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INFORMAL REPORT

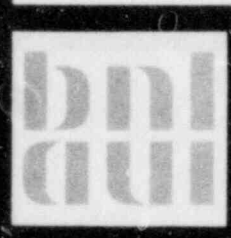
EFFECTS ON BURIAL SITE PERFORMANCE AND BURIAL SITE MONITORING OF NEW ENGLAND NUCLEAR CORPORATION RADIOACTIVE WASTE

DRAFT REPORT

E. Veakis and E. P. Gause

February 1982

NUCLEAR WASTE MANAGEMENT DIVISION
DEPARTMENT OF NUCLEAR ENERGY BROOKHAVEN NATIONAL LABORATORY
UPTON, NEW YORK 11973



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E. Veakis and E. P. Gause

Manuscript Completed: February 1982

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Office of Nuclear Materials Safety and Safeguards
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ABSTRACT

The New England Nuclear Corporation (NEN) low-level radioactive waste components were evaluated with respect to their possible adverse effects to the performance of the shallow-land burial facilities currently receiving their waste. Current monitoring practices were reviewed in those instances where data was available.

Areas of concern identified in this report as requiring further investigation include the need for initiating monitoring programs to determine the effects of organics at the burial sites. NEN's waste package for tritium gas and organics involves a glass bulb container which is susceptible to breakage. Soil-waste interactions for the majority of NEN's waste constituents have not been investigated for the types of soils present at the burial sites.

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EFFECTS ON BURIAL SITE PERFORMANCE AND BURIAL SITE MONITORING OF NEW ENGLAND NUCLEAR CORPORATION RADIOACTIVE WASTE

1. INTRODUCTION

The United States Nuclear Regulatory Commission (NRC) has contracted Brookhaven National Laboratory (BNL), under FIN A-3165, "Study of Non-Fuel Cycle Wastes," to provide technical assistance on the impact of non-fuel cycle waste at currently operating commercial low-level radioactive waste burial sites. The waste generators are identified for BNL by the NRC. The focus of the assessment is the impact of particular waste generators with respect to proposed 10 CFR Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste."

The generator whose waste stream is the focus of this report is New England Nuclear Corporation (NEN), Boston, Massachusetts.

Under FIN A-3165, the report for subtask 2A, "Characterization of the Radioactive Large Quantity Waste Package of the New England Nuclear Corporation," presented a description and assessment of NEN's waste and packaging procedures; the report for subtask 2B, "Identification of Needed Shipping Information for Large Quantity Radioactive Waste Generated by New England Nuclear Corporation," dealt with an assessment of shipping information which accompanies the wastes to the burial site.

Under subtasks 2C and 2D, the emphasis of this report is as follows:

- To identify any aspects of NEN's waste which could adversely effect site performance; specifically, effects on the ability of the burial site to retain or retard the transport of radionuclides.
- To assess current monitoring practices at the burial sites currently receiving waste from NEN with respect to chemical, as well as radiological hazards present in NEN waste.
- To present recommendations based on an assessment of the above concerns to the NRC.

The burial sites currently used by NEN for low-level waste disposal are Richland, Washington, and Beatty, Nevada, operated by U.S. Ecology Corporation (U.S.E.), formerly Nuclear Engineering Company, Incorporated, and Barnwell, South Carolina, operated by Chem-Nuclear Systems, Incorporated. A description of the Barnwell facility and monitoring procedures was given in detail in the subtask 1C and 1D report[1] and will not be repeated here. The report will focus primarily on the Richland and Beatty facilities.

2. RICHLAND COMMERCIAL WASTE MANAGEMENT FACILITY

The Richland commercial low-level radioactive waste burial facility is located on federal land at the Hanford Reservation approximately 16 km northwest of Richland, Washington. The site is operated by U.S. Ecology (USE) formally Nuclear Engineering Company, Incorporated, under license from the State of Washington (see Appendix A) and the U.S. Nuclear Regulatory Commission. A map of the site is given in Figure 2.1.

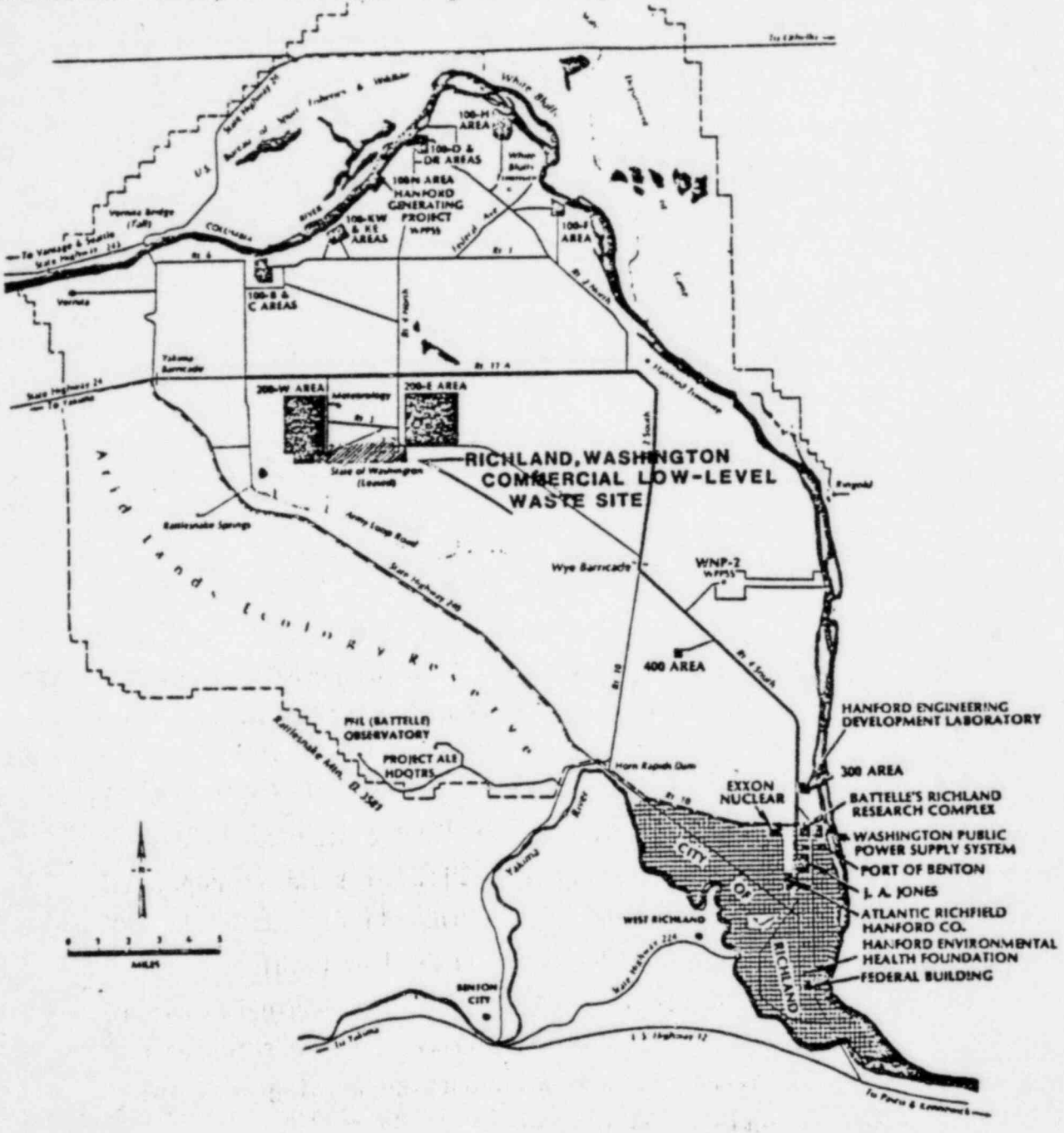

Figure 2.1 Richland, Washington, low-level waste disposal site.(2)

Information pertaining to operations and monitoring at the Richland site was obtained primarily from USE's "Site Operations Manual for Radioactive Waste Disposal at Richland, Washington."

2.1 Geology

The Richland burial facility is located in the Pasco Basin on the Columbia River Plateau. Three major geologic units comprise the Pasco Basin:

(1) The uppermost stratigraphic unit is the Hanford Formation which extends to a depth of up to 60 meters. It is composed of unconsolidated sands, silts, and gravels whose deposition is attributed to glacial flood waters.

(2) Underlying the Hanford Formation is the Ringold Formation extending in thickness of up to 370 meters and composed of semiconsolidated lake and stream sediments.

