09
PSWS 7-4-4	1.83E+02	2.89E-01	9.00E+01	3.24E-09
PSWS 7-4-5	2.17E+02	3.43E-01	1.50E+02	2.78E-09
PSWS 7-4-6	2.03E+02	3.20E-01	2.08E+02	1.75E-09

TABLE B.17-b. Potassium Fraction Leached for Static Leach Test: Whole, Small Grout in Ground Water (PSW S7-4)

SAMPLE	mg LEACHED	cum. An/Ao	TIME days	D cum. (<0.2)
PSWS 7-4-1	7.20E+00	5.88E-02	4.00E+00	2.64E-09
PSWS 7-4-2	9.84E+00	8.03E-02	1.80E+01	1.10E-09
PSWS 7-4-3	1.64E+01	1.34E-01	4.70E+01	1.16E-09
PSWS 7-4-4	1.95E+01	1.59E-01	9.00E+01	8.59E-10
PSWS 7-4-5	2.30E+01	1.88E-01	1.50E+02	7.17E-10
PSWS 7-4-6	2.30E+01	1.88E-01	2.08E+02	5.17E-10

TABLE B.17-c. Aluminum Fraction Leached for Static Leach Test: Whole, Small Grout in Ground Water (PSW S7-4)

SAMPLE	mg LEACHED	cum. An/Ao	TIME days	D cum. (<0.2)
PSWS 7-4-1	4.98E-01	3.11E-04	4.00E+00	7.39E-14
PSWS 7-4-2	1.47E+00	9.16E-04	1.80E+01	1.43E-13
PSWS 7-4-3	2.44E+00	1.52E-03	4.70E+01	1.51E-13
PSWS 7-4-4	3.21E+00	2.01E-03	9.00E+01	1.37E-13
PSWS 7-4-5	4.15E+00	2.59E-03	1.60E+02	1.37E-13
PSWS 7-4-6	4.69E+00	2.93E-03	2.08E+02	1.26E-13

TABLE B.17-d. Nitrate (NO_3) Fraction Leached for Static Leach Test: Whole, Small Grout in Ground Water (PSW S7-4)

SAMPLE	mg LEACHED	cum. An/Ao	TIME days	D cum. (<0.2)
PSWS 7-4-1	2.16E+00	2.01E-01	4.00E+00	3.10E-08
PSWS 7-4-2	9.60E-01	8.95E-02	1.80E+01	1.36E-09
PSWS 7-4-3	1.38E+00	1.29E-01	4.70E+01	1.08E-09
PSWS 7-4-4	1.84E+00	1.71E-01	9.00E+01	9.99E-10
PSWS 7-4-5	2.08E+00	1.94E-01	1.60E+02	7.70E-10
PSWS 7-4-6	2.56E+00	2.39E-01	2.08E+02	9.29E-10

TABLE B.17-e. Sulfate (SO_4) Fraction Leached for Static Leach Test: Whole, Small Grout in Ground Water (PSW S7-4)

SAMPLE	mg LEACHED	cum. An/Ao	TIME days	D cum. (<0.2)
PSWS 7-4-1	1.20E+00	2.76E-03	4.00E+00	5.82E-12
PSWS 7-4-2	-1.70E+00	-3.91E-03	1.80E+01	2.60E-12
PSWS 7-4-3	1.75E+00	4.03E-03	4.70E+01	1.05E-12
PSWS 7-4-4	-5.00E-01	-1.15E-03	9.00E+01	4.49E-14
PSWS 7-4-5	-3.61E+00	-8.30E-03	1.50E+02	1.41E-12
PSWS 7-4-6	3.05E+00	7.02E-03	2.06E+02	7.23E-13

TABLE B.17-f. Boron (as H_3BO_3) Fraction Leached for Static Leach Test: Whole, Small Grout in Ground Water (PSW S7-4)

SAMPLE	mg LEACHED	cum. An/Ao	TIME days	D cum. (<0.2)
PSWS 7-4-1	8.34E-01	6.17E-03	4.00E+00	2.91E-11
PSWS 7-4-2	1.15E+00	8.47E-03	1.80E+01	1.22E-11
PSWS 7-4-3	1.65E+00	1.22E-02	4.70E+01	9.80E-12
PSWS 7-4-4	1.70E+00	1.26E-02	9.00E+01	5.39E-12
PSWS 7-4-5	1.77E+00	1.31E-02	1.50E+02	3.48E-12
PSWS 7-4-6	1.83E+00	1.35E-02	2.06E+02	2.69E-12

TABLE B.18-1a. Uranium (total U) Fraction Leached for ANS 16.1 Leach Test: Whole, Small Grout in Hanford Ground Water (PSW A8-1)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum.
A-8-1-1	1.20E-05	7.28E-05	7.28E-05	8.33E-02	1.88E-13	1.88E-13
A-8-1-2	5.40E-05	3.28E-04	4.00E-04	2.92E-01	5.01E-12	2.27E-12
A-8-1-3	7.20E-05	4.37E-04	8.37E-04	1.00E+00	2.66E-12	2.92E-12
A-8-1-4	5.40E-05	3.28E-04	1.16E-03	2.00E+00	1.65E-12	4.01E-12
A-8-1-5	5.40E-05	3.28E-04	1.49E-03	3.00E+00	3.14E-12	8.58E-12
A-8-1-6	6.00E-05	3.64E-04	1.86E-03	4.00E+00	5.46E-12	1.02E-11
A-8-1-7	9.00E-05	5.46E-04	2.40E-03	1.80E+01	1.75E-13	1.22E-12
A-8-1-8	6.00E-05	3.64E-04	2.77E-03	4.70E+01	5.73E-14	7.79E-13
A-8-1-9	1.51E-03	9.14E-03	1.19E-02	9.00E+01	3.58E-11	9.73E-12
A-8-1-10	1.20E-03	7.28E-03	1.92E-02	1.50E+02	2.05E-11	1.81E-11
A-8-1-11	1.97E-03	1.19E-02	3.11E-02	2.08E+02	8.90E-11	4.93E-11

TABLE B.18-1b. Uranium (total U) Fraction Leached for ANS 16.1 Leach Test: Whole, Small Grout in Hanford Ground Water (PSW A8-2)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum.
A-8-2-1	3.00E-05	1.82E-04	1.82E-04	8.33E-02	1.17E-12	1.17E-12
A-8-2-2	1.26E-04	7.64E-04	9.46E-04	2.92E-01	2.73E-11	1.27E-11
A-8-2-3	1.20E-04	7.28E-04	1.67E-03	1.00E+00	7.40E-12	1.17E-11
A-8-2-4	1.20E-04	7.28E-04	2.40E-03	2.00E+00	9.12E-12	1.70E-11
A-8-2-5	1.26E-04	7.64E-04	3.17E-03	3.00E+00	1.71E-11	2.96E-11
A-8-2-6	1.56E-04	9.46E-04	4.11E-03	4.00E+00	3.68E-11	5.00E-11
A-8-2-7	1.80E-05	1.09E-04	4.22E-03	1.80E+01	7.00E-15	3.76E-12
A-8-2-8	6.18E-04	3.75E-03	7.97E-03	4.70E+01	6.00E-12	6.47E-12
A-8-2-9	1.43E-03	8.68E-03	1.66E-02	9.00E+01	3.20E-11	1.90E-11
A-8-2-10	1.43E-03	8.68E-03	2.53E-02	1.50E+02	2.91E-11	3.15E-11
A-8-2-11	1.40E-03	8.48E-03	3.38E-02	2.08E+02	4.49E-11	5.81E-11

TABLE B.18-1c. Uranium (total U) Fraction Leached for ANS 16.1 Leach Test: Whole, Small Grout in Hanford Ground Water (PSW A8-3)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum.
A-8-3-1	8.40E-05	5.10E-04	5.10E-04	8.33E-02	9.20E-12	9.20E-12
A-8-3-2	1.62E-04	9.83E-04	1.49E-03	2.92E-01	4.51E-11	3.16E-11
A-8-3-3	1.44E-04	8.74E-04	2.37E-03	1.00E+00	1.07E-11	2.33E-11
A-8-3-4	6.60E-05	4.00E-04	2.77E-03	2.00E+00	2.76E-12	2.26E-11
A-8-3-5	1.44E-04	8.74E-04	3.64E-03	3.00E+00	2.23E-11	3.91E-11
A-8-3-6	1.26E-04	7.64E-04	4.40E-03	4.00E+00	2.40E-11	5.73E-11
A-8-3-7	5.40E-05	3.28E-04	4.73E-03	1.80E+01	6.30E-14	4.72E-12
A-8-3-8	5.40E-05	3.28E-04	5.06E-03	4.70E+01	4.64E-14	2.61E-12
A-8-3-9	1.28E-03	7.76E-03	1.28E-02	9.00E+01	2.56E-11	1.13E-11
A-8-3-10	9.00E-04	5.46E-03	1.83E-02	1.50E+02	1.16E-11	1.64E-11
A-8-3-11	8.28E-04	5.02E-03	2.33E-02	2.08E+02	1.58E-11	2.76E-11

TABLE B.18-1d. Uranium (total U) Fraction Leached for ANS 16.1 Leach Test: Whole, Large Grout in Hanford Ground Water (PSW LA8-6)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum.
LA-8-6-1	3.52E-04	4.66E-04	4.66E-04	8.33E-02	2.01E-11	2.01E-11
LA-8-6-2	1.12E-04	1.48E-04	6.15E-04	2.92E-01	2.68E-12	1.40E-11
LA-8-6-3	3.20E-04	4.24E-04	1.04E-03	1.00E+00	6.54E-12	1.17E-11
LA-8-6-4	3.04E-04	4.03E-04	1.44E-03	2.00E+00	7.28E-12	1.60E-11
LA-8-6-5	3.04E-04	4.03E-04	1.84E-03	3.00E+00	1.24E-11	2.62E-11
LA-8-6-6	2.24E-04	2.97E-04	2.14E-03	4.00E+00	9.44E-12	3.53E-11
LA-8-6-7	1.76E-04	2.33E-04	2.37E-03	1.80E+01	6.32E-14	3.10E-12
LA-8-6-8	1.28E-03	1.70E-03	4.07E-03	4.70E+01	3.24E-12	4.40E-12
LA-8-6-9	1.34E-03	1.78E-03	5.85E-03	9.00E+01	3.52E-12	6.13E-12
LA-8-6-10	6.03E-03	7.99E-03	1.38E-02	1.50E+02	8.45E-11	2.46E-11

TABLE B.18-2a. Uranium (total U) Fraction Leached for Static Leach Test: Whole, Small Grout in Hanford Ground Water (PSW 8-4)

SAMPLE	mg LEACHED	cum An/Ao	TIME days	D cum.
S-8-4-1	3.00E-05	1.82E-05	4.00E+00	2.45E-16
S-8-4-2	3.25E-05	1.97E-05	1.80E+01	6.20E-17
S-8-4-3	9.00E-06	5.46E-06	4.70E+01	3.04E-16
S-8-4-4	9.50E-06	5.76E-06	9.00E+01	2.28E-16
S-8-4-5	1.70E-03	1.03E-03	1.50E+02	5.23E-14
S-8-4-6	2.25E-04	1.36E-04	2.08E+02	9.49E-16

TABLE B.18-2b. Uranium (total U) Fraction Leached for Static Leach Test: Whole, Small Grout in Hanford Ground Water (PSW 8-5)

SAMPLE	mg LEACHED	cum An/Ao	TIME days	D cum.
S-8-5-1	5.10E-05	3.09E-05	4.00E+00	7.07E-16
S-8-5-2	5.53E-05	3.35E-05	1.80E+01	2.37E-16
S-8-5-3	1.08E-05	6.52E-06	4.70E+01	4.33E-16
S-8-5-4	1.13E-05	6.82E-06	9.00E+01	3.20E-16
S-8-5-5	1.03E-03	6.26E-04	1.50E+02	1.93E-14
S-8-5-6	2.14E-04	1.30E-04	2.08E+02	8.60E-16

TABLE B.18-2c. Uranium (total U) Fraction Leached for Static Leach Test: Whole, Small Grout in Hanford Ground Water (PSW BATCH 9-4)

SAMPLE	mg LEACHED	cum An/Ao	TIME days	D cum.
S-9-4-1	2.40E-05	1.46E-05	4.00E+00	1.56E-16
S-9-4-2	2.60E-05	1.58E-05	1.80E+01	5.25E-17
S-9-4-3	2.80E-05	1.70E-05	4.70E+01	2.94E-17
S-9-4-4	1.05E-05	6.37E-06	9.00E+01	2.79E-18
S-9-4-5	3.94E-04	2.39E-04	1.50E+02	2.82E-15
S-9-4-6	4.57E-04	2.77E-04	2.08E+02	3.91E-15

TABLE B.18-2d. Uranium (total U) Fraction Leached for Static Leach Test: Whole, Small Grout in Hanford Ground Water (PSW BATCH 9-5)

SAMPLE	mg LEACHED	cum An/Ao	TIME days	D cum.
S-9-5-1	6.00E-06	3.64E-06	4.00E+00	9.78E-18
S-9-5-2	6.50E-06	3.94E-06	1.80E+01	3.28E-18
S-9-5-3	2.65E-05	1.61E-05	4.70E+01	2.63E-17
S-9-5-4	9.00E-06	5.46E-06	9.00E+01	2.05E-18
S-9-5-5	6.53E-04	3.96E-04	1.50E+02	7.72E-15
S-9-5-6	1.57E-04	9.52E-05	2.08E+02	4.62E-16

TABLE B.19-a. Uranium (total U) Fraction Leached for ANS 16.1 Leach Test: Whole, Small Grout in Hanford Ground Water (PSW A9-1)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum.
A9-1-1	9.00E-05	5.68E-05	5.68E-05	8.33E-02	1.14E-13	1.14E-13
A9-1-2	1.20E-04	7.57E-05	1.32E-04	2.92E-01	2.68E-13	2.49E-13
A9-1-3	1.38E-04	8.71E-05	2.20E-04	1.00E+00	1.06E-13	2.01E-13
A9-1-4	1.38E-04	8.71E-05	3.07E-04	2.00E+00	1.30E-13	2.78E-13
A9-1-5	1.38E-04	8.71E-05	3.94E-04	3.00E+00	2.22E-13	4.58E-13
A9-1-6	1.38E-04	8.71E-05	4.81E-04	4.00E+00	3.12E-13	6.83E-13
A9-1-7	1.14E-04	7.19E-05	5.53E-04	1.80E+01	3.04E-15	6.44E-14
A9-1-8	7.80E-05	4.92E-05	6.02E-04	4.70E+01	1.05E-15	3.69E-14
A9-1-9	1.54E-03	9.69E-04	1.57E-03	9.00E+01	4.01E-13	1.70E-13
A9-1-10	1.20E-03	7.57E-04	2.33E-03	1.50E+02	2.22E-13	2.67E-13
A9-1-11	1.02E-03	6.44E-04	2.97E-03	2.08E+02	2.59E-13	4.50E-13

TABLE B.19-b. Uranium (total U) Fraction Leached for ANS 16.1 Leach Test: Whole, Small Grout in Hanford Ground Water (PSW A9-2)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum.
A9-2-1	1.02E-04	6.64E-05	6.64E-05	8.33E-02	1.51E-13	1.51E-13
A9-2-2	1.50E-04	9.76E-05	1.64E-04	2.92E-01	4.30E-13	3.68E-13
A9-2-3	1.08E-04	7.03E-05	2.34E-04	1.00E+00	6.65E-14	2.21E-13
A9-2-4	1.26E-04	8.20E-05	3.16E-04	2.00E+00	1.12E-13	2.85E-13
A9-2-5	1.44E-04	9.37E-05	4.10E-04	3.00E+00	2.48E-13	4.79E-13
A9-2-6	1.32E-04	8.59E-05	4.96E-04	4.00E+00	2.93E-13	7.01E-13
A9-2-7	1.20E-04	7.81E-05	5.74E-04	1.80E+01	3.45E-15	6.71E-14
A9-2-8	7.80E-05	5.07E-05	6.25E-04	4.70E+01	1.08E-15	3.83E-14
A9-2-9	1.45E-03	9.45E-04	1.57E-03	9.00E+01	3.67E-13	1.63E-13
A9-2-10	1.20E-03	7.81E-04	2.35E-03	1.50E+02	2.28E-13	2.62E-13
A9-2-11	1.00E-03	6.52E-04	3.00E-03	2.08E+02	2.56E-13	4.43E-13

TABLE B.19-c. Uranium (total U) Fraction Leached for ANS 16.1 Leach Test: Whole, Small Grout in Hanford Ground Water (PSW A9-3)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum.
A9-3-1	1.20E-04	7.10E-05	7.10E-05	8.33E-02	1.85E-13	1.85E-13
A9-3-2	9.00E-05	5.33E-05	1.24E-04	2.92E-01	1.37E-13	2.27E-13
A9-3-3	1.26E-04	7.46E-05	1.99E-04	1.00E+00	8.04E-14	1.71E-13
A9-3-4	1.56E-04	9.24E-05	2.91E-04	2.00E+00	1.52E-13	2.59E-13
A9-3-5	1.38E-04	8.17E-05	3.73E-04	3.00E+00	2.02E-13	4.25E-13
A9-3-6	1.38E-04	8.17E-05	4.55E-04	4.00E+00	2.84E-13	6.32E-13
A9-3-7	1.20E-04	7.10E-05	5.26E-04	1.80E+01	3.07E-15	6.04E-14
A9-3-8	7.80E-05	4.62E-05	5.72E-04	4.70E+01	9.55E-16	3.45E-14
A9-3-9	1.43E-03	8.49E-04	1.42E-03	9.00E+01	3.18E-13	1.44E-13
A9-3-10	6.42E-04	3.80E-04	1.80E-03	1.50E+02	5.80E-14	1.65E-13
A9-3-11	4.80E-05	2.84E-05	1.83E-03	2.08E+02	5.22E-16	1.76E-13