(3) The bedrock is Yakima Basalt; a dense basaltic lava of the Columbia River Basalt Group.

Figure 2.2 shows a west to east cross section of the various formations and rock units underlying the Hanford Reservation. The alluvial plain has a complex geological history as shown in Table 2.1[2]

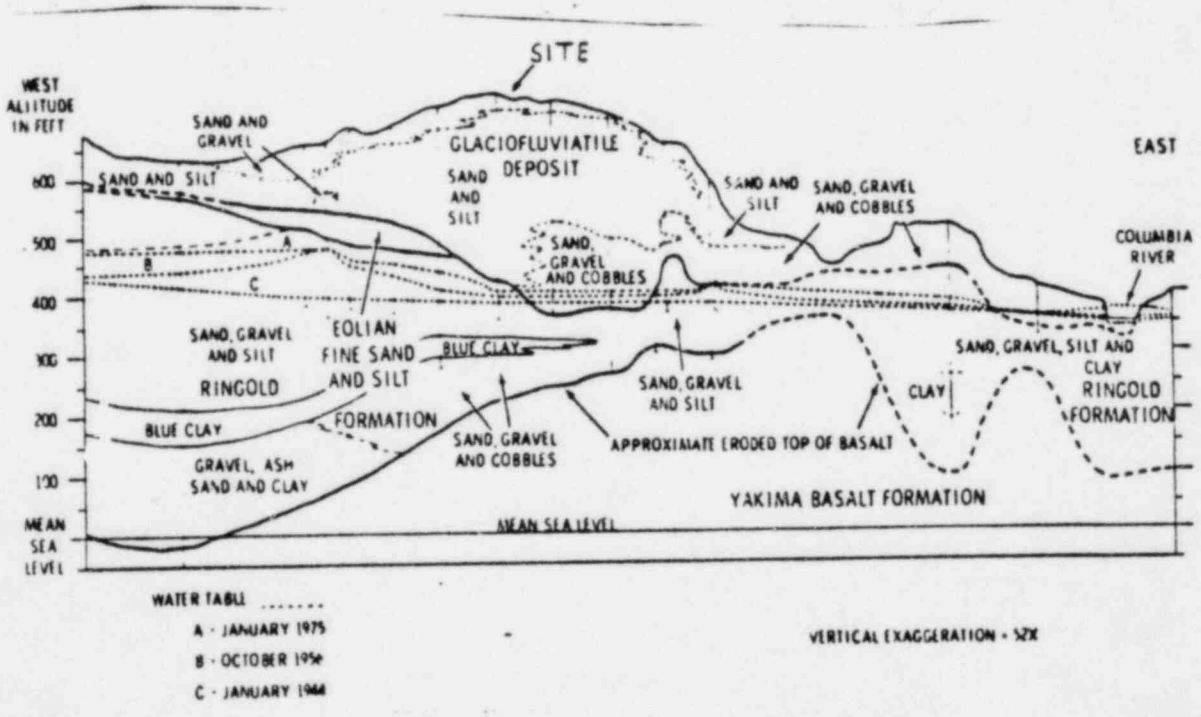

Figure 2.2 West to east section of the Hanford Reservation, showing the general distribution of the rock units, and the positions of the water table in 1944, 1956, and 1975.[3]

Table 2.1

Geological History of Pasco Basin[3]

ERA	System	Series		Geological Unit	Material
CENOZOIC	QUATERNARY	Holocene		Dunes and Eolian sediments (0 to ~12 m thick)	sands, increasingly finer and quartz-rich to the N.E.
				Alluvium, colluvium, landslides (0 to ~30 m thick)	unsorted rubble and debris, locally interfinger with Ringold Formation and Pasco gravels.
				Pasco gravels and the Touchet beds (0 to ~120 m thick)	sands and gravels occurring as glacial flood deposits. Commonly roughly graded. Unconsolidated, but highly compact.
				Palouse soils (0 to ~10 m thick)	wind transported and deposited silt, locally weathered to clay.
		Pleistocene		Ringold Formation (0 to ~370 m thick)	fluvial and flood plain silts, sand gravel. Basal portion largely silt and clay.
	TERTIARY		COLUMBIA RIVER BASALT GROUP (~4000 m thick)	Ellensburg Formation (6 to 60 m thick)	volcaniclastic rocks and their weathering products. Grades into Ringold formation sediments.
				Yakima Basalt Formation (prob. ~760 m thick)	basaltic lavas with interbedded stream sediments in upper part, locally folded and faulted.
		Miocene		Picture Gorge Formation (prob. ~460 m thick)	basaltic lavas
		Oligocene			
		Eocene		?	basaltic lavas
		Paleocene		?	probably sandstones
MESOZOIC				Rocks of uncertain age, type and structure	probably metasediments and metavolcanics intruded by granitic rocks.

2.2 Climate

Average temperatures for July and January range from a high of approximately 34°C and 3°C, respectively to a low of 16°C and -6°C, respectively.[2]

Average annual precipitation is approximately 16 cm. Tornadoes occur rarely in this region; 14 have been confirmed within 100 miles of the site in records dating from 1916.

There is no evidence at present for concern with respect to meteorologic events impacting on burial site operations.

2.3 Seismic Activity

There are no reported accounts of destructive earthquakes having occurred in the vicinity of the site. Effects on the Pasco Basin from earthquakes occurring in eastern Washington are expected with a moderate intensity of about VI on the Modified Mercalli scale. The acceleration accompanying such

earthquakes is not expected to cause serious structural damage. There is no indication of major faulting in this area.[3]

There are no indications at the present time that a seismic event would adversely effect burial site performance at the Richland site.

2.4 Hydrology

The site is located in a relatively dry region with an average annual precipitation of 160 mm. Lysimeter data indicate that annual evaporation potential exceeds total precipitation.[4]

The Columbia River flows through the Hanford Reservation approximately 12 km from the commercial waste disposal area. The annual mean flow rate of the Columbia River at McNary Dam is 5320 m^3/s.[3]

Depth to the water table at the Hanford Reservation ranges from 0.3 meters to more than 90 meters below land surface. Beneath the 200-West burial ground, which is adjacent to the USE site, the depth to the water table ranges from 60 to 70 meters. The thickness of the saturated zone (unconfined aquifer) ranges from 15 to 75 meters. The horizontal hydraulic conductivity of the aquifer ranges from 0 to 60 meters per day. The aquifer is used for consumption by the reservation, as well as the city of Richland. Figure 2.3 shows a isometric projection of the groundwater table under the Hanford Reservation.

To date, there is no indication of radionuclide migration from the USE site via the groundwater. This is attributed to low annual precipitation rate, high evapotranspiration rates, and the long distance to the water table.

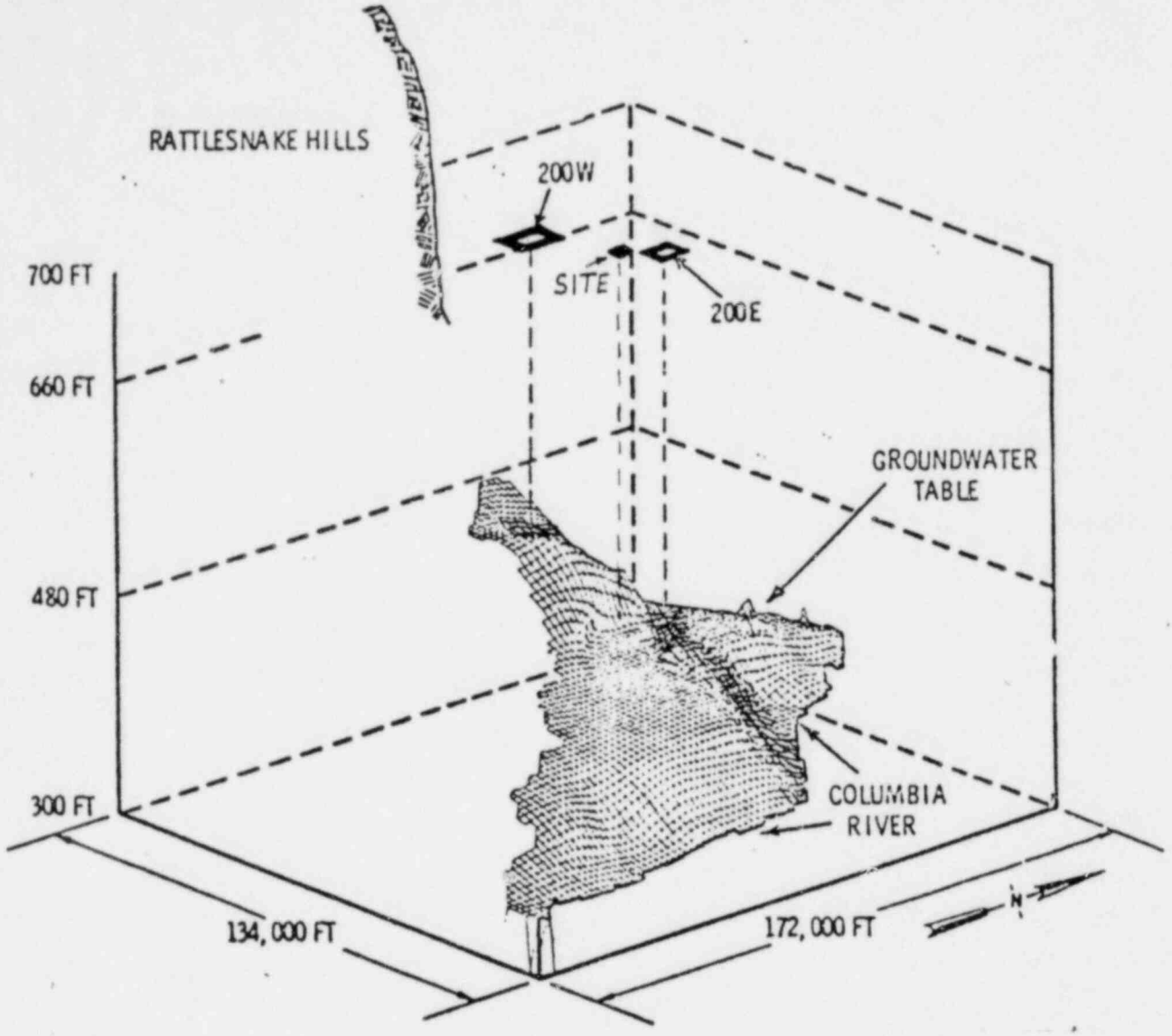

Figure 2.3 Isometric projection of the groundwater table under the Hanford reservation.(3)

2.5 Waste Trenches

Information on trench maintenance was obtained from Section 6 of USE's "Site Operation Manual." Waste trenches at the Richland site are typically 90 meters long, 8 meters wide, and 6 meters deep. A buffer zone of approximately 30 meters is maintained, separating one trench from that adjacent, as well as from the site boundary.

A mound is constructed at the close of filling operations with approximately 1 meter at the edges and 1.5 meters of earth in the center. The mound is then covered by a layer of gravel to prevent erosion. A permanent concrete marker is placed at each end of the trench with information as to opening date, closing date, volume of waste, curies of byproduct material, grams of

special nuclear material, pounds of source material, and trench dimensions. Upon completion of a trench, the trench surface is inspected at least on a quarterly basis.

There is no indication given in the Operation Manual of any waste segregation procedures other than preferentially placing the heavier containers at or near the bottom of the trench. The exception is the isolation of fissionable materials which are placed in isolated trenches. The Washington State license specifies that waste containing chelating agents in amounts >1% of the package volume is to be segregated (Site Operations Conditions, Item 34).

3. BEATTY COMMERCIAL WASTE MANAGEMENT FACILITY

The commerical low-level radioactive waste burial facility at Beatty, Nevada, is operated by U.S. Ecology, formerly Nuclear Engineering Company, Incorporated, under license from the state of Nevada (see Appendix B) and the U.S. Nuclear Regulatory Commission.

The Beatty site is located to the south-southwest of Beatty, Nevada, in the Amargosa Desert.

3.1 Geology(5)

The valley floor of the Amargosa Desert is composed of unconsolidated deposits of clay, silt, sand, and gravel. Maximum thickness has not been determined but this strata is at least 175 meters (test well data). The bedrock is assumed to be similar to that found exposed in the vicinity of Bare Mountain, which consists of sedimentary and metamorphic rocks (Paleozoic) and volcanic rocks (Tertiary).

The geology of the site is complex and includes sandstone, siltstone, dolomite, limestone, shale, phyllite, schist, and marble. Given this complexity and lack of information as to specific bedrock type at any one particular locality on the site, predictions as to permeability of the underlying strata are difficult to assess. The problem is compounded by fracturing and faulting in the area as indicated by test drilling conducted at the Nevada test site.

Additional information on permeability to water is required prior to an adequate assessment of water flow in the bedrock and in the overlying deposits.

3.2 Climate

Average annual rainfall ranges from 63.5 to 127 mm per year.(4) Average annaul temperatures for this and region range from a high of approximately 45°C to a low of approximately 5°C.

There is no evidence at present for concern with respect to meterologic events impacting on burial site operations.

3.3 Seismic Activity(3)

The site is located in a seismically active area and is expected to receive severe earthquakes. The maximum expected intensity for this region of the Amargosa Valley is a IX on the Modified Mercalli scale which would result in structural damage to buildings on site. The probability of fissure accompanying an earthquake at the site are not known; their occurrence would, however, increase the chances of water infiltration to the trenches and possibly provide a more rapid transport of released radionuclides to the environment.

The location of this site in a seismically active area requires additional information on the performance of the site in the event of an intense earthquake.

3.4 Hydrology[3,5]

The regional slope in the immediate vicinity of the site ranges from approximately 30 to 40 feet per mile. Contour maps of the site indicate that the area is well drained and that topography tends to preclude erosion under ordinary conditions of runoff.

Average rainfall in this arid region is approximately 100 mm per year. Water infiltration does not appear to be a concern as precipitation is exceeded by evapotranspiration . There are no indications of long-term exposure of burial trenches due to water accumulation. Conservative estimates of evaporation at the site are on the order of approximately 250 cm per year with a range of about 8 cm during the months of December and January to about 38 cm during the months of July and August. Information on precipitation and evaporation strongly suggests that almost all of the precipitation occurring in the area is rapidly returned to the atmosphere as water vapor.

Groundwater table at the site is located at a depth of approximately 80 to 90 meters. Data on the velocity of groundwater movement at the site is lacking.

Based on currently available information on the hydrology of the Beatty site, there are no indications of adverse effects on site performance or any concerns that relate specifically to NEN's waste.

3.5 Waste Trenches[3,6]

Waste trenches at Beatty are typically 260 meters long, 12-15 meters wide, and 8 meters deep. Trench dimensions have, in the past, ranged from 90 to 200 meters long, 1.2 to 27 meters wide, and 1.8 to 6 meters deep. The trench walls are nearly vertical in construction (>75° slope). There is a minimum of 0.9 meters of earth between the top of the emplaced waste and the surface. A trench cover of 0.6 meters (minimum) is constructed above the ground surface. The trenches are constructed with the use of heavy equipment. There are no provisions made for water collection in the event of infiltration and no compacting taking place following trench closure. Detailed plans or additional information trench design and inspection procedures were not available for the preparation of this report. There is no indication of waste segregation procedures at Beatty.

Trench documentation includes survey and location of trenches on a waste plan, documentation of contents of each trench, and a permanent monument identifying the trench and contents which is emplaced within 30 days following completion of burial operations.

4. WASTE-SOIL INTERACTIONS

4.1 Tritium

Based on NEN's 1980 breakdown of isotope quantities sent for disposal, greater than 99% of the total curies may be attributed to tritium in the gaseous form or bound with organics (approximately a 50% partitioning).

When tritiated water comes in contact with earth materials, some of the tritium atoms may be retained preferentially (with respect to protium) on the minerals, especially on clays. Several mechanisms of retention are known to occur, or at least are theoretically possible. Some of these are: exchange of tritium ions for hydrogen ions in exchange positions, exchange of tritium ions for exchangeable cations other than hydrogen ions, tritiated water molecules exchanged for ordinary water of crystallization or hydroxyl water, and replacement of lattice aluminum sites by tritium. Which mechanism or mechanisms predominate depends on pH, isotope concentration, mineral composition, and other factors. The actual conditions required for tritium to undergo fixation have not been adequately defined and at present, a quantitative prediction of tritium fixation in soils is not possible.