TABLE B.20-a. Sodium Fraction Leached for ANS 16.1 Leach Test: Whole, Small Grout in Hanford Ground Water (PSW A9-1)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum. (<0.2)
PSWA 9-1-1	2.53E+01	4.15E-02	4.15E-02	8.33E-02	6.32E-08	6.32E-08
PSWA 9-1-2	3.60E+00	5.91E-03	4.74E-02	2.90E-01	1.71E-09	2.37E-08
PSWA 9-1-3	8.94E+00	1.47E-02	6.21E-02	1.00E+00	3.10E-09	1.18E-08
PSWA 9-1-4	7.86E+00	1.29E-02	7.50E-02	2.00E+00	2.97E-09	8.60E-09
PSWA 9-1-5	5.82E+00	9.56E-03	8.45E-02	3.00E+00	2.77E-09	7.29E-09
PSWA 9-1-6	3.90E+00	6.41E-03	9.10E-02	4.00E+00	1.75E-09	6.32E-09
PSWA 9-1-7	2.73E+01	4.48E-02	1.36E-01	1.80E+01	1.22E-09	3.13E-09
PSWA 9-1-8	1.97E+01	3.24E-02	1.68E-01	4.70E+01	4.71E-10	1.84E-09
PSWA 9-1-9	1.61E+01	2.64E-02	1.95E-01	9.00E+01	3.08E-10	1.29E-09
PSWA 9-1-10	1.23E+01	2.02E-02	2.15E-01	1.50E+02	1.64E-10	1.07E-09
PSWA 9-1-11	4.32E+00	7.09E-03	2.22E-01	2.08E+02	3.25E-11	7.69E-10

TABLE B.20-b. Potassium Fraction Leached for ANS 16.1 Leach Test: Whole, Small Grout in Hanford Ground Water (PSW A9-1)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum. (<0.2)
PSWA 9-1-1	2.34E+00	1.99E-02	1.99E-02	8.33E-02	1.45E-08	1.45E-08
PSWA 9-1-2	3.60E-01	3.06E-03	2.29E-02	2.90E-01	4.57E-10	5.54E-09
PSWA 9-1-3	6.60E-01	5.60E-03	2.85E-02	1.00E+00	4.51E-10	2.49E-09
PSWA 9-1-4	6.60E-01	5.60E-03	3.41E-02	2.00E+00	5.59E-10	1.78E-09
PSWA 9-1-5	4.80E-01	4.07E-03	3.82E-02	3.00E+00	5.02E-10	1.49E-09
PSWA 9-1-6	5.40E-01	4.58E-03	4.28E-02	4.00E+00	8.95E-10	1.40E-09
PSWA 9-1-7	2.88E+00	2.44E-02	6.72E-02	1.80E+01	3.63E-10	7.68E-10
PSWA 9-1-8	2.40E+00	2.04E-02	8.76E-02	4.70E+01	1.66E-10	4.99E-10
PSWA 9-1-9	1.56E+00	1.32E-02	1.01E-01	9.00E+01	7.74E-11	3.45E-10
PSWA 9-1-10	9.18E-01	7.79E-03	1.09E-01	1.50E+02	2.44E-11	2.40E-10
PSWA 9-1-11	2.52E-01	2.14E-03	1.11E-01	2.08E+02	2.96E-12	1.80E-10

TABLE B.20-c. Boron (as H_3BO_3) Fraction Leached for ANS 16.1 Leach Test: Whole, Small Grout in Hanford Ground Water (PSW A9-1)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum. (<0.2)
PSWA 9-1-1	3.42E-01	2.63E-03	2.63E-03	8.33E-02	2.54E-10	2.54E-10
PSWA 9-1-2	6.60E-02	5.07E-04	3.14E-03	2.90E-01	1.26E-11	1.04E-10
PSWA 9-1-3	9.60E-02	7.38E-04	3.88E-03	1.00E+00	7.82E-12	4.59E-11
PSWA 9-1-4	6.60E-02	5.07E-04	4.38E-03	2.00E+00	4.59E-12	2.94E-11
PSWA 9-1-5	3.60E-02	2.77E-04	4.66E-03	3.00E+00	2.32E-12	2.21E-11
PSWA 9-1-6	3.60E-02	2.77E-04	4.94E-03	4.00E+00	3.26E-12	1.86E-11
PSWA 9-1-7	1.44E-01	1.11E-03	6.04E-03	1.80E+01	7.45E-13	6.20E-12
PSWA 9-1-8	1.56E-01	1.20E-03	7.24E-03	4.70E+01	6.44E-13	3.41E-12
PSWA 9-1-9	9.60E-02	7.38E-04	7.98E-03	9.00E+01	2.41E-13	2.18E-12
PSWA 9-1-10	6.00E-03	4.61E-05	8.03E-03	1.50E+02	8.54E-16	1.31E-12
PSWA 9-1-11	0.00E+00	0.00E+00	8.03E-03	2.08E+02	0.00E+00	9.47E-13

TABLE B.20-d. Sulfate (SO_4) Fraction Leached for ANS 16.1 Leach Test: Whole, Small Grout in Hanford Ground Water (PSW A9-1)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum. (<0.2)
PSWA 9-1-1	3.60E+00	8.62E-03	8.62E-03	8.33E-02	2.73E-09	2.73E-09
PSWA 9-1-2	-1.80E+00	-4.31E-03	4.31E-03	2.90E-01	9.10E-10	1.96E-10
PSWA 9-1-3	1.20E+00	2.87E-03	7.18E-03	1.00E+00	1.19E-10	1.58E-10
PSWA 9-1-4	0.00E+00	0.00E+00	7.18E-03	2.00E+00	0.00E+00	7.89E-11
PSWA 9-1-5	-1.80E+00	-4.31E-03	2.87E-03	3.00E+00	5.62E-10	6.42E-12
PSWA 9-1-6	1.20E+00	2.87E-03	5.75E-03	4.00E+00	3.52E-10	2.52E-11
PSWA 9-1-7	6.00E-01	1.44E-03	7.18E-03	1.60E+01	1.26E-12	8.77E-12
PSWA 9-1-8	-6.00E-01	-1.44E-03	5.75E-03	4.70E+01	9.25E-13	2.15E-12
PSWA 9-1-9	2.40E+00	5.75E-03	1.15E-02	9.00E+01	1.46E-11	4.49E-12
PSWA 9-1-10	1.14E+00	2.73E-03	1.42E-02	1.50E+02	2.99E-12	4.12E-12
PSWA 9-1-11	2.40E+00	5.75E-03	2.00E-02	2.06E+02	2.14E-11	5.86E-12

TABLE B.21-a. Sodium Fraction Leached for Static Leach Test: Whole, Small Grout in Ground Water (PSW S9-4)

SAMPLE	mg LEACHED	cum. An/Ao	TIME days	D cum.
PSWS 9-4-1	5.82E+01	9.74E-02	4.00E+00	7.00E-09
PSWS 9-4-2	8.34E+01	1.40E-01	1.80E+01	8.20E-09
PSWS 9-4-3	1.46E+02	2.45E-01	4.70E+01	4.46E-09
PSWS 9-4-4	1.64E+02	2.75E-01	9.00E+01	3.00E-09
PSWS 9-4-5	1.95E+02	3.26E-01	1.50E+02	2.60E-09
PSWS 9-4-6	1.81E+02	3.03E-01	2.08E+02	1.52E-09

TABLE B.21-b. Potassium Fraction Leached for Static Leach Test: Whole, Small Grout in Ground Water (PSW S9-4)

SAMPLE	mg LEACHED	cum. An/Ao	TIME days	D cum.
PSWS 9-4-1	5.52E+00	4.77E-02	4.00E+00	1.68E-09
PSWS 9-4-2	8.14E+00	7.04E-02	1.80E+01	8.13E-10
PSWS 9-4-3	1.49E+01	1.29E-01	4.70E+01	1.04E-09
PSWS 9-4-4	1.75E+01	1.51E-01	9.00E+01	7.50E-10
PSWS 9-4-5	2.04E+01	1.76E-01	1.50E+02	6.11E-10
PSWS 9-4-6	2.03E+01	1.76E-01	2.08E+02	4.38E-10

TABLE B.21-c. Aluminum Fraction Leached for Static Leach Test: Whole, Small Grout in Ground Water (PSW S9-4)

SAMPLE	mg LEACHED	cum. An/Ao	TIME days	D cum.
PSWS 9-4-1	6.18E-01	4.09E-04	4.00E+00	1.23E-13
PSWS 9-4-2	1.48E+00	9.79E-04	1.80E+01	1.57E-13
PSWS 9-4-3	2.55E+00	1.69E-03	4.70E+01	1.79E-13
PSWS 9-4-4	3.35E+00	2.22E-03	9.00E+01	1.61E-13
PSWS 9-4-5	4.16E+00	2.75E-03	1.50E+02	1.49E-13
PSWS 9-4-6	4.49E+00	2.97E-03	2.08E+02	1.25E-13

TABLE B.21-d. Nitrate (NO_3) Fraction Leached for Static Leach Test: Whole, Small Grout in Ground Water (PSW S9-4)

SAMPLE	mg LEACHED	cum. An/Ao	TIME days	D cum.
PSWS 9-4-1	1.08E+00	1.07E-01	4.00E+00	8.39E-09
PSWS 9-4-2	7.50E-01	7.40E-02	1.80E+01	8.99E-10
PSWS 9-4-3	2.65E-01	2.62E-02	4.70E+01	4.30E-11
PSWS 9-4-4	1.66E+00	1.63E-01	9.00E+01	8.76E-10
PSWS 9-4-5	1.90E+00	1.88E-01	1.50E+02	6.93E-10
PSWS 9-4-6	2.38E+00	2.35E-01	2.08E+02	9.29E-10

TABLE B.21-e. Sulfate (SO_4) Fraction Leached for Static Leach Test: Whole, Small Grout in Ground Water (PSW S9-4)

SAMPLE	mg LEACHED	cum. An/Ao	TIME days	D cum.
PSWS 9-4-1	0.00E+00	0.00E+00	4.00E+00	0.00E+00
PSWS 9-4-2	-3.60E+00	-8.78E-03	1.80E+01	1.27E-11
PSWS 9-4-3	1.50E+00	3.66E-03	4.70E+01	8.41E-13
PSWS 9-4-4	1.05E+00	2.56E-03	9.00E+01	2.15E-13
PSWS 9-4-5	-2.30E-01	-5.61E-04	1.50E+02	6.20E-15
PSWS 9-4-6	4.15E+00	1.01E-02	2.08E+02	1.46E-12

TABLE B.21-f. Boron (as H_3BO_3) Fraction Leached for Static Leach Test: Whole, Small Grout in Ground Water (PSW S9-4)

SAMPLE	mg LEACHED	cum. An/Ao	TIME days	D cum.
PSWS 9-4-1	6.12E-01	4.79E-03	4.00E+00	1.82E-11
PSWS 9-4-2	7.47E-01	5.85E-03	1.80E+01	6.02E-12
PSWS 9-4-3	1.18E+00	9.27E-03	4.70E+01	5.78E-12
PSWS 9-4-4	1.29E+00	1.01E-02	9.00E+01	3.59E-12
PSWS 9-4-5	1.57E+00	1.23E-02	1.50E+02	3.20E-12
PSWS 9-4-6	1.73E+00	1.35E-02	2.08E+02	2.79E-12

TABLE B.22-1a. Manganese-54 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 10-1)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	10-1-1	3.52E-04	3.52E-04	0.08	2.47E-03	2.47E-03	2.33E-10	2.33E-10
PSW	10-1-2	3.52E-04	7.03E-04	0.29	2.47E-03	4.95E-03	3.00E-10	2.67E-10
PSW	10-1-3	3.52E-04	1.06E-03	1.00	2.47E-03	7.42E-03	9.08E-11	1.74E-10
PSW	10-1-4	3.52E-04	1.41E-03	2.00	2.47E-03	9.89E-03	1.13E-10	1.55E-10
PSW	10-1-5	3.52E-04	1.76E-03	3.00	2.47E-03	1.24E-02	1.91E-10	1.61E-10
PSW	10-1-6	3.52E-04	2.11E-03	4.00	2.47E-03	1.48E-02	2.89E-10	1.74E-10
PSW	10-1-7	3.52E-04	2.46E-03	18.00	2.47E-03	1.73E-02	3.85E-12	5.27E-11
PSW	10-1-8	3.52E-04	2.81E-03	48.00	2.47E-03	1.98E-02	2.66E-12	2.58E-11
PSW	10-1-9	3.52E-04	3.17E-03	90.00	2.47E-03	2.23E-02	2.95E-12	1.74E-11
PSW	10-1-10	3.52E-04	3.52E-03	150.00	2.47E-03	2.47E-02	2.54E-12	1.29E-11

TABLE B.22-1b. Manganese-54 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 10-6)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	10-6-1	3.52E-04	3.52E-04	0.08	5.65E-04	5.65E-04	2.89E-11	2.89E-11
PSW	10-6-2	3.52E-04	7.03E-04	0.29	5.65E-04	1.13E-03	3.83E-11	3.31E-11
PSW	10-6-3	3.52E-04	1.06E-03	1.00	5.65E-04	1.69E-03	1.13E-11	2.16E-11
PSW	10-6-4	3.52E-04	1.41E-03	2.00	5.65E-04	2.26E-03	1.40E-11	1.92E-11
PSW	10-6-5	3.52E-04	1.76E-03	3.00	5.65E-04	2.82E-03	2.38E-11	2.00E-11
PSW	10-6-6	3.52E-04	2.11E-03	4.00	5.65E-04	3.39E-03	3.34E-11	2.16E-11
PSW	10-6-7	3.52E-04	2.46E-03	18.00	5.65E-04	3.95E-03	4.77E-13	6.53E-12
PSW	10-6-8	3.52E-04	2.81E-03	48.00	5.65E-04	4.52E-03	3.33E-13	3.20E-12
PSW	10-6-9	3.52E-04	3.17E-03	90.00	5.65E-04	5.08E-03	3.67E-13	2.16E-12
PSW	10-6-10	3.52E-04	3.52E-03	150.00	5.65E-04	5.65E-03	3.15E-13	1.60E-12

TABLE B.22-2a. Manganese-54 Fraction Leached for Static Leach Test: Whole Grout in Hanford Ground Water (PSW 10-4)

	SAMPLE ID	uCi LEACHED	TIME DAYS	cum An/Ao	D cum.
PSW	10-4-1	3.5173E-04	4.00	2.47E-03	4.52E-12
PSW	10-4-2	3.5173E-04	19.00	2.47E-03	9.52E-13
PSW	10-4-3	3.5173E-04	48.00	2.47E-03	3.77E-13
PSW	10-4-4	3.5173E-04	90.00	2.47E-03	2.01E-13

TABLE B.23-1a. Cobalt-60 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 10-1)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	10-1-1	4.53E-04	4.53E-04	0.08	2.04E-04	2.04E-04	1.58E-12	1.58E-12
PSW	10-1-2	4.53E-04	9.06E-04	0.29	2.04E-04	4.07E-04	2.09E-12	1.81E-12
PSW	10-1-3	4.53E-04	1.36E-03	1.00	2.04E-04	6.11E-04	6.16E-13	1.18E-12
PSW	10-1-4	4.53E-04	1.81E-03	2.00	2.04E-04	8.15E-04	7.65E-13	1.05E-12
PSW	10-1-5	4.53E-04	2.26E-03	3.00	2.04E-04	1.02E-03	1.30E-12	1.09E-12
PSW	10-1-6	4.53E-04	2.72E-03	4.00	2.04E-04	1.22E-03	1.83E-12	1.18E-12
PSW	10-1-7	4.53E-04	3.17E-03	18.00	2.04E-04	1.43E-03	2.61E-14	3.57E-13
PSW	10-1-8	4.53E-04	3.62E-03	48.00	2.04E-04	1.63E-03	1.82E-14	1.75E-13
PSW	10-1-9	4.53E-04	4.08E-03	90.00	2.04E-04	1.83E-03	2.00E-14	1.18E-13
PSW	10-1-10	4.53E-04	4.53E-03	150.00	2.04E-04	2.04E-03	1.72E-14	8.75E-14

TABLE B.23-1b. Cobalt-60 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 10-6)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	10-6-1	4.65E-04	4.65E-04	0.08	4.77E-05	4.77E-05	2.02E-13	2.02E-13
PSW	10-6-2	4.65E-04	9.30E-04	0.29	4.77E-05	9.55E-05	2.68E-13	2.31E-13
PSW	10-6-3	4.65E-04	1.39E-03	1.00	4.77E-05	1.43E-04	7.68E-14	1.51E-13
PSW	10-6-4	4.65E-04	1.86E-03	2.00	4.77E-05	1.91E-04	9.78E-14	1.34E-13
PSW	10-6-5	4.65E-04	2.32E-03	3.00	4.77E-05	2.39E-04	1.66E-13	1.40E-1[illegible]
PSW	10-6-6	4.65E-04	2.79E-03	4.00	4.77E-05	2.86E-04	2.34E-13	1.51E-1[illegible]
PSW	10-6-7	4.65E-04	3.25E-03	18.00	4.77E-05	3.34E-04	3.34E-15	4.57E-14
PSW	10-6-8	4.65E-04	3.72E-03	48.00	4.77E-05	3.82E-04	2.33E-15	2.24E-14
PSW	10-6-9	4.65E-04	4.18E-03	90.00	4.77E-05	4.30E-04	2.56E-15	1.51E-14
PSW	10-6-10	4.65E-04	4.65E-03	150.00	4.77E-05	4.77E-04	2.20E-15	1.12E-14

TABLE B.23-2a. Cobalt-60 Fraction Leached for Static Leach Test: Whole Grout in Hanford Ground Water (PSW 10-4)

	SAMPLE ID	uCi LEACHED	TIME DAYS	cum An/Ao	D cum.
PSW	4-4-1	4.5292E-04	4.00	2.04E-04	3.07E-14
PSW	4-4-2	4.5292E-04	19.00	2.04E-04	6.46E-15
PSW	4-4-3	4.5292E-04	48.00	2.04E-04	2.56E-15
PSW	4-4-4	4.5292E-04	90.00	2.04E-04	1.36E-15