Studies at the commerical burial facility at West Valley, NY,[8] indicated that a significant pathway for uncontrolled release of radioactivity to the environment appeared to be emanation of gaseous H-3 and C-14 through the trench cover. The generic character of the West Valley site for gaseous effluents is as yet undetermined. Analogous gas species found at sanitary landfills suggest that similar gaseous effluents should be observed at all other radioactive waste burial sites. The characterization of gaseous effluents from burial trenches is important given the lack of any barriers against uncontrolled release to the environment.[8]

The health hazard associated with tritiated water is much greater than that of tritium gas. A comparison of maximum permissible concentrations $(MPC)_a$ indicates that a concentration of 3.4 nCi/mL of tritium in air is equivalent to 4000 $(MPC)_a$ of tritiated water but only 10$(MPC)_a$ of tritium.[9] Thus, the conversion rate of tritium to tritiated water by second order reaction rate constant for the oxidation or isotopic exchange becomes an important parameter on the case of NEN's waste in the event of total release of tritium gas at the burial site. Eakins and Hutchinson reported on conversion rates of tritium to tritiated water in dry and humid air in the absence of a catalyst.[9] The results of this study are shown in Tables 4.1 and 4.2. For an initial tritium concentration of approximately 2×10^{-2} μmCi/mL the mean value for the oxidation of tritium in dry air was 5.6×10^{-4} $mLmCi^{-1}h^{-1}$ which agrees well with the value reported by Casaletto et al. of 6.2×10^{-4} $mLmCi^{-1}h^{-1}$.[10] With an initial concentration of tritium of 3.4×10^{-2} for Ci/cm^3 in air at 100% humidity, Eakins and Hutchinson have estimated that it would take approximately 1100 years for half the tritium to be converted to tritiated water. It is clear that at low concentrations the conversion of tritium tritiated water in air is a very slow process, independent of water vapor concentration over a considerable range.

Table 4.1

Oxidation of Tritium in Dry Air[9]

Reaction Time (hours)	Rate Constant, K ($mL\ mCi^{-1}h^{-1}$)
24	1.4×10^{-3}
96	7.1×10^{-4}
768	3.5×10^{-4}
1464	6.2×10^{-4}
Mean of Last 3:	5.6×10^{-4}

Table 4.2

Conversion to Tritiated Water in Air at 100% Humidity

Reaction Time (hours)	Rate Constant, K ($mL\ mCi^{-1}h^{-1}$)
24	8.1×10^{-3}
72	2.8×10^{-3}
168	2.7×10^{-3}
336	3.1×10^{-3}
Mean of Last 3:	2.9×10^{-3}

Results of investigations into the conversion of molecular tritium to tritiated water in soils indicated that a higher soil moisture content would tend to facilitate conversion.[11] Further, exposure of soil to molecular tritium under laboratory conditions indicated conversion of the gas to tritiated water. The conversion is attributed to the metabolic action of soil microorganisms. Various soil types exposed to tritiated gas over a three-day period yielded differing concentrations of tritiated water (Table 4.3). Exposure of closed plant-soil systems to tritium gas over a period of time yielded results as shown in Figure 4.1. The freeze-dried pine seedling exhibited the highest peak concentration of tritiated water probably attributable to plant root microorganisms. The humus layer, rich in organic matter undergoing decomposition, also exhibited high conversion rates relative to soil.

Table 4.3

Tritium Gas Exchange With Soil Water[11]

Type of Soil	Soil-Water Activity cts/(min-mL)
1. Warm, moist, loam	7978
2. Sandy loam	1492
3. Sand	640
4. Clay	443

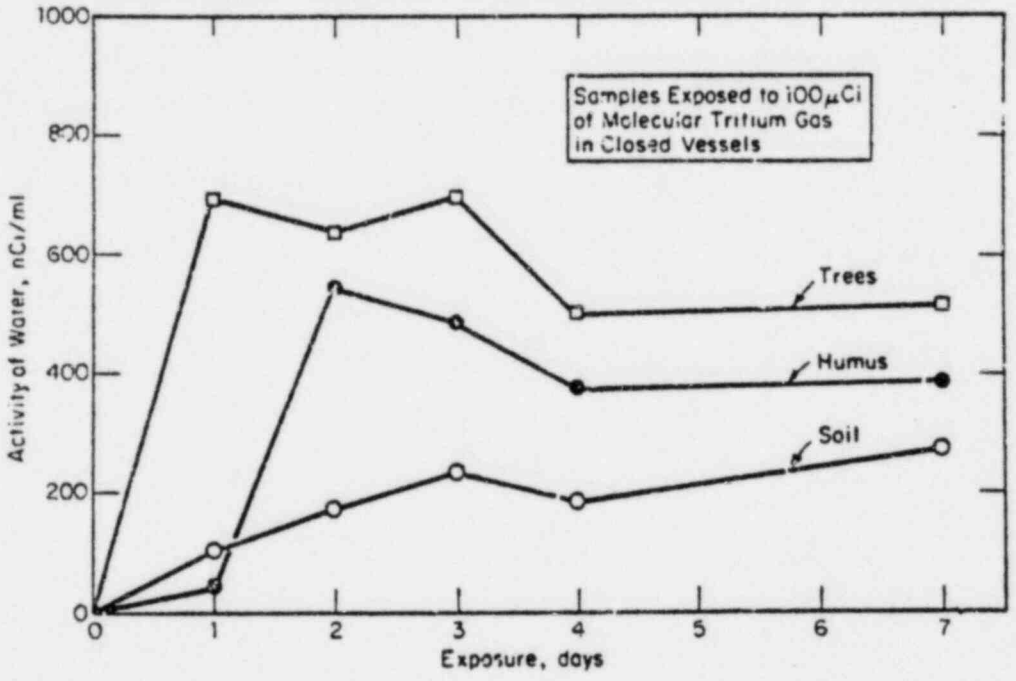

Figure 4.1 Activity of water from freeze-dried materials in pine experiments.[11]

With respect to the presence of tritium in NEN's waste, attention should be focused on waste-plant-soil interactions for those plant systems used in erosion control for the burial trenches. In the event of release of tritium gas from NEN's waste package, the humus layer generated by planting is expected to enhance conversion of gas to tritiated water.

Radioactive gases detected from the burial trenches at West Valley, New York, include CH_3T, HTO, and ^3H; also detected were $^{14}CH_4$ and other ^{14}C-hydrocarbons. The release of tritiated methane is estimated at 200 to 6000 mCi/year to the environment.[12] Degradation of complex organic compounds by microorganisms in soil contribute to the release of such gases as H_2, H_2S, CO_2, and CH_4. Table 4.4 shows the population distributions of methanegenic bacteria in trench leachate samples collected from the Maxey Flats, West Valley, Barnwell, and Sheffield, waste disposal sites. Trench water samples from these burial sites were collected under anoxic conditions. A methanogenic culture from trench 19S at Maxey Flats was isolated and the rate of methane production in 80% H_2 - 20% CO_2 and 85% N_2 - 10% CO_2 - 5% H_2 atmospheres was investigated. The results are shown in Table 4.5. The rates of methane production are shown in Figure 4.2 .

Table 4.4

Populations of Methane Bacteria in Leachate and Water Samples[12]

Sample Location	Collection Date month/yr	Methanogens MPN/mL[a]
Maxey Flats, KY		
Trench 19	5/78	4.9
Well UB1A	5/78	1.0
West Valley, NY		
Trench 3	10/78	23.0
Trench 4	10/78	1.7
Trench 5	10/78	N.D.
Trench 8	10/78	1.0
Trench 9	10/78	4.5
Barnwell, SC		
Trench 8D2	3/79	0.8
Trench 6D1	3/79	N.D.
Trench 25-21D1	3/79	0.2
Trench 3D1	3/79	N.D.
Sheffield, IL		
Trench 14A	4/79	0.2
Trench 18	4/79	N.D.
Well 525	4/79	N.D.

[a]MPN - Most probable number.
[b]N.D. - None detected.

Table 4.5

Microbial Production of $^{14}CH_4$ and CH_3T From Maxey Flats, Trench 19S Leachate[12]

Sample[a]	CH_4 Produced nmol	Total Activity pCi	
		$^{14}CH_4$	CH_3T
Control (Formaldehyde treated)	980	0.05	0.03
Inoculated (N_2+CO_2+H_2)	18000	0.59	1.0
Inoculated (CO_2 + H_2)	68000	12	57.

[a]30 mL of trench leachate in 60-mL bottle.