TABLE B.24-1a. Strontium-90 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 10-1)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	10-1-1	1.99E-06	1.99E-06	0.08	4.01E-06	4.01E-06	6.14E-16	6.14E-16
PSW	10-1-2	1.99E-06	3.98E-06	0.29	4.01E-06	8.03E-06	8.13E-16	7.03E-16
PSW	10-1-3	1.99E-06	5.97E-06	1.00	4.01E-06	1.20E-05	2.39E-16	4.59E-16
PSW	10-1-4	1.99E-06	7.96E-06	2.00	4.01E-06	1.61E-05	2.97E-16	4.08E-16
PSW	10-1-5	1.99E-06	9.95E-06	3.00	4.01E-06	2.01E-05	5.05E-16	4.25E-16
PSW	10-1-6	1.99E-06	1.19E-05	4.00	4.01E-06	2.41E-05	7.10E-16	4.59E-16
PSW	10-1-7	1.99E-06	1.39E-05	18.00	4.01E-06	2.81E-05	1.01E-17	1.39E-16
PSW	10-1-8	1.99E-06	1.59E-05	48.00	4.01E-06	3.21E-05	7.07E-18	6.80E-17
PSW	10-1-9	1.99E-06	1.79E-05	90.00	4.01E-06	3.61E-05	7.79E-18	4.59E-17
PSW	10-1-10	1.99E-06	1.99E-05	150.00	4.01E-06	4.01E-05	6.69E-18	3.40E-17
PSW	10-1-11	1.99E-06	2.19E-05	211.00	4.01E-06	4.42E-05	9.82E-18	2.92E-17

TABLE B.24-1b. Strontium-90 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 10-6)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	10-6-1	1.99E-06	1.99E-06	0.08	9.83E-07	9.83E-07	8.76E-17	8.76E-17
PSW	10-6-2	1.99E-06	3.98E-06	0.29	9.83E-07	1.97E-06	1.16E-16	1.00E-16
PSW	10-6-3	1.99E-06	5.97E-06	1.00	9.83E-07	2.95E-06	3.42E-17	6.55E-17
PSW	10-6-4	1.99E-06	7.96E-06	2.00	9.83E-07	3.93E-06	4.24E-17	5.82E-17
PSW	10-6-5	1.99E-06	9.95E-06	3.00	9.83E-07	4.91E-06	7.20E-17	6.06E-17
PSW	10-6-6	1.99E-06	1.19E-05	4.00	9.83E-07	5.90E-06	1.01E-16	6.55E-17
PSW	10-6-7	1.99E-06	1.39E-05	18.00	9.83E-07	6.88E-06	1.45E-18	1.98E-17
PSW	10-6-8	1.99E-06	1.59E-05	48.00	9.63E-07	7.86E-06	1.01E-18	9.70E-18
PSW	10-6-9	1.99E-06	1.79E-05	90.00	9.83E-07	8.85E-06	1.11E-18	6.55E-18
PSW	10-6-10	1.99E-06	1.99E-05	150.00	9.83E-07	9.83E-06	9.54E-19	4.85E-18
PSW	10-6-11	1.99E-06	2.19E-05	223.00	9.83E-07	1.08E-05	1.01E-18	3.95E-18

TABLE B.24-2a. Strontium-90 Fraction Leached for Static Leach Test: Whole Grout in Hanford Ground Water (PSW 10-4)

	SAMPLE ID	uCi LEACHED	TIME DAYS	cum An/Ao	D cum.
PSW	10-4-1	1.9890E-06	4.00	4.21E-06	1.31E-17
PSW	10-4-2	1.9890E-06	19.00	4.21E-06	2.75E-18
PSW	10-4-3	1.9890E-06	48.00	4.21E-06	1.09E-16
PSW	10-4-4	1.9890E-06	90.00	4.21E-06	5.80E-19

TABLE B.25-1a. Cesium-137 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 10-1)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	10-1-1	3.17E-04	3.17E-04	0.08	3.94E-04	3.94E-04	5.92E-12	5.92E-12
PSW	10-1-2	3.17E-04	6.34E-04	0.29	3.94E-04	7.88E-04	7.84E-12	6.78E-12
PSW	10-1-3	3.17E-04	9.52E-04	1.00	3.94E-04	1.18E-03	2.31E-12	4.43E-12
PSW	10-1-4	3.17E-04	1.27E-03	2.00	3.94E-04	1.58E-03	2.87E-12	3.93E-12
PSW	10-1-5	3.17E-04	1.59E-03	3.00	3.94E-04	1.97E-03	4.67E-12	4.10E-12
PSW	10-1-6	3.17E-04	1.90E-03	4.00	3.94E-04	2.37E-03	6.85E-12	4.43E-12
PSW	10-1-7	3.17E-04	2.22E-03	18.00	3.94E-04	2.76E-03	9.78E-14	1.34E-12
PSW	10-1-8	3.17E-04	2.54E-03	48.00	3.94E-04	3.15E-03	6.82E-14	6.58E-13
PSW	10-1-9	3.17E-04	2.85E-03	90.00	3.94E-04	3.55E-03	7.51E-14	4.43E-13
PSW	10-1-10	3.17E-04	3.17E-03	150.00	3.94E-04	3.94E-03	6.45E-14	3.28E-13

TABLE B.25-1b. Cesium-137 Fraction Leached for ANS 16.1 Leach Test: Whole Grout in Hanford Ground Water (PSW 10-6)

	SAMPLE ID	TOT. LEACH (An)	CUM. LEACH	TIME DAYS	An/Ao	cum An/Ao	D inc.	D cum.
PSW	10-6-1	3.1720E-04	3.1720E-04	0.08	9.65E-05	9.65E-05	8.44E-13	8.44E-13
PSW	10-6-2	3.1720E-04	6.3440E-04	0.29	9.65E-05	1.93E-04	1.12E-12	9.87E-13
PSW	10-6-3	3.1720E-04	9.5161E-04	1.00	9.65E-05	2.89E-04	3.29E-13	6.31E-13
PSW	10-6-4	3.1720E-04	1.2688E-03	2.00	9.65E-05	3.86E-04	4.08E-13	5.61E-13
PSW	10-6-5	3.1720E-04	1.5860E-03	3.00	9.65E-05	4.82E-04	6.94E-13	5.84E
PSW	10-6-6	3.1720E-04	1.9032E-03	4.00	9.65E-05	5.79E-04	9.76E-13	6.31E
PSW	10-6-7	3.1720E-04	2.2204E-03	18.00	9.65E-05	6.75E-04	1.39E-14	1.91E-13
PSW	10-6-8	3.1720E-04	2.5376E-03	48.00	9.65E-05	7.72E-04	9.72E-15	9.34E-14
PSW	10-6-9	3.1720E-04	2.8548E-03	90.00	9.65E-05	8.68E-04	1.07E-14	6.31E-14
PSW	10-6-10	3.1720E-04	3.1720E-03	150.00	9.65E-05	9.65E-04	9.20E-15	4.67E-14

TABLE B.25-2a. Cesium-137 Fraction Leached for Static Leach Test: Whole Grout in Hanford Ground Water (PSW 10-4)

	SAMPLE ID	uCi LEACHED	TIME DAYS	cum An/Ao	D cum.
PSW	10-4-1	3.1720E-04	4.00	4.13E-04	1.26E-13
PSW	10-4-2	3.1720E-04	19.00	4.13E-04	2.65E-14
PSW	10-4-3	3.1720E-04	48.00	4.13E-04	1.05E-14
PSW	10-4-4	3.1720E-04	90.00	4.13E-04	5.60E-15

TABLE B.26-1a. Uranium (total U) Fraction Leached for ANS 16.1 Leach Test: Whole, Small Grout in Hanford Ground Water (PSW A10-1)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum.
A-10-1-1	9.98E-04	6.04E-04	6.04E-04	8.33E-02	1.29E-11	1.29E-11
A-10-1-2	1.20E-03	7.28E-04	1.33E-03	2.92E-01	2.48E-11	2.52E-11
A-10-1-3	8.46E-04	5.13E-04	1.85E-03	1.00E+00	3.68E-12	1.42E-11
A-10-1-4	1.24E-03	7.53E-04	2.60E-03	2.00E+00	9.77E-12	1.99E-11
A-10-1-5	1.12E-03	6.81E-04	3.28E-03	3.00E+00	1.35E-11	3.18E-11
A-10-1-6	1.29E-03	7.83E-04	4.06E-03	4.00E+00	2.52E-11	4.67E-11
A-10-1-7	2.88E-04	1.75E-04	4.24E-03	1.80E+01	1.79E-14	3.79E-12
A-10-1-8	9.00E-05	5.46E-05	4.29E-03	4.70E+01	1.29E-15	1.80E-12
A-10-1-9	1.31E-03	7.93E-04	5.08E-03	9.00E+01	2.69E-13	1.78E-12
A-10-1-10	1.20E-03	7.28E-04	5.81E-03	1.50E+02	2.05E-13	1.66E-12
A-10-1-11	1.06E-03	6.44E-04	6.46E-03	2.08E+02	2.59E-13	2.12E-12

TABLE B.26-1b. Uranium (total U) Fraction Leached for ANS 16.1 Leach Test: Whole, Small Grout in Hanford Ground Water (PSW A10-2)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum.
A-10-2-1	9.60E-04	5.82E-04	5.82E-04	8.33E-02	1.20E-11	1.20E-11
A-10-2-2	9.60E-04	5.82E-04	1.16E-03	2.92E-01	1.56E-11	1.92E-11
A-10-2-3	7.02E-04	4.26E-04	1.59E-03	1.00E+00	2.53E-12	1.06E-11
A-10-2-4	1.09E-03	6.62E-04	2.25E-03	2.00E+00	7.55E-12	1.50E-11
A-10-2-5	1.09E-03	6.62E-04	2.92E-03	3.00E+00	1.20E-11	2.51E-11
A-10-2-6	1.24E-03	7.53E-04	3.67E-03	4.00E+00	2.33E-11	3.98E-11
A-10-2-7	1.65E-03	1.00E-03	4.67E-03	1.80E+01	5.86E-13	4.60E-12
A-10-2-8	9.60E-05	5.82E-05	4.73E-03	4.70E+01	1.47E-15	2.28E-12
A-10-2-9	1.58E-03	9.57E-04	5.69E-03	9.00E+01	3.91E-13	2.22E-12
A-10-2-10	1.58E-03	9.57E-04	6.64E-03	1.50E+02	3.55E-13	2.17E-12
A-10-2-11	9.30E-04	5.64E-04	7.21E-03	2.08E+02	1.99E-13	2.64E-12

TABLE B.26-2a. Uranium (total U) Fraction Leached for ANS 16.1 Leach Test: Whole, Large Grout in Hanford Ground Water (PSW LA10-6)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum.
LA-10-6-1	2.93E-03	3.88E-04	3.88E-04	8.33E-02	1.39E-11	1.39E-11
LA-10-6-2	2.64E-03	3.50E-04	7.38E-04	2.92E-01	1.49E-11	2.01E-11
LA-10-6-3	2.40E-03	3.18E-04	1.06E-03	1.00E+00	3.68E-12	1.21E-11
LA-10-6-4	2.70E-03	3.58E-04	1.41E-03	2.00E+00	5.76E-12	1.54E-11
LA-10-6-5	2.61E-03	3.46E-04	1.76E-03	3.00E+00	9.10E-12	2.38E-11
LA-10-6-6	2.61E-03	3.46E-04	2.11E-03	4.00E+00	1.28E-11	3.41E-11
LA-10-6-7	1.44E-03	1.91E-04	2.30E-03	1.80E+01	5.57E-14	2.90E-12
LA-10-6-8	1.62E-03	2.14E-04	2.51E-03	4.70E+01	5.17E-14	1.67E-12
LA-10-6-9	4.43E-03	5.87E-04	3.10E-03	9.00E+01	3.83E-13	1.72E-12
LA-10-6-10	4.32E-03	5.72E-04	3.67E-03	1.50E+02	3.31E-13	1.73E-12
LA-10-6-11	4.32E-03	5.72E-04	4.24E-03	2.08E+02	5.33E-13	2.39E-12

TABLE B.27-a. Sodium Fraction Leached for ANS 16.1 Leach Test: Whole, Small Grout in Hanford Ground Water (PSW A10-1)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum. (<0.2)
PSWA 10-1-1	1.87E+01	3.20E-02	3.20E-02	8.33E-02	3.88E-08	3.88E-08
PSWA 10-1-2	6.78E+00	1.16E-02	4.36E-02	2.90E-01	6.84E-09	2.07E-08
PSWA 10-1-3	1.21E+01	2.07E-02	6.42E-02	1.00E+00	6.34E-09	1.31E-08
PSWA 10-1-4	9.00E+00	1.54E-02	7.97E-02	2.00E+00	4.38E-09	1.00E-08
PSWA 10-1-5	7.80E+00	1.34E-02	9.30E-02	3.00E+00	5.59E-09	9.12E-09
PSWA 10-1-6	4.74E+00	8.12E-03	1.01E-01	4.00E+00	2.91E-09	8.09E-09
PSWA 10-1-7	3.87E+01	6.63E-02	1.67E-01	1.90E+01	2.50E-09	4.87E-09
PSWA 10-1-8	6.24E+01	1.07E-01	2.74E-01	4.80E+01	5.48E-09	5.33E-09
PSWA 10-1-9	2.30E+01	3.95E-02	3.14E-01	9.00E+01	7.53E-10	3.75E-09
PSWA 10-1-10	1.50E+01	2.57E-02	3.39E-01	1.50E+02	2.74E-10	2.78E-09
PSWA 10-1-11	6.96E+00	1.19E-02	3.51E-01	2.11E+02	8.68E-11	2.11E-09

TABLE B.27-b. Potassium Fraction Leached for ANS 16.1 Leach Test: Whole, Small Grout in Hanford Ground Water (PSW A10-1)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum. (<0.2)
PSWA 10-1-1	2.28E+00	2.02E-02	2.02E-02	8.33E-02	1.55E-08	1.55E-08
PSWA 10-1-2	8.40E-01	7.44E-03	2.76E-02	2.90E-01	2.81E-09	8.33E-09
PSWA 10-1-3	1.56E+00	1.38E-02	4.15E-02	1.00E+00	2.84E-09	5.44E-09
PSWA 10-1-4	1.14E+00	1.01E-02	5.16E-02	2.00E+00	1.88E-09	4.20E-09
PSWA 10-1-5	8.40E-01	7.44E-03	5.90E-02	3.00E+00	1.73E-09	3.67E-09
PSWA 10-1-6	3.60E-01	3.19E-03	6.22E-02	4.00E+00	4.48E-10	3.06E-09
PSWA 10-1-7	4.80E+00	4.25E-02	1.05E-01	1.90E+01	1.03E-09	1.83E-09
PSWA 10-1-8	6.84E+00	6.06E-02	1.65E-01	4.80E+01	1.76E-09	1.80E-09
PSWA 10-1-9	2.46E+00	2.18E-02	1.87E-01	9.00E+01	2.29E-10	1.23E-09
PSWA 10-1-10	1.92E+00	1.70E-02	2.04E-01	1.50E+02	1.20E-10	8.79E-10
PSWA 10-1-11	1.38E+00	1.22E-02	2.16E-01	2.11E+02	9.11E-11	7.02E-10

TABLE B.27-c. Boron (as H_3BO_3) Fraction Leached for ANS 16.1 Leach Test: Whole, Small Grout in Hanford Ground Water (PSW A10-1)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum. (<0.2)
PSWA 10-1-1	2.94E-01	2.36E-03	2.36E-03	8.33E-02	2.11E-10	2.11E-10
PSWA 10-1-2	1.02E-01	8.18E-04	3.18E-03	2.90E-01	3.39E-11	1.10E-10
PSWA 10-1-3	-2.23E-01	-1.79E-03	1.39E-03	1.00E+00	4.73E-11	6.12E-12
PSWA 10-1-4	6.60E-02	5.29E-04	1.92E-03	2.00E+00	5.17E-12	5.83E-12
PSWA 10-1-5	4.80E-02	3.85E-04	2.30E-03	3.00E+00	4.64E-12	5.60E-12
PSWA 10-1-6	6.00E-03	4.81E-05	2.35E-03	4.00E+00	1.02E-13	4.38E-12
PSWA 10-1-7	2.10E-01	1.68E-03	4.04E-03	1.90E+01	1.61E-12	2.71E-12
PSWA 10-1-8	2.70E-01	2.17E-03	6.20E-03	4.80E+01	2.25E-12	2.54E-12
PSWA 10-1-9	2.40E-02	1.92E-04	6.39E-03	9.00E+01	1.79E-14	1.44E-12
PSWA 10-1-10	3.00E-02	2.41E-04	6.64E-03	1.50E+02	2.40E-14	9.29E-13
PSWA 10-1-11	3.60E-02	2.89E-04	6.92E-03	2.11E+02	5.08E-14	7.19E-13

TABLE B.27-d. Sulfate (SO_4) Fraction Leached for ANS 16.1 Leach Test: Whole, Small Grout in Hanford Ground Water (PSW A10-1)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum. (<0.2)
PSWA 10-1-1	3.60E+00	8.99E-03	8.99E-03	8.33E-02	3.07E-09	3.07E-09
PSWA 10-1-2	2.40E+00	5.99E-03	1.50E-02	2.90E-01	1.82E-09	2.45E-09
PSWA 10-1-3	1.20E+00	3.00E-03	1.80E-02	1.00E+00	1.33E-10	1.02E-09
PSWA 10-1-4	1.20E+00	3.00E-03	2.10E-02	2.00E+00	1.66E-10	8.96E-10
PSWA 10-1-5	6.00E-01	1.50E-03	2.25E-02	3.00E+00	7.03E-11	5.33E-10
PSWA 10-1-6	-6.00E-01	-1.50E-03	2.10E-02	4.00E+00	9.90E-11	3.48E-10
PSWA 10-1-7	-6.00E-01	-1.50E-03	1.95E-02	1.90E+01	1.28E-12	6.32E-11
PSWA 10-1-8	2.40E+00	5.99E-03	2.55E-02	4.80E+01	1.72E-11	4.28E-11
PSWA 10-1-9	-1.80E+00	-4.50E-03	2.10E-02	9.00E+01	9.77E-12	1.55E-11
PSWA 10-1-10	2.70E-01	6.74E-04	2.17E-02	1.50E+02	1.89E-13	9.89E-12
PSWA 10-1-11	2.34E+00	5.84E-03	2.75E-02	2.11E+02	2.08E-11	1.13E-11