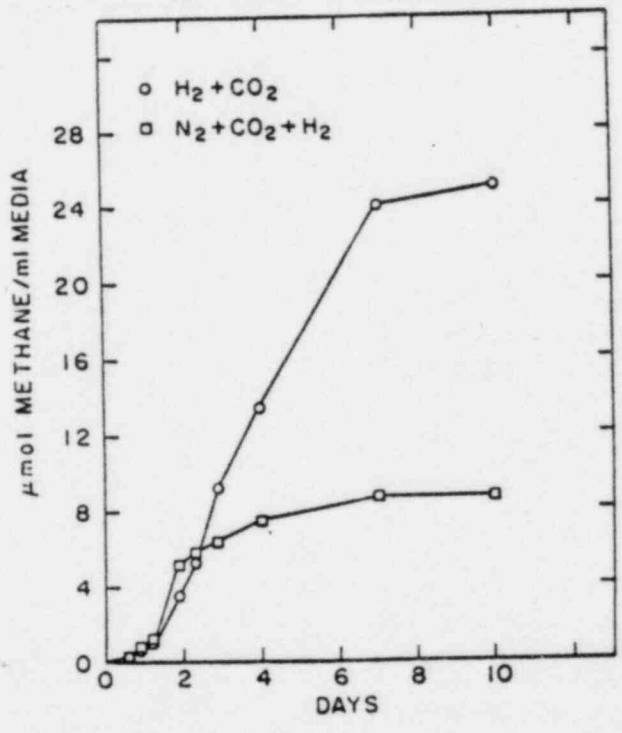

Figure 4.2 Production of methane by mixed methanogenic culture from synthetic media incubated under 80% H_2 + 20% CO_2 and 85% N_2 + 10% CO_2 + H_2 gas phase.[12]

Information pertaining to a quantitative assessment of methane bacteria in leachate at Beatty and Hanford is not available at the present time. The concerns, however, with respect to bacteria in the leachate at these sites areless in comparison to Barnwell given the arid environment of the western sites. However, at the present time, information concerning methane bacteria in Beatty and Hanford leachate is not available for an adequate assessment of any possible problem.

Studies on the oxidation of tritium by McFarlane et al. indicate a rapid rate of reaction in nonsterile soils occurring primarily near the soil surface.[13] The rate of oxidation of tritium to tritiated water (HTO) for leaves and sterilized clay loam showed less than 4% conversion of HT to HTO after 48 hours. Exposure of unsterilized clay loam to tritium resulted in greater than 97% conversion of HT to HTO.

The study involved 1500 nCi of tritium reacting with 20 g of soil and 15 mL water inside a flask; results were also obtained in tritiated water formation following exposure of leaves to tritium (see Tables 4.6 and 4.7).

The results of these studies indicate that gaseous tritium waste may represent a significant source and contribution to tritiated water in the environment.

Table 4.6

Formation of Tritiated Water in Various Solutions Exposed to 1500 nCi of Tritium for 48 h[13]

Sample Type	% of Tritium Recovered as HTO
Corn leaf (segment)	1.12 ± 0.20[a]
Tabacco leaf (detached)	1.09 ± 0.38
Bean leaf (attached)[b]	0.86 ± 0.06
Bean leaf (detached)	1.06 ± 0.10
H_2O	1.98 ± 1.24
H_2O shaking	1.16 ± 0.51
H_2O on filter paper	1.08 ± 0.31
HCl 0.4 N	3.32 ± 0.30
NaOH 0.5 M	3.05 ± 0.12
Humic Material[c]	2.30 ± 0.10

[a] ±1 standard deviation.
[b] Exposure to HT was 8 h.
[c] Extracted from soil in 0.5 M NaOH.

Table 4.7

Conversion of Tritium to
Tritiated Water in Presence of Soil[13]

Sample Type	% of Tritium Recovered as HTO After 90 h Exposure
Sterilized clay loam	3.4 ± 0.7
Natural clay loam	100.0 ± 1.2

4.2 Organics

The behavior of the organics present in burial trenches is, for the most part, unknown. An attempt should be made to characterize the organics present in the trench waters at the burial sites as these may enhance radionuclide mobility.

Toluene and benzene are known to be constituents of NEN's waste. With respect to the solubility of these constituents thre are a wide range of values in the literature for any given product. This wide range is attributed to the difference in the specific method of analysis used, as well as on the purity of the product. Verschueren[14] suggests the following classification for solubilities:

Rating	Maximum Solubility
practically insoluble	20 mg/L or less
slightly soluble	20 to 200 mg/L
moderately soluble	200 to 1000 mg/L
highly soluble	1000 to 10000 mg/L
extremely soluble	10000 mg/L or more

The solubility of toluene in water is 515 mg/L at 20°C; the solubility of benzene in water is 1780 mg/L at 20°C.

The solubility of these organics is an important parameter insofar as a soluble leachate will tend to be more mobile. Complexation may further enhance the mobility of the leachate. Date on the adsorption of organics in burial trench leachates are lacking. This study is in agreement with a recent evaluation conducted by General Reserach Corporation[15] that research is needed in the areas of complexation and transport mechanisms of organic constituents present at low-level waste disposal sites.

Research into the behavior of toluene, known to be a component of NEN's waste in soil is need in order to address possible adverse effects of this organic to burial site performance.

In a recent publication by Wilson et al.,[16] the transport of selected organics in unsaturated soil was investigated by passing a feed solution of water plus organics through a soil column and determining the concentration of the compound in the effluent. Toluene exhibited a low retardation factor (interstital water velocity/velocity of pollutant was <2) in soil (average composition: 92% sand; 5.9% silt; 2.1% clay). The presence of this organic in the burial trench may enhance the mobility or radionuclides present in the waste.

Toluene is degraded by a variety of soil microorganisms[17] however, in this study degradation occurred when toluene was applied at a concentration of 0.9 mg/L, but not at 0.2 mg/L (see Table 4.8). The study cautions that biodegradation studies may only indicate a potential for degradation and further cautions extrapolating laboratory results to field situations.

The results of this study reflect the need for additional reserach which will utilize site-specific soils and site-specific determinations of organic constituents since the expected degradation may not occur for a given set of field conditions.

Table 4.8

Behavior of Toluene in Sandy Soil[16]

Concentration Applied mg/L	Volatilized	Column Effluent	Degraded or not Accounted for
	% of Material Applied		
0.90	38 ± 11[a]	2 ± 1.7	60 ± 8
0.20	66 ± 19	13 ± 6	21 ± 15

[a]Means ± 95% confidence intervals.

4.3 Cesium-137 and Cobalt-60

Data pertaining to waste-soil interactions involving radionuclides present in NEN waste for site-specific soils are lacking.

Information supplied by NEN indicates that out of 125,704 curies shipped for burial in 1980, 99.6% (125,197) was H-3 and 0.3% (425) was C-14 (see Table 4.9 for 1980 curie breakdown).

Table 4.9

1980 Radwaste Shipments - Isotope Quantities in Curies

Curies	Isotopes
125,197.491045	H-3
424.9149592	C-14
0.0111032	Na-22
35.9420174	P-32
12.474972	S-35
0.01102	Cl-36
0.05001	Ca-45
0.05253	Sc-46
6.073519	Cr-51
0.0456	Mn-54
0.243325	Fe-55
1.3787446	Co-57
0.001	Cr-57
0.000031	Fe-58
0.0001	Ni-58
0.336205	Co-58
0.0993585	Fe-59
0.012	Mn-59
0.130467	Co-60
0.302101	Ni-63
3.554228	Zn-65
0.140005	Ga-67
0.005506	Ge-68
1.212201	Se-75
0.006	Rb-84
0.029	Sr-85
0.2281	Rb-86
0.103502	Sr-90
0.02549	Nb-95
0.026	Zr-95
0.123132	Ru-103
0.2151083	Cd-109
0.059	Ag-110m
0.003006	In-111
0.01	Sn-111
0.0506001	Sn-113
0.001	Sn-119
4.040432	I-125
0.0001	Sb-125
0.0004202	I-131
0.003135	Ba-133
0.011	Cs-134
5.074537	Cs-137
0.1311069	Ce-141
0.00171	Gd-153
0.00166	Yb-169
0.01	W-181
0.115403	Au-195
0.004	Au-198
0.061	Pb-201
8.546002	Tl-201
0.1022359	Tl-202
0.315152	Hg-203
0.03445	Pb-203
0.059	Pb-210
0.00008	Am-241

Total Curies = 125,703.877209

There is a lack of information on the behavior of most radionuclides present in NEN's waste with respect to site-specific soils. Information on Co and Cs in soil was available and is included below. The inclusion of these radionuclides reflects the availability of data on their behavior in soil and not their importance with respect to total contribution to the site.