TABLE B.28-a. Sodium Fraction Leached for ANS 16.1 Leach Test: Whole, Large Grout in Hanford Ground Water (LA PSW10-6)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum.
PSWLA 10-6-1	3.79E+01	1.48E-02	1.48E-02	8.33E-02	1.99E-08	1.99E-08
PSWLA 10-6-2	2.59E+01	1.01E-02	2.50E-02	2.90E-01	1.24E-08	1.62E-08
PSWLA 10-6-3	4.40E+01	1.72E-02	4.22E-02	1.00E+00	1.05E-08	1.34E-08
PSWLA 10-6-4	3.23E+01	1.26E-02	5.48E-02	2.00E+00	7.01E-09	1.13E-08
PSWLA 10-6-5	2.38E+01	9.33E-03	6.41E-02	3.00E+00	6.48E-09	1.03E-08
PSWLA 10-6-6	1.79E+01	7.01E-03	7.12E-02	4.00E+00	5.15E-09	9.53E-09
PSWLA 10-6-7	9.82E+01	3.84E-02	1.10E-01	1.90E+01	2.00E-09	4.76E-09
PSWLA 10-6-8	1.13E+02	4.42E-02	1.54E-01	4.80E+01	2.23E-09	3.71E-09
PSWLA 10-6-9	4.18E+01	1.63E-02	1.70E-01	9.00E+01	3.07E-10	2.42E-09
PSWLA 10-6-10	3.02E+01	1.18E-02	1.82E-01	1.50E+02	1.37E-10	1.66E-09
PSWLA 10-6-11	1.86E+01	7.28E-03	1.89E-01	2.11E+02	7.64E-11	1.28E-09

TABLE B.28-b. Potassium Fraction Leached for ANS 16.1 Leach Test: Whole, Large Grout in Hanford Ground Water (LA PSW10-6)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum.
PSWLA 10-6-1	5.12E+00	1.03E-02	1.03E-02	8.33E-02	9.68E-09	9.68E-09
PSWLA 10-6-2	4.32E+00	8.73E-03	1.91E-02	2.90E-01	9.20E-09	9.45E-09
PSWLA 10-6-3	6.56E+00	1.33E-02	3.23E-02	1.00E+00	6.22E-09	7.87E-09
PSWLA 10-6-4	5.92E+00	1.20E-02	4.43E-02	2.00E+00	6.28E-09	7.39E-09
PSWLA 10-6-5	1.12E+00	2.26E-03	4.66E-02	3.00E+00	3.82E-10	5.44E-09
PSWLA 10-6-6	1.28E+00	2.59E-03	4.92E-02	4.00E+00	7.02E-10	4.55E-09
PSWLA 10-6-7	1.09E+01	2.20E-02	7.12E-02	1.90E+01	6.54E-10	2.01E-09
PSWLA 10-6-8	1.28E+01	2.59E-02	9.70E-02	4.80E+01	7.63E-10	1.48E-09
PSWLA 10-6-9	4.48E+00	9.06E-03	1.06E-01	9.00E+01	9.43E-11	9.41E-10
PSWLA 10-6-10	4.00E+00	8.09E-03	1.14E-01	1.50E+02	6.48E-11	6.54E-10
PSWLA 10-6-11	2.08E+00	4.20E-03	1.18E-01	2.11E+02	2.56E-11	5.00E-10

TABLE B.28-c. Boron (as H_3BO_3) Fraction Leached for ANS 16.1 Leach Test: Whole, Large Grout in Hanford Ground Water (LA PSW10-6)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum.
PSWLA 10-6-1	5.28E-01	9.67E-04	9.67E-04	8.33E-02	8.45E-11	8.45E-11
PSWLA 10-6-2	3.68E-01	6.74E-04	1.64E-03	2.90E-01	5.48E-11	6.99E-11
PSWLA 10-6-3	5.44E-01	9.96E-04	2.64E-03	1.00E+00	3.51E-11	5.23E-11
PSWLA 10-6-4	2.56E-01	4.69E-04	3.11E-03	2.00E+00	9.64E-12	3.83E-11
PSWLA 10-6-5	3.20E-02	5.86E-05	3.16E-03	3.00E+00	2.56E-13	2.51E-11
PSWLA 10-6-6	1.60E-02	2.93E-05	3.19E-03	4.00E+00	9.00E-14	1.92E-11
PSWLA 10-6-7	4.32E-01	7.91E-04	3.98E-03	1.90E+01	8.47E-13	6.29E-12
PSWLA 10-6-8	4.96E-01	9.08E-04	4.89E-03	4.80E+01	9.41E-13	3.76E-12
PSWLA 10-6-9	0.00E+00	0.00E+00	4.89E-03	9.00E+01	0.00E+00	2.00E-12
PSWLA 10-6-10	1.60E-02	2.93E-05	4.92E-03	1.50E+02	8.48E-16	1.22E-12
PSWLA 10-6-11	3.20E-02	5.86E-05	4.98E-03	2.11E+02	4.98E-15	8.85E-13

TABLE B.28-d. Sulfate (SO_4) Fraction Leached for ANS 16.1 Leach Test: Whole, Large Grout in Hanford Ground Water (LA PSW10-6)

SAMPLE	mg LEACHED	An/Ao	cum. An/Ao	TIME days	D inc.	D cum.
PSWLA 10-6-1	4.80E+00	2.74E-03	2.74E-03	8.33E-02	6.77E-10	6.77E-10
PSWLA 10-6-2	1.60E+00	9.13E-04	3.65E-03	2.90E-01	1.00E-10	3.46E-10
PSWLA 10-6-3	9.60E+00	5.48E-03	9.13E-03	1.00E+00	1.06E-09	6.27E-10
PSWLA 10-6-4	-3.20E+00	-1.83E-03	7.30E-03	2.00E+00	1.46E-10	2.01E-10
PSWLA 10-6-5	-1.60E+00	-9.13E-04	6.39E-03	3.00E+00	6.20E-11	1.02E-10
PSWLA 10-6-6	1.60E+00	9.13E-04	7.30E-03	4.00E+00	8.73E-11	1.00E-10
PSWLA 10-6-7	-3.20E+00	-1.83E-03	5.46E-03	1.90E+01	4.51E-12	1.19E-11
PSWLA 10-6-8	-9.60E+00	-5.48E-03	2.53E-19	4.80E+01	3.42E-11	1.01E-44
PSWLA 10-6-9	-6.40E+00	-3.65E-03	-3.65E-03	9.00E+01	1.53E-11	1.11E-12
PSWLA 10-6-10	8.00E-01	4.56E-04	-3.19E-03	1.50E+02	2.06E-13	5.12E-13
PSWLA 10-6-11	8.00E+00	4.56E-03	1.37E-03	2.11E+02	3.02E-11	6.68E-14

TABLE B.29-a. Sodium Fraction Leached for Static Leach Test: Whole, Small Grout in Ground Water (PSW S10-4)

SAMPLE	mg LEACHED	cum. An/Ao	TIME days	D cum. (<0.2)
PSWS 10-4-1	7.06E+01	1.21E-01	4.00E+00	1.13E-08
PSWS 10-4-2	1.43E+02	2.46E-01	1.90E+01	1.10E-08
PSWS 10-4-3	2.09E+02	3.59E-01	4.80E+01	9.93E-09
PSWS 10-4-4	2.30E+02	3.93E-01	9.00E+01	6.36E-09
PSWS 10-4-5	2.39E+02	4.10E-01	1.50E+02	4.29E-09
PSWS 10-4-6	2.33E+02	3.99E-01	2.11E+02	2.71E-09

TABLE B.29-b. Potassium (K) Fraction Leached for Static Leach Test: Whole, Small Grout in Ground Water (PSW S10-4)

SAMPLE	mg LEACHED	cum. An/Ao	TIME days	D cum. (<0.2)
PSWS 10-4-1	8.10E+00	7.17E-02	4.00E+00	3.94E-09
PSWS 10-4-2	1.21E+01	1.07E-01	1.90E+01	1.84E-09
PSWS 10-4-3	2.33E+01	2.07E-01	4.80E+01	3.01E-09
PSWS 10-4-4	2.53E+01	2.24E-01	9.00E+01	1.95E-09
PSWS 10-4-5	2.73E+01	2.42E-01	1.50E+02	1.29E-09
PSWS 10-4-6	2.76E+01	2.44E-01	2.11E+02	9.16E-10

TABLE B.29-c. Aluminum (Al) Fraction Leached for Static Leach Test: Whole, Small Grout in Ground Water (PSW S10-4)

SAMPLE	mg LEACHED	cum. An/Ao	TIME days	D cum. (<0.2)
PSWS 10-4-1	8.16E-01	5.53E-04	4.00E+00	2.34E-13
PSWS 10-4-2	1.99E+00	1.35E-03	1.90E+01	2.92E-13
PSWS 10-4-3	3.62E+00	2.46E-03	4.80E+01	3.84E-13
PSWS 10-4-4	4.34E+00	2.94E-03	9.00E+01	2.95E-13
PSWS 10-4-5	4.87E+00	3.30E-03	1.50E+02	2.22E-13
PSWS 10-4-6	5.07E+00	3.44E-03	2.11E+02	1.71E-13

TABLE B.29-d. Nitrite (NO_3) Fraction Leached for Static Leach Test: Whole, Small Grout in Ground Water (PSW S10-4)

SAMPLE	mg LEACHED	cum. An/Ao	TIME days	D cum. (<0.2)
PSWS 10-4-1	0.00E+00	0.00E+00	4.00E+00	0.00E+00
PSWS 10-4-2	0.00E+00	0.00E+00	1.90E+01	0.00E+00
PSWS 10-4-3	1.20E-01	1.21E-02	4.80E+01	9.40E-12
PSWS 10-4-4	1.00E-02	1.01E-03	9.00E+01	3.48E-14
PSWS 10-4-5	1.00E-02	1.01E-03	1.50E+02	2.09E-14
PSWS 10-4-6	1.00E-02	1.01E-03	2.11E+02	1.48E-14

TABLE B.30-a. Sulfate (SO_4) Fraction Leached for Static Leach Test: Whole, Small Grout in Ground Water (PSW S10-4)

SAMPLE	mg LEACHED	cum. An/Ao	TIME days	D cum. (<0.2)
PSWS 10-4-1	4.20E+00	1.05E-02	4.00E+00	8.42E-11
PSWS 10-4-2	3.95E+00	9.87E-03	1.90E+01	1.57E-11
PSWS 10-4-3	4.85E+00	1.21E-02	4.80E+01	9.38E-12
PSWS 10-4-4	4.00E+00	1.00E-02	9.00E+01	3.40E-12
PSWS 10-4-5	6.35E+00	1.59E-02	1.50E+02	5.13E-12
PSWS 10-4-8	8.45E+00	2.11E-02	2.11E+02	6.46E-12

TABLE B.30-b. Boron (as H_3BO_3) Fraction Leached for Static Leach Test: Whole, Small Grout in Ground Water (PSW S10-4)

SAMPLE	mg LEACHED	cum. An/Ao	TIME days	D cum. (<0.2)
PSWS 10-4-1	8.76E-01	7.03E-03	4.00E+00	3.76E-11
PSWS 10-4-2	1.19E+00	9.53E-03	1.90E+01	1.46E-11
PSWS 10-4-3	1.69E+00	1.36E-02	4.80E+01	1.17E-11
PSWS 10-4-4	1.75E+00	1.40E-02	9.00E+01	6.67E-12
PSWS 10-4-5	1.81E+00	1.45E-02	1.50E+02	4.30E-12
PSWS 10-4-6	1.87E+00	1.50E-02	2.11E+02	3.27E-12

TABLE B.31-a. Uranium (total U) Fraction Leached for Static Leach Test: Whole, Small Grout in Hanford Ground Water (PSW S10-4)

SAMPLE	mg LEACHED	cum An/Ao	TIME days	D cum.
S-10-4-1	2.64E-04	1.60E-04	4.00E+00	1.89E-14
S-10-4-2	2.86E-04	1.73E-04	1.90E+01	5.93E-15
S-10-4-3	2.95E-04	1.79E-04	4.80E+01	3.26E-15
S-10-4-4	1.86E-04	1.13E-04	9.00E+01	8.96E-16
S-10-4-5	2.81E-04	1.71E-04	1.50E+02	1.44E-15
S-10-4-6	2.21E-04	1.34E-04	2.11E+02	8.70E-16

TABLE B.31-b. Uranium (total U) Fraction Leached for Static Leach Test: Whole, Small Grout in Hanford Ground Water (PSW S10-5)

SAMPLE	mg LEACHED	cum An/Ao	TIME days	D cum.
S-10-5-1	2.52E-04	1.53E-04	4 00E+00	1.73E-14
S-10-5-2	2.73E-04	1.66E-04	1 90E+01	5.40E-15
S-10-5-3	2.94E-04	1.78E-04	4.80E+01	3.24E-15
S-10-5-4	2.04E-04	1.24E-04	9.00E+01	1.08E-15
S-10-5-5	2.04E-04	1.24E-04	1.50E+02	7.54E-16
S-10-5-6	2.15E-04	1.31E-04	2.11E+02	8.27E-16

APPENDIX C

MASS BALANCE CALCULATIONS (ESTIMATES OF TOTAL MASS LEACHED BASED ON CHANGES IN SOLUTION)

TABLE C.1. Mass Balance Calculations for PSW 5-1 (ANS 16.1 Leach Test)

Ca

SAMPLE NO.	EFFLUENT	HGW CONC.	ELUTED	SUM ELUTED
--------	ppm Ca	ppm Ca	mg Ca	mg Ca
5-1-1	24.20	50.60	-15.84	-15.84
5-1-2	43.40	50.60	-4.32	-20.16
5-1-3	18.20	50.60	-19.44	-39.60
5-1-4	28.90	50.60	-13.02	-52.62
5-1-5	28.30	50.60	-13.38	-66.00
5-1-6	32.50	50.60	-10.86	-76.86
5-1-7	2.41	50.60	-28.91	-105.77
5-1-8	3.70	50.60	-28.14	-133.91
5-1-9	6.15	50.60	-26.67	-160.58
5-1-10	15.10	50.60	-21.30	-181.88
5-1-11	16.90	50.60	-20.22	-202.10

Na

SAMPLE NO.	EFFLUENT	HGW CONC.	ELUTED	SUM ELUTED
--------	ppm Na	ppm Na	mg Na	mg Na
5-1-1	57.30	25.00	19.38	19.38
5-1-2	31.40	25.00	3.84	23.22
5-1-3	53.20	25.00	16.92	40.14
5-1-4	45.50	25.00	12.30	52.44
5-1-5	38.10	25.00	7.86	60.30
5-1-6	34.10	25.00	5.46	65.76
5-1-7	91.70	25.00	40.02	105.78
5-1-8	108.00	25.00	49.80	155.58
5-1-9	71.80	25.00	28.08	183.66
5-1-10	56.20	25.00	18.72	202.38
5-1-11	43.00	25.00	10.80	213.18

K

SAMPLE NO.	EFFLUENT	HGW CONC.	ELUTED	SUM ELUTED
--------	ppm K	ppm K	mg K	mg K
5-1-1	12.30	8.00	2.58	2.58
5-1-2	9.40	8.00	0.84	3.42
5-1-3	11.70	8.00	2.22	5.64
5-1-4	10.70	8.00	1.62	7.26
5-1-5	9.40	8.00	0.84	8.10
5-1-6	8.60	8.00	0.36	8.46
5-1-7	16.00	8.00	4.80	13.26
5-1-8	16.00	8.00	4.80	18.06
5-1-9	12.80	8.00	2.88	20.94
5-1-10	11.70	8.00	2.22	23.16
5-1-11	10.00	8.00	1.20	24.36

Al

SAMPLE NO.	EFFLUENT	HGW CONC.	ELUTED	SUM ELUTED
--------	ppm Al	ppm Al	mg Al	mg Al
5-1-1	0.07	0.03	0.02	0.02
5-1-2	0.05	0.03	0.01	0.03
5-1-3	0.14	0.03	0.06	0.10
5-1-4	0.03	0.03	0.00	0.10
5-1-5	0.03	0.03	0.00	0.10
5-1-6	0.03	0.03	0.00	0.10
5-1-7	0.03	0.03	0.00	0.10
5-1-8	0.03	0.03	0.00	0.10
5-1-9	0.03	0.03	0.00	0.10
5-1-10	0.03	0.03	0.00	0.10
5-1-11	0.03	0.03	0.00	0.10

Si

SAMPLE NO.	EFFLUENT	HGW CONC.	ELUTED	SUM ELUTED
--------	ppm Si	ppm Si	mg Si	mg Si
5-1-1	14.10	15.00	-0.54	-0.54
5-1-2	15.00	15.00	0.00	-0.54
5-1-3	13.60	15.00	-0.84	-1.38
5-1-4	14.80	15.00	-0.12	-1.50
5-1-5	14.50	15.00	-0.30	-1.80
5-1-6	14.70	15.00	-0.18	-1.98
5-1-7	11.40	15.00	-2.16	-4.14
5-1-8	12.80	15.00	-1.32	-5.46
5-1-9	13.50	15.00	-0.90	-6.36
5-1-10	15.10	15.00	0.06	-6.30
5-1-11	13.80	15.00	-0.72	-7.02

Mg

SAMPLE NO.	EFFLUENT	HGW CONC.	ELUTED	SUM ELUTED
--------	ppm Mg	ppm Mg	mg Mg	mg Mg
5-1-1	11.20	13.40	-1.32	-1.32
5-1-2	13.60	13.40	0.12	-1.20
5-1-3	10.30	13.40	-1.86	-3.06
5-1-4	11.90	13.40	-0.90	-3.96
5-1-5	11.70	13.40	-1.02	-4.98
5-1-6	12.40	13.40	-0.60	-5.58
5-1-7	0.98	13.40	-7.45	-13.03
5-1-8	1.84	13.40	-6.94	-19.97
5-1-9	8.72	13.40	-2.81	-22.77
5-1-10	10.20	13.40	-1.92	-24.69
5-1-11	11.10	13.40	-1.38	-26.07

TABLE C.1. (contd)

H3BO3

SAMPLE NO	EFFLUENT ppm B	HGW CONC. ppm B	ELUTED mg B	SUM ELUTE mg B
5-1-1	0.80	0.41	0.23	0.23
5-1-2	0.46	0.41	0.03	0.26
5-1-3	0.68	0.41	0.16	0.43
5-1-4	0.54	0.41	0.08	0.50
5-1-5	0.48	0.41	0.04	0.55
5-1-6	0.45	0.41	0.02	0.57
5-1-7	0.78	0.41	0.22	0.79
5-1-8	0.74	0.41	0.20	0.99
5-1-9	0.52	0.41	0.07	1.06
5-1-10	0.00	0.41	-0.25	0.81
5-1-11	0.42	0.41	0.01	0.82

SO4

SAMPLE NO	EFFLUENT ppm SO4	HGW CONC. ppm SO4	ELUTED mg SO4	SUM ELUTE mg SO4
5-1-1	71.00	67.00	2.40	2.40
5-1-2	75.00	67.00	4.80	7.20
5-1-3	73.00	67.00	3.60	10.80
5-1-4	77.00	67.00	6.00	16.80
5-1-5	79.00	67.00	7.20	24.00
5-1-6	75.00	67.00	4.80	28.80
5-1-7	66.00	67.00	-0.60	28.20
5-1-8	66.00	67.00	-0.60	27.60
5-1-9	70.00	67.00	1.80	29.40
5-1-10	64.40	67.00	-1.56	27.84
5-1-11	71.00	67.00	2.40	30.24

IC

SAMPLE NO	EFFLUENT ppm IC	HGW CONC. ppm IC	ELUTED mg IC	SUM ELUTE mg IC
5-1-1	19.65	34.10	17.33	17.33
5-1-2	30.12	34.10	-2.39	14.94
5-1-3	17.67	34.10	-9.86	5.08
5-1-4	18.48	34.10	-9.37	-4.29
5-1-5	24.07	34.10	-6.02	-10.31
5-1-6	25.37	34.10	-5.24	-15.54
5-1-7	12.40	34.10	-13.02	-28.56
5-1-8	15.69	34.10	-11.05	-39.61
5-1-9	20.04	34.10	-8.44	-48.05
5-1-10	23.88	34.10	-6.13	-54.18

TOC

SAMPLE NO	EFFLUENT ppm TOC	HGW CONC. ppm TOC	ELUTED mg TOC	SUM ELUTE mg TOC
5-1-1	0.86	0.45	0.25	0.25
5-1-2	1.20	0.45	0.45	0.70
5-1-3	0.85	0.45	0.24	0.94
5-1-4	1.14	0.45	0.41	1.35
5-1-5	0.67	0.45	0.13	1.48
5-1-6	0.61	0.45	0.10	1.58
5-1-7	1.06	0.45	0.37	1.94
5-1-8	2.51	0.45	1.24	3.18
5-1-9	1.43	0.45	0.59	3.77
5-1-10	1.36	0.45	0.55	4.31

TABLE C.2. Mass Balance Calculations for PSWA 7-1 (ANS 16.1 Leach Test)

Ca

SAMPLE NO.	EFFLUENT ppm Ca	HGW CONC. ppm Ca	ELUTED mg Ca	SUM ELUTED mg Ca
7-1-1	9.02	50.60	-24.95	-24.95
7-1-2	42.10	50.60	-5.10	-30.05
7-1-3	25.50	50.60	-15.06	-45.11
7-1-4	31.80	50.60	-11.28	-56.39
7-1-5	35.30	50.60	-9.18	-65.57
7-1-6	40.10	50.60	-6.30	-71.87
7-1-7	4.53	50.60	-27.64	-99.51
7-1-8	8.99	50.60	-24.97	-124.48
7-1-9	24.80	50.60	-15.48	-139.96
7-1-10	24.70	50.60	-15.54	-155.50
7-1-11	32.80	50.60	-10.68	-166.18

Na

SAMPLE NO.	EFFLUENT ppm Na	HGW CONC. ppm Na	ELUTED mg Na	SUM ELUTED mg Na
7-1-1	93.80	25.00	41.28	41.28
7-1-2	30.50	25.00	3.30	44.58
7-1-3	39.10	25.00	8.46	53.04
7-1-4	36.10	25.00	6.66	59.70
7-1-5	35.40	25.00	6.24	65.94
7-1-6	32.10	25.00	4.26	70.20
7-1-7	79.50	25.00	32.70	102.90
7-1-8	56.60	25.00	18.96	121.86
7-1-9	43.10	25.00	10.86	132.72
7-1-10	40.70	25.00	9.42	142.14
7-1-11	31.00	25.00	3.60	145.74

K

SAMPLE NO.	EFFLUENT ppm K	HGW CONC. ppm K	ELUTED mg K	SUM ELUTED mg K
7-1-1	15.80	8.00	4.68	4.68
7-1-2	8.90	8.00	0.54	5.22
7-1-3	9.60	8.00	0.96	6.18
7-1-4	10.00	8.00	1.20	7.38
7-1-5	10.00	8.00	1.20	8.58
7-1-6	8.60	8.00	0.36	8.94
7-1-7	14.00	8.00	3.60	12.54
7-1-8	12.00	8.00	2.40	14.94
7-1-9	8.90	8.00	0.54	15.48
7-1-10	8.71	8.00	0.43	15.91
7-1-11	8.11	8.00	0.07	15.97

Al

SAMPLE NO.	EFFLUENT ppm Al	HGW CONC. ppm Al	ELUTED mg Al	SUM ELUTED mg Al
7-1-1	0.08	0.03	0.03	0.03
7-1-2	0.13	0.03	0.06	0.09
7-1-3	0.06	0.03	0.02	0.11
7-1-4	0.06	0.03	0.02	0.13
7-1-5	0.05	0.03	0.01	0.14
7-1-6	0.03	0.03	0.00	0.14
7-1-7	0.04	0.03	0.00	0.15
7-1-8	0.03	0.03	0.00	0.15
7-1-9	0.03	0.03	0.00	0.15
7-1-10	0.03	0.03	0.00	0.15
7-1-11	0.03	0.03	0.00	0.15

Si

SAMPLE NO.	EFFLUENT ppm Si	HGW CONC. ppm Si	ELUTED mg Si	SUM ELUTED mg Si
7-1-1	11.00	15.00	-2.40	-2.40
7-1-2	13.60	15.00	-0.84	-3.24
7-1-3	12.80	15.00	-1.32	-4.56
7-1-4	13.40	15.00	-0.96	-5.52
7-1-5	14.30	15.00	-0.42	-5.94
7-1-6	14.30	15.00	-0.42	-6.36
7-1-7	13.70	15.00	-0.78	-7.14
7-1-8	14.10	15.00	-0.54	-7.68
7-1-9	14.60	15.00	-0.24	-7.92
7-1-10	15.00	15.00	0.00	-7.92
7-1-11	14.20	15.00	-0.48	-8.40

Mg

SAMPLE NO.	EFFLUENT ppm Mg	HGW CONC. ppm Mg	ELUTED mg Mg	SUM ELUTED mg Mg
7-1-1	5.08	13.40	-4.99	-4.99
7-1-2	12.10	13.40	-0.78	-5.77
7-1-3	10.20	13.40	-1.92	-7.69
7-1-4	10.80	13.40	-1.56	-9.25
7-1-5	11.50	13.40	-1.14	-10.39
7-1-6	12.00	13.40	-0.84	-11.23
7-1-7	3.89	13.40	-5.71	-16.94
7-1-8	8.03	13.40	-3.22	-20.16
7-1-9	11.50	13.40	-1.14	-21.30
7-1-10	12.50	13.40	-0.54	-21.84
7-1-11	13.20	13.40	-0.12	-21.96

TABLE C.2. (contd)

H3BO3

SAMPLE NO	EFFLUENT ppm B	HGW CONC. ppm B	ELUTED mg B	SUM ELUTE mg B
7-1-1	1.25	0.41	0.50	0.50
7-1-2	0.47	0.41	0.04	0.54
7-1-3	0.65	0.41	0.14	0.68
7-1-4	0.53	0.41	0.07	0.76
7-1-5	0.50	0.41	0.05	0.81
7-1-6	0.43	0.41	0.01	0.82
7-1-7	0.76	0.41	0.21	1.03
7-1-8	0.51	0.41	0.06	1.09
7-1-9	0.40	0.41	-0.01	1.09
7-1-10	0.40	0.41	-0.01	1.08
7-1-11	0.42	0.41	0.01	1.09

SO4

SAMPLE NO	EFFLUENT ppm SO4	HGW CONC. ppm SO4	ELUTED mg SO4	SUM ELUTE mg SO4
7-1-1	75.00	67.00	4.80	4.80
7-1-2	67.00	67.00	0.00	4.80
7-1-3	69.00	67.00	1.20	6.00
7-1-4	71.00	67.00	2.40	8.40
7-1-5	69.00	67.00	1.20	9.60
7-1-6	69.00	67.00	1.20	10.80
7-1-7	66.00	67.00	-0.60	10.20
7-1-8	66.00	67.00	-0.60	9.60
7-1-9	71.00	67.00	2.40	12.00
7-1-10	68.90	67.00	1.14	13.14
7-1-11	70.00	67.00	1.80	14.94

IC

SAMPLE NO	EFFLUENT ppm IC	HGW CONC. ppm IC	ELUTED mg IC	SUM ELUTE mg IC
7-1-1	37.02	34.10	17.33	17.33
7-1-2	26.98	34.10	-4.27	13.06
7-1-3	19.59	34.10	-8.71	4.35
7-1-4	26.07	34.10	-4.82	-0.47
7-1-5	27.42	34.10	-4.01	-4.47
7-1-6	30.56	34.10	-2.12	-6.60
7-1-7	11.41	34.10	-13.61	-20.21
7-1-8	16.26	34.10	-10.70	-30.92
7-1-9	5.73	34.10	-17.02	-47.94

TOC

SAMPLE NO	EFFLUENT ppm TOC	HGW CONC. ppm TOC	ELUTED mg TOC	SUM ELUTE mg TOC
7-1-1	1.38	0.45	0.56	0.56
7-1-2	0.68	0.45	0.14	0.70
7-1-3	0.45	0.45	0.00	0.70
7-1-4	0.62	0.45	0.10	0.80
7-1-5	0.68	0.45	0.14	0.94
7-1-6	0.79	0.45	0.20	1.14
7-1-7	0.94	0.45	0.29	1.43
7-1-8	0.82	0.45	0.22	1.66
7-1-9	0.44	0.45	-0.01	1.65

TABLE C.3. Mass Balance Calculations for PSWLA 7-6 (ANS 16.1 Leach Test)

Ca

SAMPLE NO.	EFFLUENT ppm Ca	HGW CONC. ppm Ca	ELUTED mg Ca	SUM ELUTED mg Ca
7-6-1	32.30	50.60	-29.28	-29.28
7-6-2	36.50	50.60	-22.56	-51.84
7-6-3	15.30	50.60	-56.48	-108.32
7-6-4	27.20	50.60	-37.44	-145.76
7-6-5	26.40	50.60	-38.72	-184.48
7-6-6	33.20	50.60	-27.84	-212.32
7-6-7	5.28	50.60	-72.51	-284.83
7-6-8	7.43	50.60	-69.07	-353.90
7-6-9	16.00	50.60	-55.36	-409.26
7-6-10	20.90	50.60	-47.52	-456.78
7-6-11	21.60	50.60	-46.40	-503.18

Na

SAMPLE NO.	EFFLUENT ppm Na	HGW CONC. ppm Na	ELUTED mg Na	SUM ELUTED mg Na
7-6-1	51.40	25.00	42.24	42.24
7-6-2	38.40	25.00	21.44	63.68
7-6-3	54.60	25.00	47.36	111.04
7-6-4	44.80	25.00	31.68	142.72
7-6-5	40.90	25.00	25.44	168.16
7-6-6	35.70	25.00	17.12	185.28
7-6-7	85.10	25.00	96.16	281.44
7-6-8	61.20	25.00	57.92	339.36
7-6-9	49.80	25.00	39.68	379.04
7-6-10	47.50	25.00	36.00	415.04
7-6-11	39.70	25.00	23.52	438.56

K

SAMPLE NO.	EFFLUENT ppm K	HGW CONC. ppm K	ELUTED mg K	SUM ELUTED mg K
7-6-1	11.30	8.00	5.28	5.28
7-6-2	9.40	8.00	2.24	7.52
7-6-3	12.40	8.00	7.04	14.56
7-6-4	11.60	8.00	5.76	20.32
7-6-5	10.80	8.00	4.48	24.80
7-6-6	10.20	8.00	3.52	28.32
7-6-7	16.40	8.00	13.44	41.76
7-6-8	13.00	8.00	8.00	49.76
7-6-9	10.60	8.00	4.16	53.92
7-6-10	9.51	8.00	2.42	56.34
7-6-11	10.00	8.00	3.20	59.54

Al

SAMPLE NO.	EFFLUENT ppm Al	HGW CONC. ppm Al	ELUTED mg Al	SUM ELUTED mg Al
7-6-1	0.20	0.03	0.28	0.28
7-6-2	0.11	0.03	0.13	0.41
7-6-3	0.11	0.03	0.13	0.54
7-6-4	0.10	0.03	0.11	0.66
7-6-5	0.04	0.03	0.02	0.68
7-6-6	0.03	0.03	0.00	0.68
7-6-7	0.06	0.03	0.05	0.73
7-6-8	0.03	0.03	0.00	0.73
7-6-9	0.00	0.03	-0.04	0.69
7-6-10	0.05	0.03	0.03	0.72
7-6-11	0.00	0.03	-0.04	0.67

Si

SAMPLE NO.	EFFLUENT ppm Si	HGW CONC. ppm Si	ELUTED mg Si	SUM ELUTED mg Si
7-6-1	14.10	15.00	-1.44	-1.44
7-6-2	14.60	15.00	-0.64	-2.08
7-6-3	14.20	15.00	-1.28	-3.36
7-6-4	14.10	15.00	-1.44	-4.80
7-6-5	14.50	15.00	-0.80	-5.60
7-6-6	14.70	15.00	-0.48	-6.08
7-6-7	13.40	15.00	-2.56	-8.64
7-6-8	12.70	15.00	-3.68	-12.32
7-6-9	13.50	15.00	-2.40	-14.72
7-6-10	13.60	15.00	-2.24	-16.96
7-6-11	13.50	15.00	-2.40	-19.36

Mg

SAMPLE NO.	EFFLUENT ppm Mg	HGW CONC. ppm Mg	ELUTED mg Mg	SUM ELUTED mg Mg
7-6-1	12.00	13.40	-2.24	-2.24
7-6-2	12.70	13.40	-1.12	-3.36
7-6-3	10.70	13.40	-4.32	-7.68
7-6-4	11.20	13.40	-3.52	-11.20
7-6-5	11.30	13.40	-3.36	-14.56
7-6-6	12.00	13.40	-2.24	-16.80
7-6-7	6.17	13.40	-11.57	-28.37
7-6-8	6.81	13.40	-10.54	-38.91
7-6-9	8.09	13.40	-8.50	-47.41
7-6-10	8.38	13.40	-8.03	-55.44
7-6-11	9.52	13.40	-6.21	-61.65

TABLE C.3. (contd)

H3BO3

SAMPLE NO.	EFFLUENT ppm B	HGW CONC. ppm B	ELUTED mg B	SUM ELUTE mg B
7-6-1	0.63	0.41	0.35	0.35
7-6-2	0.51	0.41	0.16	0.51
7-6-3	0.67	0.41	0.42	0.93
7-6-4	0.55	0.41	0.22	1.15
7-6-5	0.49	0.41	0.13	1.28
7-6-6	0.45	0.41	0.06	1.34
7-6-7	0.76	0.41	0.56	1.90
7-6-8	0.52	0.41	0.18	2.08
7-6-9	0.52	0.41	0.18	2.26
7-6-10	0.50	0.41	0.14	2.40
7-6-11	0.42	0.41	0.02	2.42

SO4

SAMPLE NO.	EFFLUENT ppm SO4	HGW CONC. ppm SO4	ELUTED mg SO4	SUM ELUTE mg SO4
7-6-1	71.00	67.00	6.40	6.40
7-6-2	67.00	67.00	0.00	6.40
7-6-3	71.00	67.00	6.40	12.80
7-6-4	69.00	67.00	3.20	16.00
7-6-5	67.00	67.00	0.00	16.00
7-6-6	67.00	67.00	0.00	16.00
7-6-7	70.68	67.00	5.89	21.69
7-6-8	65.00	67.00	-3.20	18.69
7-6-9	71.00	67.00	6.40	25.09
7-6-10	66.80	67.00	-0.32	24.77
7-6-11	71.00	67.00	6.40	31.17

IC

SAMPLE NO.	EFFLUENT ppm IC	HGW CONC. ppm IC	ELUTED mg IC	SUM ELUTE mg IC
7-6-1	21.72	34.10	-19.81	-19.81
7-6-2	25.89	34.10	-13.14	-32.94
7-6-3	17.86	34.10	-25.98	-58.93
7-6-4	20.46	34.10	-21.82	-80.75
7-6-5	23.71	34.10	-16.62	-97.38
7-6-6	26.91	34.10	-11.50	-108.86
7-6-7	18.39	34.10	-28.34	-137.22
7-6-8	18.81	34.10	-24.46	-161.68
7-6-9	4.22	34.10	-47.81	-209.49

TOC

SAMPLE NO.	EFFLUENT ppm TOC	HGW CONC. ppm TOC	ELUTED mg TOC	SUM ELUTE mg TOC
7-6-1	0.86	0.45	0.66	0.66
7-6-2	0.94	0.45	0.78	1.44
7-6-3	0.83	0.45	0.61	2.05
7-6-4	0.82	0.45	0.59	2.64
7-6-5	0.59	0.45	0.22	2.86
7-6-6	0.98	0.45	0.85	3.71
7-6-7	1.31	0.45	1.38	5.09
7-6-8	0.95	0.45	0.80	5.89
7-6-9	0.41	0.45	-0.06	5.82

TABLE C.4. Mass Balance Calculations for PSW 9-1 (ANS 16.1 Leach Test)

Ca

SAMPLE NO.	EFFLUENT ppm Ca	HGW CONC. ppm Ca	ELUTED mg Ca	SUM ELUTED mg Ca
9-1-1	16.90	50.60	-20.22	-20.22
9-1-2	41.00	50.60	-5.76	-25.98
9-1-3	26.40	50.60	-14.52	-40.50
9-1-4	32.40	50.60	-10.92	-51.42
9-1-5	36.50	50.60	-8.46	-59.88
9-1-6	42.10	50.60	-5.10	-64.98
9-1-7	5.34	50.60	-27.16	-92.14
9-1-8	7.57	50.60	-25.82	-117.96
9-1-9	13.30	50.60	-22.38	-140.33
9-1-10	19.20	50.60	-18.84	-159.17
9-1-11	26.80	50.60	-14.28	-173.45

Na

SAMPLE NO.	EFFLUENT ppm Na	HGW CONC. ppm Na	ELUTED mg Na	SUM ELUTED mg Na
9-1-1	67.10	25.00	25.26	25.26
9-1-2	31.00	25.00	3.60	28.86
9-1-3	39.90	25.00	8.94	37.80
9-1-4	38.10	25.00	7.86	45.66
9-1-5	34.70	25.00	5.82	51.48
9-1-6	31.50	25.00	3.90	55.38
9-1-7	70.50	25.00	27.30	82.68
9-1-8	57.90	25.00	19.74	102.42
9-1-9	51.80	25.00	16.08	118.50
9-1-10	45.50	25.00	12.30	130.80
9-1-11	32.20	25.00	4.32	135.12