With respect to particular radionuclides present in NEN's waste, cesium sorption to soil is decreased in the presence of detergents[18] and by high concentrations of Na^+.[19] Maximum Cs sorption occurs in the pH range of 7 to 9 and is poorly complexed by humic acid (relative order of complexation: Ce > Fe > Mn > Co $\geq$ Ru > Sr > Cs > I). McFadden[20] states that the low relative stabilities of Cs chelates tends to negate any direct chelate effect on the migration of this isotope.

In the case of cobalt complexes can occur in both the II and III oxidation states,[19] EDTA is known to mobilize ^{60}Co in burial trench waters at Oak Ridge National Laboratory. Co is also known to complex in reducing soils by amino acids.[21] Research has shown that approximately 5 to 10% of the ^{60}Co was mobilized by naturally occurring organic acids in groundwater and approximately 90 to 95% mobilized by synthetic organics with a molecular weight of approximately 300.[22]

Sorption properties of the soil at the Richland site were not available for this report. Studies have been conducted for the Hanford site 200 separation areas. The low-level waste disposal site is located between the 200-West and 200-East fuel reprocessing areas (see Figure 2.1). On the assumption that soil properties for these areas would tend to approximate those under the Richland commerical burial facility, information pertaining to ^{137}Cs and ^{60}Co sorption is included in this report.

The study[23] was conducted in order to relate distribution coefficients (K_ds) values to sodium (Na^+), calcium (Ca^{+2}), and potassium (K^+) concentrations in the soil. Twenty-one Hanford sediment types from the 200 separation areas were included in the study. The results indicate that cesium sorption was controlled to a greater extent by K^+, to a lesser extent by Na^+, and was independent of Ca^{+2}. Cobalt sorption was controlled by Ca^{+2}. Figures 4.3, 4.4, and 4.5 illustrate the results obtained in this study. The sediment used in the analyses indicated in the figures is composed of 1.92% clay, 8.34% silt, 89.74% sand; cation exchange capacity is 3.6 meg/100 g; $CaCO_3$ is 34 mg/g. The major components of this sediment are quartz and feldspar for the sand fraction, vermiculite for the silt fraction, and vermiculite, montmorillonite, and mica for the clay fraction. Tables 4.10 and 4.11 present information on the sample localities and sediment properties used in this study. The variation in composition with depth and horizontal distance as indicated by these tables suggests that studies similar to this should be conducted for the soils underlying the commerical burial facility in order to determine variability and sorption properties. Given the compositional variability mentioned above it is not possible, at this time, to assess the ability of the soil to retard radionuclides within the area occupied by the commercial burial facility.

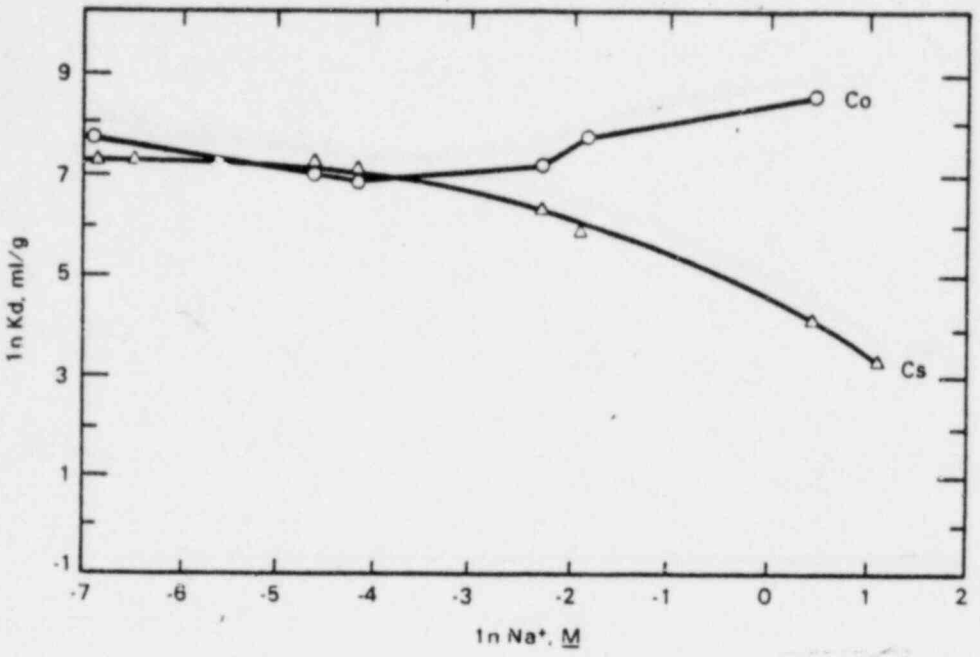

Figure 4.3 ln K_d as a function of equilibrium ln Na^+ for the 35- to 255-ft level of well E17-4 sediment.(23)

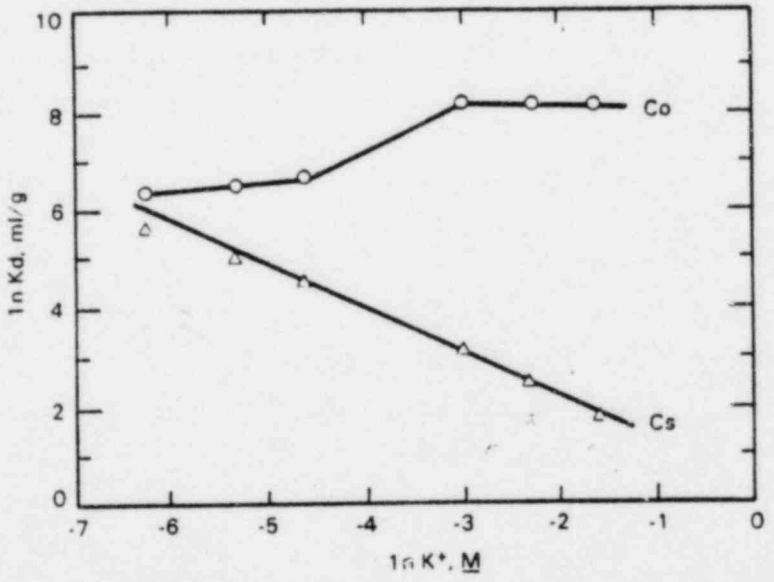

Figure 4.4 ln K_d as a function of equilibrium ln K^+ for the 35- to 255-ft level of well E17-4 sediment.(23)

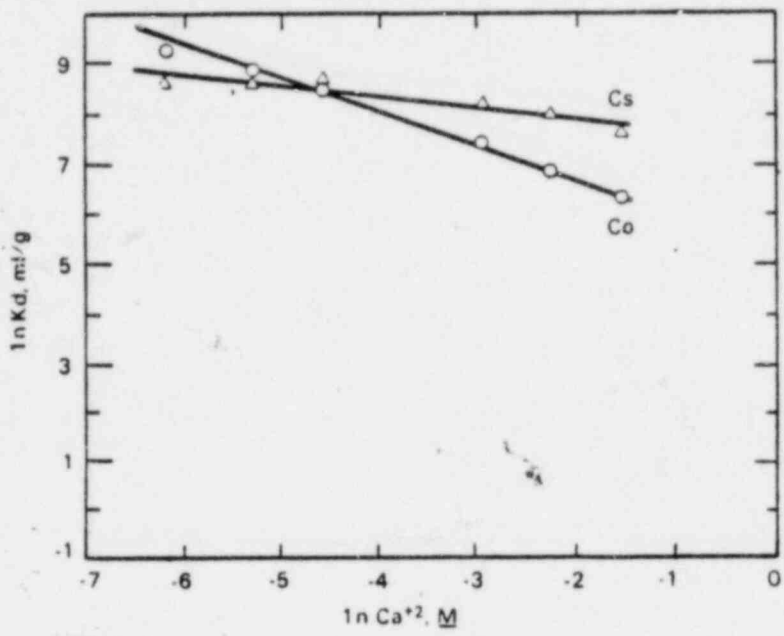

Figure 4.5 ln K_d as a function of equilibrium ln Ca^{+2} for the 35- to 255-ft level of well E17-4 sediment.(23)

Data pertaining to waste-soil interactions involving Beatty soils were not available at the present time. Waste soil-interaction studies involving Barnwell soil have been addressed under subtask 1C and will not be repeated here in the same detail.

Analyses of trench water samples and flow-through column experiments involving Barnwell cores were conducted at Brookhaven National Laboratory.(24) The results indicate relatively high soil permeability at Barnwell. Batch sorption studies were undertaken using trench water samples from trench 6D1 and silty sand (Hawthorne formation) obtained from a drill core. Characterization of the silty sand is given in Table 4.12.