K

SAMPLE NO.	EFFLUENT ppm K	HGW CONC. ppm K	ELUTED mg K	SUM ELUTED mg K
9-1-1	11.90	8.00	2.34	2.34
9-1-2	8.60	8.00	0.36	2.70
9-1-3	9.10	8.00	0.66	3.36
9-1-4	9.10	8.00	0.66	4.02
9-1-5	8.80	8.00	0.48	4.50
9-1-6	8.90	8.00	0.54	5.04
9-1-7	12.80	8.00	2.88	7.92
9-1-8	12.00	8.00	2.40	10.32
9-1-9	10.60	8.00	1.56	11.88
9-1-10	9.53	8.00	0.92	12.80
9-1-11	8.42	8.00	0.25	13.05

Al

SAMPLE NO.	EFFLUENT ppm Al	HGW CONC. ppm Al	ELUTED mg Al	SUM ELUTED mg Al
9-1-1	0.43	0.03	0.24	0.24
9-1-2	0.12	0.03	0.05	0.29
9-1-3	0.03	0.03	0.00	0.29
9-1-4	0.03	0.03	0.00	0.29
9-1-5	0.03	0.03	0.00	0.29
9-1-6	0.03	0.03	0.00	0.29
9-1-7	0.03	0.03	0.00	0.29
9-1-8	0.03	0.03	0.00	0.29
9-1-9	0.03	0.03	0.00	0.29
9-1-10	0.03	0.03	0.00	0.29
9-1-11	0.03	0.03	0.00	0.29

Si

SAMPLE NO.	EFFLUENT ppm Si	HGW CONC. ppm Si	ELUTED mg Si	SUM ELUTED mg Si
9-1-1	12.50	15.00	-1.50	-1.50
9-1-2	13.60	15.00	-0.84	-2.34
9-1-3	13.10	15.00	-1.14	-3.48
9-1-4	13.60	15.00	-0.84	-4.32
9-1-5	14.60	15.00	-0.24	-4.56
9-1-6	14.80	15.00	-0.12	-4.68
9-1-7	14.00	15.00	-0.60	-5.28
9-1-8	13.70	15.00	-0.78	-6.06
9-1-9	13.90	15.00	-0.66	-6.72
9-1-10	14.90	15.00	-0.06	-6.78
9-1-11	14.40	15.00	-0.36	-7.14

Mg

SAMPLE NO.	EFFLUENT ppm Mg	HGW CONC. ppm Mg	ELUTED mg Mg	SUM ELUTED mg Mg
9-1-1	9.66	13.40	-2.24	-2.24
9-1-2	11.90	13.40	-0.90	-3.14
9-1-3	10.20	13.40	-1.92	-5.06
9-1-4	11.00	13.40	-1.44	-6.50
9-1-5	12.00	13.40	-0.84	-7.34
9-1-6	12.60	13.40	-0.48	-7.82
9-1-7	6.92	13.40	-3.89	-11.71
9-1-8	5.81	13.40	-4.55	-16.27
9-1-9	7.95	13.40	-3.27	-19.54
9-1-10	11.80	13.40	-0.96	-20.50
9-1-11	13.30	13.40	-0.06	-20.56

TABLE C.4. (contd)

H3BO3

SAMPLE NO	EFFLUENT ppm B	HGW CONC. ppm B	ELUTED mg B	SUM ELUTE mg B
9-1-1	0.98	0.41	0.34	0.34
9-1-2	0.52	0.41	0.07	0.41
9-1-3	0.57	0.41	0.10	0.50
9-1-4	0.52	0.41	0.07	0.57
9-1-5	0.47	0.41	0.04	0.61
9-1-6	0.47	0.41	0.04	0.64
9-1-7	0.65	0.41	0.14	0.79
9-1-8	0.67	0.41	0.16	0.94
9-1-9	0.57	0.41	0.10	1.04
9-1-10	0.42	0.41	0.01	1.04
9-1-11	0.41	0.41	0.00	1.04

SO4

SAMPLE NO	EFFLUENT ppm SO4	HGW CONC. ppm SO4	ELUTED mg SO4	SUM ELUTE mg SO4
9-1-1	73.00	67.00	3.60	3.60
9-1-2	64.00	67.00	-1.80	1.80
9-1-3	69.00	67.00	1.20	3.00
9-1-4	67.00	67.00	0.00	3.00
9-1-5	64.00	67.00	-1.80	1.20
9-1-6	69.00	67.00	1.20	2.40
9-1-7	68.00	67.00	0.60	3.00
9-1-8	66.00	67.00	-0.60	2.40
9-1-9	71.00	67.00	2.40	4.80
9-1-10	66.90	67.00	1.14	5.94
9-1-11	71.00	67.00	2.40	8.34

IC

SAMPLE NO	EFFLUENT ppm IC	HGW CONC. ppm IC	ELUTED mg IC	SUM ELUTE mg IC
9-1-1	18.87	34.10	17.33	17.33
9-1-2	27.92	34.10	-3.71	13.62
9-1-3	21.95	34.10	-7.29	6.33
9-1-4	26.38	34.10	-4.63	1.70
9-1-5	28.34	34.10	-3.46	-1.76
9-1-6	31.33	34.10	-1.66	-3.42
9-1-7	16.39	34.10	-10.63	-14.04
9-1-8	14.25	34.10	-11.91	-25.95
9-1-9	4.09	34.10	-18.01	-43.96

TOC

SAMPLE NO	EFFLUENT ppm TOC	HGW CONC. ppm TOC	ELUTED mg TOC	SUM ELUTE mg TOC
9-1-1	1.08	0.45	0.38	0.38
9-1-2	0.91	0.45	0.28	0.65
9-1-3	0.75	0.45	0.18	0.83
9-1-4	0.73	0.45	0.17	1.00
9-1-5	0.66	0.45	0.13	1.13
9-1-6	0.67	0.45	0.13	1.26
9-1-7	0.65	0.45	0.24	1.50
9-1-8	0.67	0.45	0.13	1.63
9-1-9	0.54	0.45	0.05	1.69

TABLE C.5. Mass Balance Calculations for PSWA 10-1 (ANS 16.1 Leach Test)

Ca

SAMPLE NO.	EFFLUENT ppm Ca	HGW CONC. ppm Ca	ELUTED mg Ca	SUM ELUTED mg Ca
10-1-1	26.20	50.60	-14.64	-14.64
10-1-2	43.60	50.60	-4.20	-18.84
10-1-3	28.10	50.60	-13.50	-32.34
10-1-4	32.10	50.60	-11.10	-43.44
10-1-5	32.20	50.60	-11.04	-54.48
10-1-6	36.20	50.60	-8.64	-63.12
10-1-7	1.79	50.60	-29.29	-92.41
10-1-8	1.70	50.60	-29.34	-121.75
10-1-9	7.52	50.60	-25.85	-147.59
10-1-10	11.91	50.60	-23.21	-170.81
10-1-11	16.30	50.60	-20.58	-191.39

Na

SAMPLE NO.	EFFLUENT ppm Na	HGW CONC. ppm Na	ELUTED mg Na	SUM ELUTED mg Na
10-1-1	56.10	25.00	18.66	18.66
10-1-2	36.30	25.00	6.78	25.44
10-1-3	45.10	25.00	12.06	37.50
10-1-4	40.00	25.00	9.00	46.50
10-1-5	38.00	25.00	7.80	54.30
10-1-6	32.90	25.00	4.74	59.04
10-1-7	89.50	25.00	38.70	97.74
10-1-8	129.00	25.00	62.40	160.14
10-1-9	63.40	25.00	23.04	183.18
10-1-10	50.00	25.00	15.00	198.18
10-1-11	36.60	25.00	6.96	205.14

K

SAMPLE NO.	EFFLUENT ppm K	HGW CONC. ppm K	ELUTED mg K	SUM ELUTED mg K
10-1-1	11.80	8.00	2.28	2.28
10-1-2	9.40	8.00	0.84	3.12
10-1-3	10.60	8.00	1.56	4.68
10-1-4	9.90	8.00	1.14	5.82
10-1-5	9.40	8.00	0.84	6.66
10-1-6	8.60	8.00	0.36	7.02
10-1-7	16.00	8.00	4.80	11.82
10-1-8	19.40	8.00	6.84	18.66
10-1-9	12.10	8.00	2.46	21.12
10-1-10	11.20	8.00	1.92	23.04
10-1-11	10.30	8.00	1.38	24.42

Al

SAMPLE NO.	EFFLUENT ppm Al	HGW CONC. ppm Al	ELUTED mg Al	SUM ELUTED mg Al
10-1-1	0.19	0.03	0.10	0.10
10-1-2	0.21	0.03	0.11	0.20
10-1-3	0.21	0.03	0.11	0.31
10-1-4	0.05	0.03	0.01	0.32
10-1-5	0.03	0.03	0.00	0.32
10-1-6	0.03	0.03	0.00	0.32
10-1-7	0.03	0.03	0.00	0.32
10-1-8	0.03	0.03	0.00	0.32
10-1-9	0.03	0.03	0.00	0.32
10-1-10	0.03	0.03	0.00	0.32
10-1-11	0.03	0.03	0.00	0.32

Si

SAMPLE NO.	EFFLUENT ppm Si	HGW CONC. ppm Si	ELUTED mg Si	SUM ELUTED mg Si
10-1-1	13.70	15.00	-0.78	-0.78
10-1-2	13.90	15.00	-0.66	-1.44
10-1-3	12.50	15.00	-1.50	-2.94
10-1-4	12.60	15.00	-1.32	-4.26
10-1-5	14.10	15.00	-0.54	-4.80
10-1-6	14.10	15.00	-0.54	-5.34
10-1-7	13.90	15.00	-0.66	-6.00
10-1-8	12.90	15.00	-1.26	-7.26
10-1-9	13.10	15.00	-1.14	-8.40
10-1-10	6.58	15.00	-5.05	-13.45
10-1-11	0.06	15.00	-8.96	-22.42

Mg

SAMPLE NO.	EFFLUENT ppm Mg	HGW CONC. ppm Mg	ELUTED mg Mg	SUM ELUTED mg Mg
10-1-1	11.50	13.40	-1.14	-1.14
10-1-2	17.40	13.40	2.40	1.26
10-1-3	9.87	13.40	-2.12	-0.86
10-1-4	10.40	13.40	-1.80	-2.66
10-1-5	11.80	13.40	-0.96	-3.62
10-1-6	12.20	13.40	-0.72	-4.34
10-1-7	2.24	13.40	-6.70	-11.03
10-1-8	0.07	13.40	-8.00	-19.03
10-1-9	8.12	13.40	-3.17	-22.20
10-1-10	8.85	13.40	-2.73	-24.93
10-1-11	9.58	13.40	-2.29	-27.22

TABLE C.5. (contd)

H3BO3

SAMPLE NO	EFFLUENT ppm B	HGW CONC. ppm B	ELUTED mg B	SUM ELUTE mg B
10-1-1	0.96	0.46	0.29	0.29
10-1-2	0.63	0.46	0.10	0.40
10-1-3	0.71	0.46	0.15	0.55
10-1-4	0.57	0.46	0.07	0.61
10-1-5	0.54	0.46	0.05	0.66
10-1-6	0.47	0.46	0.01	0.67
10-1-7	0.81	0.46	0.21	0.88
10-1-8	0.91	0.46	0.27	1.15
10-1-9	0.50	0.46	0.02	1.17
10-1-10	0.51	0.46	0.03	1.20
10-1-11	0.52	0.46	0.04	1.24

SO4

SAMPLE NO	EFFLUENT ppm SO4	HGW CONC. ppm SO4	ELUTED mg SO4	SUM ELUTE mg SO4
10-1-1	73.00	67.00	3.60	3.60
10-1-2	71.00	67.00	2.40	6.00
10-1-3	69.00	67.00	1.20	7.20
10-1-4	69.00	67.00	1.20	8.40
10-1-5	68.00	67.00	0.60	9.00
10-1-6	66.00	67.00	-0.60	8.40
10-1-7	66.00	67.00	-0.60	7.80
10-1-8	71.00	67.00	2.40	10.20
10-1-9	64.00	67.00	-1.80	8.40
10-1-10	67.45	67.00	0.27	8.67
10-1-11	70.90	67.00	2.34	11.01

IC

SAMPLE NO	EFFLUENT ppm IC	HGW CONC. ppm IC	ELUTED mg IC	SUM ELUTE mg IC
10-1-1	20.13	34.10	-8.38	-8.38
10-1-2	23.43	34.10	-6.40	-14.78
10-1-3	17.00	34.10	-10.26	-25.04
10-1-4	23.42	34.10	-6.41	-31.45
10-1-5	26.08	34.10	-4.81	-36.26
10-1-6	28.29	34.10	-3.49	-39.75
10-1-7	12.55	34.10	-12.93	-52.68
10-1-8	13.36	34.10	-12.44	-65.12
10-1-9		34.10	-20.46	-85.58

TOC

SAMPLE NO	EFFLUENT ppm TOC	HGW CONC. ppm TOC	ELUTED mg TOC	SUM ELUTE mg TOC
10-1-1	1.45	0.45	0.60	0.60
10-1-2	0.70	0.45	0.15	0.75
10-1-3	0.64	0.45	0.11	0.86
10-1-4	0.58	0.45	0.08	0.94
10-1-5	0.72	0.45	0.16	1.10
10-1-6	0.77	0.45	0.19	1.30
10-1-7	1.45	0.45	0.60	1.90
10-1-8	1.19	0.45	0.44	2.34
10-1-9	1.39	0.45	0.56	2.90

TABLE C.6. Mass Balance Calculations for PSWLA 10-6 (ANS 16.1 Leach Test)

Ca

SAMPLE NO.	EFFLUENT	HGW CONC.	ELUTED	SUM ELUTED
--------	ppm Ca	ppm Ca	mg Ca	mg Ca
10-6-1	32.80	50.60	-28.48	-28.48
10-6-2	26.00	50.60	-39.36	-67.84
10-6-3	23.30	50.60	-43.68	-111.52
10-6-4	21.90	50.60	-45.92	-157.44
10-6-5	27.20	50.60	-37.44	-194.88
10-6-6	32.60	50.60	-28.80	-223.68
10-6-7	4.83	50.60	-73.23	-296.91
10-8-8	1.61	50.60	-78.38	-375.30
10-6-9	13.80	50.60	-58.88	-434.18
10-6-10	17.75	50.60	-52.56	-486.74
10-6-11	21.70	50.60	-46.24	-532.98

Na

SAMPLE NO.	EFFLUENT	HGW CONC.	ELUTED	SUM ELUTED
--------	ppm Na	ppm Na	mg Na	mg Na
10-6-1	48.70	25.00	37.92	37.92
10-6-2	41.20	25.00	25.92	63.84
10-6-3	52.50	25.00	44.00	107.84
10-6-4	45.20	25.00	32.32	140.16
10-6-5	39.90	25.00	23.84	164.00
10-6-6	36.20	25.00	17.92	181.92
10-6-7	86.40	25.00	98.24	280.16
10-6-8	95.60	25.00	112.96	393.12
10-6-9	51.10	25.00	41.76	434.88
10-6-10	43.85	25.00	30.16	465.04
10-6-11	36.60	25.00	18.56	483.60

K

SAMPLE NO.	EFFLUENT	HGW CONC.	ELUTED	SUM ELUTED
--------	ppm K	ppm K	mg K	mg K
10-6-1	11.20	8.00	5.12	5.12
10-6-2	10.70	8.00	4.32	9.44
10-6-3	12.10	8.00	6.56	16.00
10-6-4	11.70	8.00	5.92	21.92
10-6-5	8.70	8.00	1.12	23.04
10-6-6	8.80	8.00	1.28	24.32
10-6-7	14.80	8.00	10.88	35.20
10-6-8	16.00	8.00	12.80	48.00
10-6-9	10.80	8.00	4.48	52.48
10-6-10	10.05	8.00	3.28	55.76
10-6-11	9.30	8.00	2.08	57.84

Al

SAMPLE NO.	EFFLUENT	HGW CONC.	ELUTED	SUM ELUTED
--------	ppm Al	ppm Al	mg Al	mg Al
10-6-1	0.09	0.03	0.09	0.09
10-8-2	0.17	0.03	0.22	0.32
10-6-3	0.22	0.03	0.30	0.62
10-6-4	0.07	0.03	0.07	0.69
10-6-5	0.03	0.03	0.00	0.69
10-6-6	0.03	0.03	0.00	0.69
10-6-7	0.04	0.03	0.02	0.71
10-6-8	0.03	0.03	0.00	0.71
10-6-9	0.04	0.03	0.02	0.73
10-6-10	0.04	0.03	0.01	0.74
10-6-11	0.03	0.03	0.00	0.74

Si

SAMPLE NO.	EFFLUENT	HGW CONC.	ELUTED	SUM ELUTED
--------	ppm Si	ppm Si	mg Si	mg Si
10-6-1	14.60	15.00	-0.64	-0.64
10-6-2	14.20	15.00	-1.28	-1.92
10-6-3	13.50	15.00	-2.40	-4.32
10-6-4	13.50	15.00	-2.40	-6.72
10-6-5	13.80	15.00	-1.92	-8.64
10-6-6	14.40	15.00	-0.96	-9.60
10-6-7	13.40	15.00	-2.56	-12.16
10-6-8	11.50	15.00	-5.60	-17.76
10-6-9	13.50	15.00	-2.40	-20.16
10-6-10	13.65	15.00	-2.16	-22.32
10-6-11	13.80	15.00	-1.92	-24.24

Mg

SAMPLE NO.	EFFLUENT	HGW CONC.	ELUTED	SUM ELUTED
--------	ppm Mg	ppm Mg	mg Mg	mg Mg
10-6-1	12.20	13.40	-1.92	-1.92
10-6-2	11.90	13.40	-2.40	-4.32
10-6-3	10.30	13.40	-4.96	-9.28
10-6-4	10.70	13.40	-4.32	-13.60
10-6-5	11.80	13.40	-2.56	-16.16
10-6-6	12.50	13.40	-1.44	-17.60
10-6-7	6.14	13.40	-11.62	-29.22
10-6-8	3.32	13.40	-16.13	-45.34
10-6-9	10.30	13.40	-4.96	-50.30
10-6-10	11.05	13.40	-3.76	-54.08
10-6-11	11.60	13.40	-2.56	-56.62

TABLE C.6. (contd)

H3B03				
SAMPLE NO	EFFLUENT ppm B	HGW CONC. ppm B	ELUTED mg B	SUM ELUTE mg B
10-6-1	0.74	0.41	0.53	0.53
10-6-2	0.64	0.41	0.37	0.90
10-6-3	0.75	0.41	0.54	1.44
10-6-4	0.57	0.41	0.26	1.70
10-6-5	0.43	0.41	0.03	1.73
10-6-6	0.42	0.41	0.02	1.74
10-6-7	0.68	0.41	0.43	2.18
10-6-8	0.72	0.41	0.50	2.67
10-6-9	0.41	0.41	0.00	2.67
10-6-10	0.42	0.41	0.02	2.69
10-6-11	0.43	0.41	0.03	2.72

S04				
SAMPLE NO	EFFLUENT ppm S04	HGW CONC. ppm S04	ELUTED mg S04	SUM ELUTE mg S04
10-6-1	70.00	67.00	4.80	4.80
10-6-2	68.00	67.00	1.60	6.40
10-6-3	73.00	67.00	9.60	16.00
10-6-4	65.00	67.00	-3.20	12.80
10-6-5	66.00	67.00	-1.60	11.20
10-6-6	68.00	67.00	1.60	12.80
10-6-7	66.00	67.00	-1.60	11.20
10-6-8	61.00	67.00	-9.60	1.60
10-6-9	63.00	67.00	-6.40	-4.80
10-6-10	67.70	67.00	1.12	-3.68
10-6-11	72.40	67.00	8.64	4.96

IC				
SAMPLE NO	EFFLUENT ppm IC	HGW CONC. ppm IC	ELUTED mg IC	SUM ELUTE mg IC
10-6-1	22.14	34.10	-19.14	-19.14
10-6-2	23.48	34.10	-16.99	-36.13
10-6-3	17.44	34.10	-26.66	-62.78
10-6-4	18.63	34.10	-24.75	-87.54
10-6-5	27.42	34.10	-10.69	-98.22
10-6-6	27.51	34.10	-10.54	-106.77
10-6-7	17.06	34.10	-27.26	-136.03
10-6-8	21.23	34.10	-20.59	-156.62

TOC				
SAMPLE NO	EFFLUENT ppm TOC	HGW CONC. ppm TOC	ELUTED mg TOC	SUM ELUTE mg TOC
10-6-1	1.16	0.45	1.14	1.14
10-6-2	0.83	0.45	0.61	1.74
10-6-3	0.51	0.45	0.10	1.84
10-6-4	0.56	0.45	0.18	2.02
10-6-5	0.47	0.45	0.03	2.05
10-6-6	0.61	0.45	0.26	2.30
10-6-7	0.56	0.45	0.16	2.48
10-6-6	1.90	0.45	2.32	4.80

TABLE C.7. Mass Balance Calculations for PSW 5-4 (Static Leach Test)

Ca

SAMPLE NO.	EFFLUENT ppm Ca	HGW CONC. ppm Ca	ELUTED mg Ca	TOTAL CHANGE mg Ca
MB-5-4-1	1.71	50.60	-29.33	-29.33
MB-5-4-2	7.77	50.60	1.19	-28.14
MB-5-4-3	17.90	50.60	3.94	-24.21
MB-5-4-4	21.80	50.60	0.59	-23.62
MB-5-4-5	23.30	50.60	-0.43	-24.05
MB-5-4-6	13.00	50.60	-6.61	-30.66

Na

SAMPLE NO.	EFFLUENT ppm Na	HGW CONC. ppm Na	ELUTED mg Na	TOTAL CHANGE mg Na
MB-5-4-1	139.00	25.00	68.40	68.40
MB-5-4-2	206.00	25.00	47.10	115.50
MB-5-4-3	254.00	25.00	36.75	152.25
MB-5-4-4	327.00	25.00	55.25	207.50
MB-5-4-5	313.00	25.00	6.70	214.20
MB-5-4-6	313.00	25.00	6.70	220.90

K

SAMPLE NO.	EFFLUENT ppm K	HGW CONC. ppm K	ELUTED mg K	TOTAL CHANGE mg K
MB-5-4-1	19.60	8.00	6.96	6.96
MB-5-4-2	26.80	8.00	4.90	11.86
MB-5-4-3	30.00	8.00	2.86	14.72
MB-5-4-4	39.40	8.00	6.74	21.46
MB-5-4-5	41.00	8.00	2.53	23.99
MB-5-4-6	41.50	8.00	2.83	26.82

Al

SAMPLE NO.	EFFLUENT ppm Al	HGW CONC. ppm Al	ELUTED mg Al	TOTAL CHANGE mg Al
MB-5-4-1	0.83	0.03	0.48	0.48
MB-5-4-2	2.69	0.03	1.15	1.64
MB-5-4-3	3.48	0.03	0.59	2.23
MB-5-4-4	4.48	0.03	0.78	3.01
MB-5-4-5	1.70	0.03	-1.45	1.57
MB-5-4-6	6.29	0.03	1.31	2.88

Si

SAMPLE NO.	EFFLUENT ppm Si	HGW CONC. ppm Si	ELUTED mg Si	TOTAL CHANGE mg Si
MB-5-4-1	9.76	15.00	-3.13	-3.13
MB-5-4-2	10.20	15.00	-0.01	-3.14
MB-5-4-3	9.51	15.00	-0.66	-3.80
MB-5-4-4	11.10	15.00	0.68	-3.12
MB-5-4-5	10.50	15.00	-0.55	-3.67
MB-5-4-6	12.40	15.00	0.58	-3.09

Mg

SAMPLE NO.	EFFLUENT ppm Mg	HGW CONC. ppm Mg	ELUTED mg Mg	TOTAL CHANGE mg Mg
MB-5-4-1	0.08	13.40	-8.00	-8.00
MB-5-4-2	0.06	13.40	-0.67	-8.67
MB-5-4-3	0.11	13.40	-0.64	-9.31
MB-5-4-4	0.06	13.40	-0.70	-10.00
MB-5-4-5	0.05	13.40	-0.67	-10.68
MB-5-4-6	0.05	13.40	-0.67	-11.35

NO3

SAMPLE NO.	EFFLUENT ppm NO3	HGW CONC. ppm NO3	ELUTED mg NO3	TOTAL CHANGE mg NO3
MB-5-4-1	0.50	0.50	0.00	0.00
MB-5-4-2	0.50	0.50	-0.00	-0.00
MB-5-4-3	3.20	0.50	1.62	1.62
MB-5-4-4	3.50	0.50	0.31	1.93
MB-5-4-5	3.90	0.50	0.39	2.32
MB-5-4-6	5.00	0.50	1.05	3.37

H3BO3

SAMPLE NO.	EFFLUENT ppm B	HGW CONC. ppm B	ELUTED mg B	TOTAL CHANGE mg B
MB-5-4-1	1.53	0.41	0.76	0.76
MB-5-4-2	1.94	0.41	0.34	1.10
MB-5-4-3	2.07	0.41	0.17	1.27
MB-5-4-4	2.64	0.41	0.47	1.74
MB-5-4-5	2.91	0.41	0.30	2.05
MB-5-4-6	3.13	0.41	-1.62	0.43

TABLE C.7. (contd)

SO4

SAMPLE NO.	EFFLUENT ppm SO4	HGW CONC. ppm SO4	ELUTED mg SO4	TOTAL CHANGE mg SO4
MB-5-4-1	75.00	67.00	4.80	4.80
MB-5-4-2	69.00	67.00	-3.20	1.60
MB-5-4-3	56.00	67.00	-7.70	-6.10
MB-5-4-4	61.00	67.00	2.45	-3.65
MB-5-4-5	55.30	67.00	-3.72	-7.37
MB-5-4-6	69.00	67.00	4.50	-2.87

IC

SAMPLE NO.	EFFLUENT ppm IC	HGW CONC. ppm IC	ELUTED mg IC	TOTAL CHANGE mg IC
MB-5-4-1	26.38	34.10	-4.63	-4.63
MB-5-4-2	7.67	34.10	-11.61	-16.24
MB-5-4-3	6.52	34.10	-2.01	-18.26

TOC

SAMPLE NO.	EFFLUENT ppm TOC	HGW CONC. ppm TOC	ELUTED mg TOC	TOTAL CHANGE mg TOC
MB-5-4-1	2.32	0.45	1.12	1.12
MB-5-4-2	2.31	0.45	0.09	1.21
MB-5-4-3	3.10	0.45	0.57	1.78

TABLE C.8. Mass Balance Calculations for PSW 7-4 (Static Leach Test)

Ca

SAMPLE NO.	EFFLUENT ppm Ca	HGW CONC. ppm Ca	ELUTED mg Ca	TOTAL CHANGE mg Ca
MB-7-4-1	5.74	50.60	-26.92	-26.92
MB-7-4-2	8.30	50.60	-0.71	-27.62
MB-7-4-3	12.40	50.60	0.34	-27.28
MB-7-4-4	10.50	50.60	-3.05	-30.33
MB-7-4-5	6.50	50.60	-4.41	-34.73
MB-7-4-6	1.11	50.60	-7.64	-42.37

Na

SAMPLE NO.	EFFLUENT ppm Na	HGW CONC. ppm Na	ELUTED mg Na	TOTAL CHANGE mg Na
MB-7-4-1	137.00	25.00	67.20	67.20
MB-7-4-2	173.00	25.00	27.20	94.40
MB-7-4-3	271.00	25.00	66.20	160.60
MB-7-4-4	288.00	25.00	22.50	183.10
MB-7-4-5	323.00	25.00	34.15	217.25
MB-7-4-6	299.00	25.00	19.75	237.00

K

SAMPLE NO.	EFFLUENT ppm K	HGW CONC. ppm K	ELUTED mg K	TOTAL CHANGE mg K
MB-7-4-1	20.00	8.00	7.20	7.20
MB-7-4-2	23.40	8.00	2.64	9.84
MB-7-4-3	33.00	8.00	6.53	16.37
MB-7-4-4	36.10	8.00	3.11	19.48
MB-7-4-5	39.80	8.00	3.50	22.98
MB-7-4-6	39.60	8.00	3.50	26.49

Al

SAMPLE NO.	EFFLUENT ppm Al	HGW CONC. ppm Al	ELUTED mg Al	TOTAL CHANGE mg Al
MB-7-4-1	0.86	0.03	0.50	0.50
MB-7-4-2	2.41	0.03	0.97	1.47
MB-7-4-3	3.83	0.03	0.97	2.44
MB-7-4-4	4.80	0.03	0.77	3.21
MB-7-4-5	5.97	0.03	0.94	4.15
MB-7-4-6	6.86	0.03	1.47	5.63

Si

SAMPLE NO.	EFFLUENT ppm Si	HGW CONC. ppm Si	ELUTED mg Si	TOTAL CHANGE mg Si
MB-7-4-1	11.40	15.00	-2.16	-2.16
MB-7-4-2	11.20	15.00	-0.30	-2.46
MB-7-4-3	13.40	15.00	1.13	-1.33
MB-7-4-4	14.50	15.00	0.58	-0.75
MB-7-4-5	18.30	15.00	1.05	0.30
MB-7-4-6	18.70	15.00	2.49	2.80

Mg

SAMPLE NO.	EFFLUENT ppm Mg	HGW CONC. ppm Mg	ELUTED mg Mg	TOTAL CHANGE mg Mg
MB-7-4-1	0.46	13.40	-7.76	-7.76
MB-7-4-2	0.06	13.40	-0.89	-8.65
MB-7-4-3	0.06	13.40	-0.67	-9.32
MB-7-4-4	0.06	13.40	-0.67	-9.99
MB-7-4-5	0.06	13.40	-0.67	-10.65
MB-7-4-6	0.06	13.40	-0.67	-11.32

NO3

SAMPLE NO.	EFFLUENT ppm NO3	HGW CONC. ppm NO3	ELUTED mg NO3	TOTAL CHANGE mg NO3
MB-7-4-1	41.00	0.50	24.30	24.30
MB-7-4-2	1.80	0.50	-21.50	2.80
MB-7-4-3	2.40	0.50	0.42	3.23
MB-7-4-4	3.00	0.50	0.45	3.68
MB-7-4-5	3.20	0.50	0.24	3.93
MB-7-4-6	4.00	0.50	0.72	4.65

H3BO3

SAMPLE NO.	EFFLUENT ppm B	HGW CONC. ppm B	ELUTED mg B	TOTAL CHANGE mg B
MB-7-4-1	1.69	0.41	0.77	0.77
MB-7-4-2	1.66	0.41	0.05	0.81
MB-7-4-3	2.18	0.41	0.36	1.18
MB-7-4-4	2.28	0.41	0.16	1.34
MB-7-4-5	2.55	0.41	0.26	1.59
MB-7-4-6	2.70	0.41	0.35	1.94

TABLE C.8. (contd)

SO4

SAMPLE NO.	EFFLUENT ppm SO4	HGW CONC. ppm SO4	ELUTED mg SO4	TOTAL CHANGE mg SO4
MB-7-4-1	69.00	67.00	1.20	1.20
MB-7-4-2	64.00	67.00	-2.90	-1.70
MB-7-4-3	70.00	67.00	3.45	1.75
MB-7-4-4	66.00	67.00	-2.25	-0.50
MB-7-4-5	60.90	67.00	-3.11	-3.61
MB-7-4-6	72.00	67.00	3.55	-0.06

IC

SAMPLE NO.	EFFLUENT ppm IC	HGW CONC. ppm IC	ELUTED mg IC	TOTAL CHANGE mg IC
MB-7-4-1	9.82	34.10	-14.57	-14.57
MB-7-4-2	8.42	34.10	-3.25	-17.82
MB-7-4-3	4.93	34.10	-2.28	-20.10
MB-7-4-4	4.51	34.10	-1.71	-21.81

TOC

SAMPLE NO.	EFFLUENT ppm TOC	HGW CONC. ppm TOC	ELUTED mg TOC	TOTAL CHANGE mg TOC
MB-7-4-1	3.05	0.45	1.56	1.56
MB-7-4-2	2.88	0.45	0.03	1.59
MB-7-4-3	2.92	0.45	0.15	1.73
MB-7-4-4	0.94	0.45	-1.06	0.67

TABLE C.9. Mass Balance Calculations for PSW 9-4 (Static Leach Test)

Ca

SAMPLE NO.	EFFLUENT ppm Ca	HGW CONC. ppm Ca	ELUTED mg Ca	TOTAL CHANGE mg Ca
MB-9-4-1	3.47	50.60	-28.28	-28.28
MB-9-4-2	4.01	50.60	-2.03	-30.31
MB-9-4-3	4.52	50.60	-2.02	-32.33
MB-9-4-4	4.04	50.60	-2.59	-34.93
MB-9-4-5	4.52	50.60	-2.04	-36.97
MB-9-4-6	3.82	50.60	-2.46	-39.43

Na

SAMPLE NO.	EFFLUENT ppm Na	HGW CONC. ppm Na	ELUTED mg Na	TOTAL CHANGE mg Na
MB-9-4-1	122.00	25.00	58.20	58.20
MB-9-4-2	156.00	25.00	25.25	83.45
MB-9-4-3	150.00	25.00	2.95	86.40
MB-9-4-4	261.00	25.00	72.85	159.25
MB-9-4-5	292.00	25.00	30.40	189.65
MB-9-4-6	269.00	25.00	16.60	206.25

K

SAMPLE NO.	EFFLUENT ppm K	HGW CONC. ppm K	ELUTED mg K	TOTAL CHANGE mg K
MB-9-4-1	17.20	8.00	5.52	5.52
MB-9-4-2	20.80	8.00	2.62	8.14
MB-9-4-3	31.00	8.00	6.76	14.90
MB-9-4-4	33.40	8.00	2.59	17.49
MB-9-4-5	36.10	8.00	2.89	20.38
MB-9-4-6	38.00	8.00	2.83	23.21

Al

SAMPLE NO.	EFFLUENT ppm Al	HGW CONC. ppm Al	ELUTED mg Al	TOTAL CHANGE mg Al
MB-9-4-1	1.66	0.03	0.62	0.62
MB-9-4-2	2.41	0.03	0.86	1.48
MB-9-4-3	4.00	0.03	1.07	2.55
MB-9-4-4	5.60	0.03	0.80	3.35
MB-9-4-5	5.93	0.03	0.81	4.16
MB-9-4-6	6.49	0.03	1.14	5.30

SAMPLE NO.	EFFLUENT ppm Si	HGW CONC. ppm Si	ELUTED mg Si	TOTAL CHANGE mg Si
MB-9-4-1	10.70	15.00	-2.58	-2.58
MB-9-4-2	12.90	15.00	1.10	-1.48
MB-9-4-3	17.80	15.00	2.83	1.36
MB-9-4-4	19.80	15.00	1.34	2.70
MB-9-4-5	21.30	15.00	1.14	3.84
MB-9-4-6	22.40	15.00	1.80	5.64

Mg

SAMPLE NO.	EFFLUENT ppm Mg	HGW CONC. ppm Mg	ELUTED mg Mg	TOTAL CHANGE mg Mg
MB-9-4-1	0.30	13.40	-7.86	-7.86
MB-9-4-2	0.06	13.40	-0.80	-8.66
MB-9-4-3	0.06	13.40	-0.67	-9.33
MB-9-4-4	0.06	13.40	-0.67	-9.99
MB-9-4-5	0.06	13.40	-0.67	-10.66
MB-9-4-6	0.06	13.40	-0.67	-11.33

NO3

SAMPLE NO.	EFFLUENT ppm NO3	HGW CONC. ppm NO3	ELUTED mg NO3	TOTAL CHANGE mg NO3
MB-9-4-1	2.30	0.50	1.08	1.08
MB-9-4-2	1.60	0.50	-0.33	0.75
MB-9-4-3	0.70	0.50	-0.49	0.26
MB-9-4-4	3.00	0.50	1.39	1.65
MB-9-4-5	3.20	0.50	0.24	1.90
MB-9-4-6	4.00	0.50	0.72	2.62

H3BO3

SAMPLE NO.	EFFLUENT ppm B	HGW CONC. ppm B	ELUTED mg B	TOTAL CHANGE mg B
MB-9-4-1	1.43	0.41	0.61	0.61
MB-9-4-2	1.57	0.41	0.13	0.75
MB-9-4-3	2.20	0.41	0.44	1.18
MB-9-4-4	2.23	0.41	0.11	1.29
MB-9-4-5	2.55	0.41	0.28	1.57
MB-9-4-6	2.63	0.41	0.33	1.90