Barnwell trench waters were determined to be chemically more oxidized water regimes in contrast to the anoxic conditions encountered at Maxey Flats and West Valley. Preliminary results based on Brookhaven's batch sorption experiments indicate slight decreases in ^{134}Cs and ^{137}Cs concentrations in solution and a large increase in ^{60}Co concentration. The Brookhaven study indicated radionuclide migration was enhanced in the presence of organics (e.g., EDTA). Results indicated a decrease in sorption for ^{60}Co where organics were added to the soil-water systems.

Table 4.10

Selected Well Locations and Sediment Types for Characterization of 200 Areas[23]

Well Location	Crib	Tank Farm	Sediment Designation	Sediment Interval (ft)
200 East Area				
E13-8	BC		1	0 - 40
			2	45 - 60
			3	165 - 220
			4	225 - 265
			5	270 - 320
E33-22	BY	B	6	0 - 35
		BX	7	40 - 80
		BY	8	85 - 195
			9	195 - 240
E17-4	A5,A10, A-36		10	0 - 30
			11	35 - 255
			12	260 - 300
Near E28017	A8,A24	A[a]		
		AX		
		AY		
200 West Area				
W22-25	S	S	13	0 - 40
		SX	14	45 - 65
		SY	15	70 - 120
		U	16	125 - 145
			17	150 - 205
W10-9	T	T	18	0 - 40
		TX	19	45 - 80
		TY	20	80 - 185
		U	21	190 - 225

[a]Not selected.

Table 4.11

Textural Properties, Cation Exchange Capacity (CEC), and $CaCO_3$ Content of Hanford Site Separation Areas Sediments.(23)

Sediment Type	Clay %	Silt %	Sand %	>2 mm %	CEC meq/100 g	$CaCO_3$ mg/g
1	1.71	3.57	94.72	13.6	5.2	5
2	1.50	2.20	96.30	2.3	3.5	15
3	2.03	3.20	94.77	1.6	2.4	13
4	2.14	2.33	95.53	26.1	3.8	7
5	1.11	3.50	95.39	0.0	3.1	6
6	4.36	17.96	77.68	29.5	5.4	10
7	2.9	7.64	89.46	7.8	3.0	19
8	1.34	6.90	91.76	6.8	3.5	19
9	3.14	8.85	88.01	41.0	2.7	4
10[a]	---	---	---	10.0	3.6	21
11	1.92	8.34	89.74	3.5	3.6	34
12	3.86	15.73	80.41	14.2	3.8	8
13	3.49	18.87	81.12	4.2	5.0	22
14	3.19	17.99	78.02	20.0	3.7	17
15	2.13	10.05	87.82	0.5	3.9	17
16	9.53	43.70	46.77	5.7	2.0	20
17	4.08	18.80	77.12	24.6	4.1	12
18	2.27	38.96	58.77	14.6	5.7	0
19	2.95	10.32	87.48	20.5	6.8	0
20	5.92	40.5	53.58	2.1	5.4	0
21	7.14	28.46	64.40	12.0	6.9	0

[a]Insufficient sample available to make this analysis.

Table 4.12

Characterization of Barnwell Silty Sand Used in BNL Sorption Experiments[24]

Particle size distribution; sand: silt: clay weight percent bulk sample (avg.)	75:10:15
Surface area, m^2/g	0.3 - 13
Cation exchange capacity, meq/100 g (sodium indexing ion)	6.0
Organic carbon, weight percent	0.03
Extractable iron, weight percent	0.2 - 0.3
Carbonate content, weight percent	0.0
Mineralogy:	
(M) major component	quartz (M)
(m) minor component	mica (m)
(Tr) trace amounts	kaolinite (m)
	goethite (Tr)
	hematite (Tr)

Distributions of tritium with depth in four Barnwell cores are shown in Figure 4.6. The resurgence of activity at greater depths may be attributed to earlier accumulations of tritium-bearing water possibly associated with seasonal (periodic) rainfall.

Gamma spectroscopy detected only ^{60}Co occurring in the core from Trench 2. ^{60}Co activity vs depth is shown in Table 4.13.

Conclusions drawn from the information presented above indicate that,

- In the event of release from the waste package tritium migration is expected to be rapid at all three burial sites;
- In the event of release from the waste package, C-14 migration is expected, as indicated by the information available from West Valley, possibly as $^{14}CH_4$ an other ^{14}C-hydrocarbons;
- Enhanced mobility is expected for Co-60 and Cs-137 in the presence of organics which may not be a part of the NEN waste package, but may be present in the burial trench leachate.
- The soluble nature of benzene and toluene is expected to enhance the mobility of the leachate containing these organics. Data on complexation involving radionculide constituents is not available for the three commercial low-level waste burial sites and a quantitative assessment of the contribution of these organics to radionuclide transport can not be made at this time.

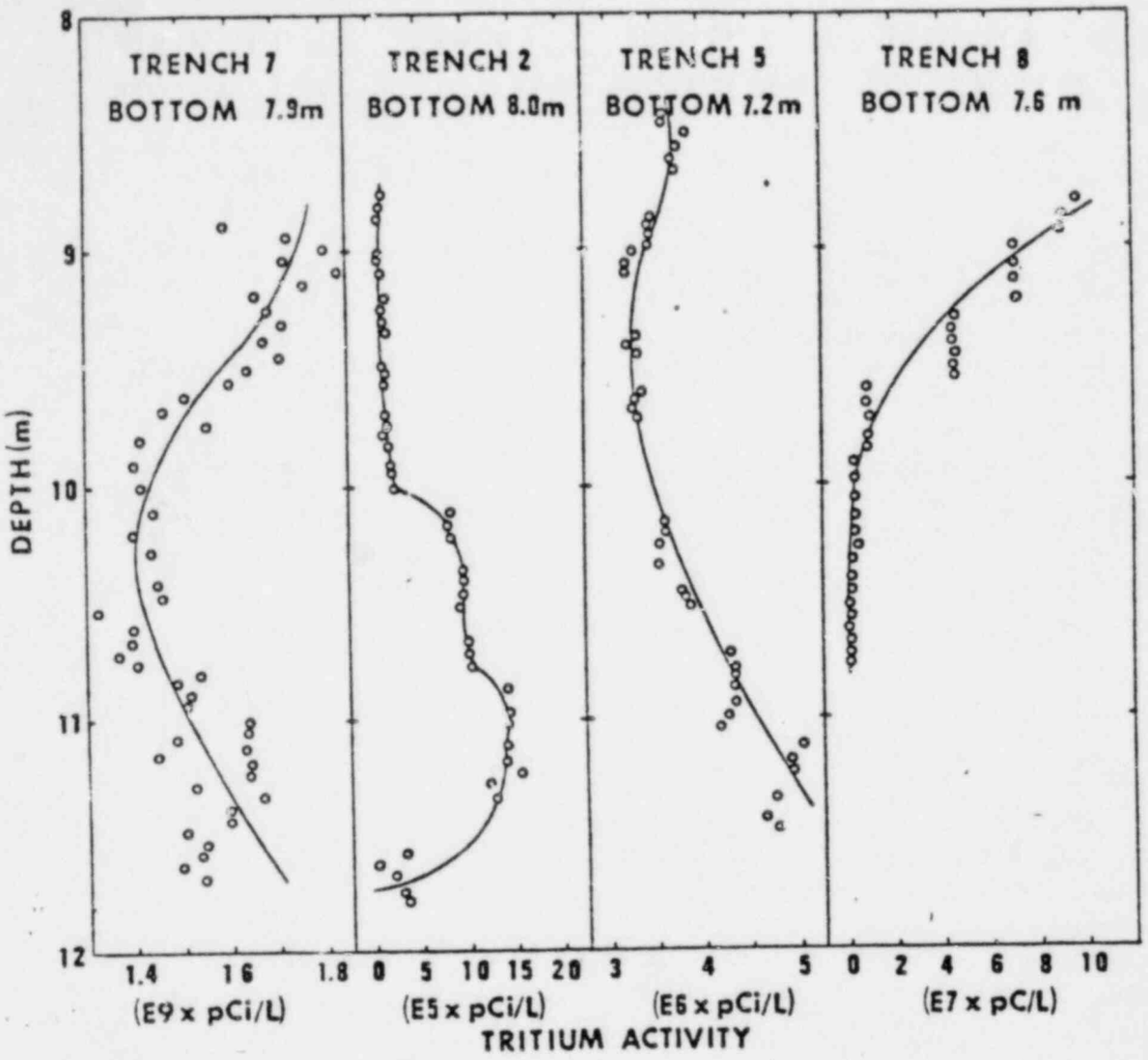

Figure 4.6 Tritium activity vs depth - Barnwell, South Carolina, disposal trench cores.(24)