TABLE C.9. (contd)

SO4

SAMPLE NO.	EFFLUENT ppm SO4	HGW CONC. ppm SO4	ELUTED mg SO4	TOTAL CHANGE mg SO4
MB-9-4-1	67.00	67.00	0.00	0.00
MB-9-4-2	61.00	67.00	-3.60	-3.60
MB-9-4-3	70.00	67.00	5.10	1.50
MB-9-4-4	69.00	67.00	-0.45	1.05
MB-9-4-5	66.70	67.00	-1.28	-0.23
MB-9-4-6	74.00	67.00	3.10	2.87

IC

SAMPLE NO.	EFFLUENT ppm IC	HGW CONC. ppm IC	ELUTED mg IC	TOTAL CHANGE mg IC
MB-9-4-1	13.43	34.10	-12.40	-12.40
MB-9-4-2	9.83	34.10	-3.19	-15.60
MB-9-4-3	7.18	34.10	-2.80	-18.40
MB-9-4-4	4.53	34.10	-2.94	-21.34

TOC

SAMPLE NO.	EFFLUENT ppm TOC	HGW CONC. ppm TOC	ELUTED mg TOC	TOTAL CHANGE mg TOC
MB-9-4-1	2.93	0.45	1.49	1.49
MB-9-4-2	3.32	0.45	0.36	1.85
MB-9-4-3	2.38	0.45	-0.42	1.43
MB-9-4-4	1.44	0.45	-0.47	0.96

TABLE C.10. Mass Balance Calculations for PSW 10-4 (Static Leach Test)

Ca

SAMPLE NO.	EFFLUENT ppm Ca	HGW CONC. ppm Ca	ELUTED mg Ca	TOTAL CHANGE mg Ca
MB-10-4-1	4.03	50.60	-27.94	-27.94
MB-10-4-2	0.14	50.60	-4.66	-32.61
MB-10-4-3	18.90	50.60	8.73	-23.87
MB-10-4-4	16.30	50.60	-3.15	-27.02
MB-10-4-5	13.85	50.60	-3.19	-30.20
MB-10-4-6	11.40	50.60	-4.66	-34.86

Na

SAMPLE NO.	EFFLUENT ppm Na	HGW CONC. ppm Na	ELUTED mg Na	TOTAL CHANGE mg Na
MB-10-4-1	143.00	25.00	70.80	70.80
MB-10-4-2	254.00	25.00	72.50	143.30
MB-10-4-3	345.00	25.00	66.05	209.35
MB-10-4-4	352.00	25.00	20.20	229.55
MB-10-4-5	341.00	25.00	9.75	239.30
MB-10-4-6	330.00	25.00	3.15	242.45

K

SAMPLE NO.	EFFLUENT ppm K	HGW CONC. ppm K	ELUTED mg K	TOTAL CHANGE mg K
MB-10-4-1	21.50	8.00	8.10	8.10
MB-10-4-2	27.00	8.00	3.97	12.07
MB-10-4-3	44.20	8.00	11.27	23.35
MB-10-4-4	44.40	8.00	1.93	25.27
MB-10-4-5	44.60	8.00	2.06	27.33
MB-10-4-6	45.20	8.00	2.30	29.63

Al

SAMPLE NO.	EFFLUENT ppm Al	HGW CONC. ppm Al	ELUTED mg Al	TOTAL CHANGE mg Al
MB-10-4-1	1.39	0.03	0.82	0.82
MB-10-4-2	3.23	0.03	1.17	1.99
MB-10-4-3	5.69	0.03	1.64	3.62
MB-10-4-4	6.42	0.03	0.72	4.35
MB-10-4-5	6.76	0.03	0.52	4.87
MB-10-4-6	7.10	0.03	0.73	5.60

Si

SAMPLE NO.	EFFLUENT ppm Si	HGW CONC. ppm Si	ELUTED mg Si	TOTAL CHANGE mg Si
MB-10-4-1	9.23	15.00	-3.46	-3.46
MB-10-4-2	9.09	15.00	-0.37	-3.83
MB-10-4-3	12.00	15.00	1.45	-2.38
MB-10-4-4	12.40	15.00	0.09	-2.29
MB-10-4-5	13.15	15.00	0.32	-1.97
MB-10-4-6	13.90	15.00	0.77	-1.20

Mg

SAMPLE NO.	EFFLUENT ppm Mg	HGW CONC. ppm Mg	ELUTED mg Mg	TOTAL CHANGE mg Mg
MB-10-4-1	0.06	13.40	-8.00	-8.00
MB-10-4-2	0.06	13.40	-0.67	-8.67
MB-10-4-3	0.06	13.40	-0.67	-9.34
MB-10-4-4	0.06	13.40	-0.67	-10.00
MB-10-4-5	0.06	13.40	-0.67	-10.67
MB-10-4-6	0.06	13.40	-0.67	-11.34

H3BO3

SAMPLE NO.	EFFLUENT ppm B	HGW CONC. ppm B	ELUTED mg B	TOTAL CHANGE mg B
MB-10-4-1	1.80	0.41	0.83	0.83
MB-10-4-2	2.32	0.41	0.38	1.22
MB-10-4-3	3.16	0.41	0.60	1.82
MB-10-4-4	3.25	0.41	0.19	2.01
MB-10-4-5	3.36	0.41	0.20	2.21
MB-10-4-6	3.46	0.41	0.27	2.48

SO4

SAMPLE NO.	EFFLUENT ppm SO4	HGW CONC. ppm SO4	ELUTED mg SO4	TOTAL CHANGE mg SO4
MB-10-4-1	74.00	67.00	4.20	4.20
MB-10-4-2	73.00	67.00	-0.25	3.95
MB-10-4-3	74.00	67.00	0.90	4.85
MB-10-4-4	72.00	67.00	-0.85	4.00
MB-10-4-5	75.50	67.00	2.35	6.35
MB-10-4-6	79.00	67.00	4.45	10.80

TABLE C.10. (contd)

NO3

SAMPLE NO.	EFFLUENT ppm NO3	HGW CONC. ppm NO3	ELUTED mg NO3	TOTAL CHANGE mg NO3

MB-10-4-1	0.50	0.50	0.00	0.00
MB-10-4-2	0.70	0.50	0.12	0.12
MB-10-4-3	0.50	0.50	-0.11	0.01
MB-10-4-4	0.50	0.50	-0.00	0.01
MB-10-4-5	0.50	0.50	-0.00	0.01
MB-10-4-6	0.50	0.50	-0.00	0.01

IC

SAMPLE NO.	EFFLUENT ppm IC	HGW CONC. ppm IC	ELUTED mg IC	TOTAL CHANGE mg IC

MB-10-4-1	3.34	34.10	-18.46	-18.46
MB-10-4-2	16.46	34.10	6.33	-12.13
MB-10-4-3	29.57	34.10	6.99	-5.14

TOC

SAMPLE NO.	EFFLUENT ppm TOC	HGW CONC. ppm TOC	ELUTED mg TOC	TOTAL CHANGE mg TOC

MB-10-4-1	3.71	0.45	1.96	1.96
MB-10-4-2	3.64	0.45	0.12	2.08
MB-10-4-3	3.57	0.45	0.12	2.19

APPENDIX D

SAMPLE SPECIFICATIONS

TABLE D.1. Sample Specifications

Sample	Length (cm)	Diameter (cm)	Wet Weight (g)	Surface Area (cm^2)	Volume (cm^3)
Batch 1					
A1-1	4.4	3.2	51.43	60.32	35.39
A1-2	4.2	3.2	48.73	58.31	33.78
S1-4	4.3	3.2	49.22	59.31	34.58
S1-5	4.5	3.2	50.91	61.32	36.19
Batch 2					
A2-1	4.4	3.1	53.09	57.95	33.21
A2-2	4.4	3.1	54.07	57.95	33.21
A2-3	4.4	3.1	53.29	57.95	33.21
S2-4	4.3	3.2	52.22	59.31	34.58
S2-5	4.4	3.1	52.04	51.95	33.21
Batch 3					
A3-1	4.1	3.3	49.36	59.61	35.07
A3-2	4.3	3.2	52.28	59.31	34.58
A3-3	4.2	3.2	52.25	58.31	33.78
S3-4	4.1	3.2	52.09	57.30	32.97
S3-5	4.2	3.2	52.70	58.31	33.78
Batch 4					
A4-1	4.4	3.1	51.65	57.95	33.21
A4-2	4.3	3.2	51.94	59.31	34.58
A4-3	4.3	3.2	52.35	59.31	34.58
S4-4	4.3	3.2	51.44	59.31	34.58
S4-5	4.4	3.2	52.79	60.32	35.39
LA4-6	9.0	4.5	232.06	159.04	143.14

TABLE D.1. (contd)

Sample	Length (cm)	Diameter (cm)	Wet Weight (g)	Surface Area (cm^2)	Volume (cm^3)
Batch 5					
A5-1	4.3	3.2	51.75	59.31	34.58
A5-2	4.2	3.2	51.53	58.31	33.78
A5-3	4.2	3.2	51.85	58.31	33.78
S5-4	4.3	3.2	53.46	59.31	34.58
S5-5	4.1	3.2	51.56	57.30	32.97
LA5-6	8.5	4.6	218.06	156.07	141.26
Batch 6					
A6-1	4.5	3.2	53.11	61.32	36.19
A6-2	4.4	3.2	53.31	60.32	35.39
S6-4	4.5	3.2	54.35	61.32	36.19
S6-5	4.3	3.2	51.60	59.31	34.58
LA6-6	8.9	4.6	230.04	161.85	147.91
Batch 7					
A7-1	4.3	3.2	49.67	59.31	34.58
A7-2	4.3	3.2	51.75	59.31	34.58
A7-3	4.2	3.2	50.77	58.31	33.78
S7-4	4.2	3.2	52.76	58.31	33.78
S7-5	4.4	3.2	53.45	58.31	35.39
LA7-6	8.8	4.6	233.19	160.41	146.25
Batch 8					
A8-1	4.1	3.2	50.72	57.30	32.97
A8-2	4.1	3.2	49.71	57.30	32.97
A8-3	4.1	3.2	50.78	57.30	32.97
S8-4	4.0	3.1	49.03	54.05	30.19

TABLE D.1. (contd)

Sample	Length (cm)	Diameter (cm)	Wet Weight (g)	Surface Area (cm^2)	Volume (cm^3)
S8-5	4.1	3.2	50.53	57.30	32.97
LA8-6	8.7	4.7	227.90	163.16	150.94
Batch 9					
A9-1	4.2	3.1	50.73	56.00	31.70
A9-2	4.1	3.1	49.33	55.02	30.95
A9-3	4.2	3.2	50.68	58.31	33.78
Batch 10					
A10-1	4.4	3.2	48.64	60.32	35.39
A10-2	4.3	3.2	48.68	59.31	34.58
S10-4	4.2	3.2	48.61	58.31	33.78
S10-5	4.1	3.2	48.48	57.30	32.97
LA10-6	8.7	4.6	213.00	158.96	144.58
Batch 11					
A11-1	4.2	3.2	47.92	58.31	33.78
A11-2	4.3	3.1	49.20	56.97	32.46
S11-4	4.3	3.2	48.77	59.31	34.58
S11-5	4.4	3.2	49.66	60.32	35.39
Batch 12					
A12-1	4.1	3.2	47.50	57.30	32.97
A12-2	4.2	3.2	47.90	58.31	33.78
A12-3	4.2	3.2	49.35	58.31	33.78
S12-4	4.0	3.2	46.44	56.30	32.17
S12-5	4.3	3.2	50.97	59.31	34.58
S12-6	4.2	3.1	48.94	56.00	31.70

APPENDIX E

TOTAL INVENTORIES OF PSW GROUT

TABLE E.1. Isotopic A_0 Determination of PSW Grout (all values in μCi unless otherwise specified)

Sample ID	Isotope	Ao Value (μCi)
1-1	C-14	13.75
1-2	C-14	13.03
1-4	C-14	13.16
1-5	C-14	13.61
2-1	CD-109	1.17
2-2	CD-109	1.19
2-3	CD-109	1.17
2-4	CD-109	1.15
2-5	CD-109	1.14
2-1	HG-203	.036
2-2	HG-203	.036
2-3	HG-203	.036
2-4	HG-203	.035
2-5	HG-203	.035
2-1	As(STABLE)	.3 mg
2-2	As(STABLE)	.3 mg
2-3	As(STABLE)	.3 mg
2-4	As(STABLE)	.3 mg
2-5	As(STABLE)	.3 mg
3-1	SE-75	1.02
3-2	SE-75	1.08
3-3	SE-75	1.08
3-4	SE-75	1.07
3-5	SE-75	1.07
3-1	AG-110M	1.47
3-2	AG-110M	1.56
3-3	AG-110M	1.56
3-4	AG-110M	1.55
3-5	AG-110M	1.55
4-1	I-125	.644
4-2	I-125	.648
4-3	I-125	.653
4-4	I-125	.642
4-5	I-125	.659
4-6	I-125	2.90
4-1	CR-51	.283
4-2	CR-51	.284
4-3	CR-51	.287
4-4	CR-51	.282
4-5	CR-51	.289
4-6	CR-51	1.27
4-1	PB-210	1.00
4-2	PB-210	1.01
4-3	PB-210	1.02
4-4	PB-210	.999
4-5	PB-210	1.03
4-6	PB-210	4.51
5-1	I-125	.631
5-2	I-125	.628

TABLE E.1. (contd)

Sample ID	Isotope	Ao Value (μCi)
5-3	I-125	.632
5-4	I-125	.652
5-5	I-125	.629
5-6	I-125	.266
5-1	CR-51	2.84
5-2	CR-51	2.82
5-3	CR-51	2.84
5-4	CR-51	2.93
5-5	CR-51	2.83
5-6	CR-51	11.95
6-1	TC-99	2.18
6-2	TC-99	2.19
6-4	TC-99	2.19
6-5	TC-99	2.12
6-6	TC-99	9.46
7-1	TC-99	4.57
7-2	TC-99	4.76
7-3	TC-99	4.67
7-4	TC-99	4.85
7-5	TC-99	4.92
7-6	TC-99	21.45
8-1	URANIUM	.17 mg
8-2	URANIUM	.17 mg
8-3	URANIUM	.17 mg
8-4	URANIUM	.17 mg
8-5	URANIUM	.17 mg
B-6	URANIUM	.76 mg
9-1	URANIUM	1.65 mg
9-2	URANIUM	1.65 mg
9-3	URANIUM	1.65 mg
9-4	URANIUM	1.65 mg
9-5	URANIUM	1.65 mg
10-1	CO-60	2.22
10-2	CO-60	2.23
10-4	CO-60	2.22
10-5	CO-60	2.22
10-6	CO-60	9.74
10-1	MN-54	.142
10-2	MN-54	.142
10-4	MN-54	.142
10-5	MN-54	.142
10-6	MN-54	.623
10-1	CS-137	.805
10-2	CS-137	.786
10-4	CS-137	.768
10-5	CS-137	.750
10-6	CS-137	3.29
10-1	SR-90	.490
10-2	SR-90	.478

TABLE E.1. (contd)

Sample ID	Isotope	Ao Value (μCi)
10-4	SR-90	.467
10-5	SR-90	.456
10-6	SR-90	2.00
10-1	URANIUM	1.65 mg
10-2	URANIUM	1.65 mg
10-4	URANIUM	1.65 mg
10-5	URANIUM	1.65 mg
10-6	URANIUM	7.55 mg

TABLE E.2. Elemental A_0 Determination of PSW Grouts (all values in mg)

Elements	GroutID	PSWA5-1	PSWS5-4	PSWA7-1	PSWS7-4	PSWLA7-6	PSWA9-1	PSWS9-4	PSWA10-1	PSWS10-4	PSWLA10-6
Al		1570.90	1622.81	1507.76	1602.56	7078.60	1539.93	1511.70	1476.49	1475.58	6465.72
B		23.20	23.97	22.27	23.65	104.55	22.74	22.33	21.81	21.79	95.50
H_3BO_3		132.67	137.05	127.34	135.26	597.82	130.06	127.67	124.70	125.62	546.06
Ba		22.57	23.31	21.66	23.01	101.69	22.12	21.72	21.21	21.20	92.89
Ca		5692.76	5880.87	5463.95	5803.86	25652.07	5580.55	5478.25	5350.64	5347.34	23431.07
Cu		2.92	3.01	2.80	2.97	13.14	2.86	2.81	2.74	2.74	12.00
Fe		921.75	952.20	884.70	939.73	4153.46	903.58	887.01	866.35	865.82	3793.85
K		120.19	124.17	115.36	122.54	541.61	117.83	115.67	112.97	112.90	494.71
Mg		289.96	299.54	278.31	295.62	1306.60	284.25	279.04	272.54	272.37	1193.47
Mn		103.08	106.48	98.94	105.09	464.48	101.05	99.19	96.88	96.82	424.26
Na		621.13	641.66	596.17	633.25	2798.87	608.89	597.73	583.80	583.44	2556.54
Ni		3.42	3.54	3.29	3.49	15.43	3.36	3.29	3.22	3.22	14.09
Pb		0.76	0.79	0.73	0.78	3.43	0.75	0.73	0.72	0.71	3.13
Si		4178.92	4317.00	4010.95	4260.48	18830.56	4096.55	4021.45	3927.78	3925.35	17200.18
Sr		27.89	28.81	26.77	28.44	125.69	27.34	26.84	26.22	26.20	114.81
Ti		293.51	303.21	281.72	299.24	1322.60	287.73	282.45	275.87	275.70	1208.08
V		10.52	10.87	10.10	10.73	47.42	10.32	10.13	9.89	9.88	43.31
Zr		9.76	10.09	9.37	9.95	43.99	9.57	9.39	9.18	9.17	40.18
Cl		2.54	2.62	2.43	2.59	11.43	2.49	2.44	2.38	2.38	10.44
NO_3		10.52	10.87	10.10	10.73	47.42	10.32	10.13	9.89	9.88	43.31
PO_4		262.45	271.12	251.90	267.57	1182.62	257.28	252.56	246.68	246.53	1080.23
SO_4		426.01	440.08	408.88	434.32	1919.62	417.61	409.95	400.40	400.16	1753.42

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