Table 4.13

Relative Distribution of ^{60}Co Activity in Barnwell, Trench Core #2[24]

Depth (m)	Mean Activity (pCi/g)	Mean Activity (pCi/cm^3)	Relative Activity[a] by weight	Relative Activity[a] by volume
8.76 - 8.81	491.75	1147.23	1.0000	1.0000
8.81 - 8.86	420.64	966.51	0.8554	0.8425
8.86 - 8.92	410.07	922.48	0.8339	0.8041
9.02 - 9.04	114.58	277.69	0.2330	0.2421
9.04 - 9.09	36.00	84.41	0.0732	0.0736
9.09 - 9.14	17.71	41.38	0.0360	0.0361
9.20 - 9.25	1.791	4.45	0.0036	0.0039
9.25 - 9.30	2.38	5.34	0.0048	0.0046
9.30 - 9.35				
9.45 - 9.49	1.33	3.05	0.0027	0.0027
9.49 - 9.52	1.96	3.93	0.0040	0.0034
9.52 - 9.56				
9.56 - 9.60	3.418	8.782	0.0070	0.0077
9.70 - 9.74				
9.74 - 9.78	4.25	10.52	0.0086	0.0092
9.78 - 9.83	5.63	14.45	0.0114	0.0126
9.83 - 9.91				
9.91 - 9.94				
9.94 - 10.01	2.49	6.80	0.0051	0.0059
10.01 - 10.03	4.53	---	0.0092	---
10.11 - 10.16	11.35	25.61	0.0231	0.0223
10.16 - 10.22	12.03	30.51	0.0245	0.0266
10.22 - 10.29	12.39	28.20	0.0252	0.0246
10.36 - 10.41	4.134	7.786	0.0084	0.0068
10.41 - 10.46	3.260	7.954	0.0066	0.0069
10.46 - 10.52	2.127	3.877	0.0043	0.0034
10.52 - 10.67	0.861	1.437	0.0018	0.0013
10.67 - 10.72				
10.72 - 10.77				
10.77 - 10.82				
10.92 - 10.97				
10.97 - 11.02	0.1070	0.1926	0.0002	0.0002
11.02 - 11.12	0.1539	0.3327	0.0003	0.0003
11.12 - 11.18	0.1389	0.2685	0.0003	0.0002
11.18 - 11.23				
11.23 - 11.28				
11.28 - 11.34	0.0884	0.1196	0.0002	0.0001
11.34 - 11.40				
11.59 - 11.67	0.2589	0.5028	0.0005	0.0004
11.67 - 11.74	0.0677	0.1056	0.0001	0.0001
11.74 - 11.79	N.S.[b]	N.S.	N.S.	N.S.
11.79 - 11.84	N.S.	N.S.	N.S.	N.S.

[a]Activity expressed relative to the activity of the uppermost segment in the core.

[b]N.S. = no significant activity detected.

5. ENVIRONMENTAL MONITORING AT RICHLAND

Information pertaining to environmental monitoring for the USE site was obtained in part from section 9, "Environmental Monitoring" of USE's Radiological Controls and Safety for Burial Sites Manual. The complete manual was not made available to BNL.

The aims of USE's environmental monitoring program were stated as follows (Section 9.1, page 74 of USE's "Environmental Monitoring Program"):

"1. Evaluate potential exposure pathways to any local (within approximately a 5 kilometer radius) population centers or individual habitations.

2. Through the measurement of radioactivity in the environment establish statistically significant trends in the environmental radioactivity profile.

3. Evaluate the impact on individuals or populations residing local to the burial site from the radiation exposure contribution, if any, which occurs as a result of burial site operations."

With the exception of a class of radionuclides for which specific radioisotopic analysis is performed (based on toxicity and including Cesium-137, Strontium-90, Iodine-131, Radium-226, and Plutonium-239), monitoring involves gross radioactivity measurements. Should the gross measurements exhibit some statistically significant increase above pre-established "action levels" this would result in specific radionuclide analysis for that sample to determine the cause of the increase. Action levels for beta analysis (liquid samples) are in the range of 60 to 100 picocuries per liter (depending on background); for alpha the range may vary from 30 to 60 picocuries per liter.

Tritium is a special case for which specific radioisotopic analysis is conducted on a routine basis. Action levels for tritium are recommended at levels twice the general background for the area or 2000 picocuries per liter to insure early detection. Vapor phase migration involving tritium is addressed by sampling soil moisture from monitoring wells.

USE's "Richland Environmental Air Monitoring Program," Procedure No. RW-003, and "Richland Environmental Monitoring Program," Procedure No. RW-006, are included as Appendix C and D of this report. More current revisions of these procedures were not made available to the authors at this time.

Radionuclide monitoring and reporting procedures at Richland appear to be thorough and capable of providing an adequate assessment of site performance. Emphasis should be given to the identification of nonradiological constituents at this site. Given the presence of organics in NEN's waste, some attempt should be made to determine the state of such agents in Richland trench waters.

6. ENVIRONMENTAL MONITORING AT BEATTY

The Beatty site lacks a documented operation history of monitoring which would permit an adequate assessment of site performance.

The thoroughness of documentation and conditions stipulated for the Richland site is lacking for Beatty. Richland's license conditions 46, 47, 48, and accompanying Appendix A (see Appendix A of this report) provide detailed discussion on Richland's environmental monitoring program. These procedures are also part of USE's burial site manual for Richland. An attempt should be made for a more uniform procedural approach to operations for both USE sites.

Currently monitoring involves on-site and off-site well water analysis on a monthly basis and off-site ground water or a semi-annual basis. Quarterly assays are conducted in soil and vegetation samples at off-site locations. A continuous air monitor is operating at the site. There is no information available on vapour phase tritium migration at this site.(4) This could be rectified by establishing a program of soil moisture sampling from monitoring wells.

Given the lack of data from previous years of operation, an assessment of performance for the Beatty site is not possible at the present time. USE has the technical experience acquired from its Richland operations to develop a more comprehensive monitoring program for the Beatty site.

7. SUMMARY AND RECOMMENDATIONS

The presence of organics in NEN's waste is cause for concern given the absence of any information on their behavior in soil. These concerns are compounded given the fragile nature of the waste package which involves a glass bulb container for tritium gas and organics. NEN is presently considering alternative packaging components to prevent or reduce the probability of the glass container breaking either in transit or at the burial ground. The current waste package, as described in the report for subtask 2A, is viewed as detrimental to burial site performance since breakage of the glass container would enhance radionuclide and organic constituent release to the environment. Breakage of the glass bulb containing tritium gas would have similar adverse effects for the performance of the site. NEN is currently pursuing tritium gas recycling which, if successful, would greatly reduce or eliminate this problem.

With respect to the burial sites currently receiving NEN wastes, the following points require clarification prior to any final assessment of the overall performance of the site:

- No long-term documentation is available on the operational history for the Beatty site. The limited information available does not allow for an adequate assessment of site performance or of possible impact to the site by NEN's waste.

- No site operations manual for Beatty, such as that compiled by USE for the Richland site, is available at the present time. The availability of such a document would enhance site operating performance by providing a standard reference of procedures for site personnel.

- Some compatibility of operating procedures and documentation between the Richland and Beatty sites should be attempted. The operating history of the Richland site should be reviewed for the purposes of contributing useful information towards the management of the Beatty site.

- A site buffer zone of only 3 meters at Beatty is cause for concern in the event that corrective actions are required at some future time and should be increased. The proposed 10 CFR Part 61 section 61.5228 specified at least 100 feet (approximately 30 m) of buffer zone maintained between the waste disposal units and the site boundary. An extension of the buffer zone becomes all the more important given the highly mobile nature of tritium in NEN's waste.

- Waste-soil interactions have not been adequately investigated at the three commercial low-level radioactive waste burial sites. Emphasis has been given to high-level waste streams at Hanford with the actinides predominating waste-soil interaction studies. Research should focus on generator-specific waste streams with site-specific soil

samples. To date, research has focused on investigative and corrective studies at the closed sites (such as Sheffield and West Valley) with the exception of Barnwell (see subtask 1C). Studies conducted at Los Alamos Scientific Laboratory[25] included the collection of soil samples from Beatty and mention plans to obtain samples from Hanford. No data is currently available on the analytical results of this study.

- The behavior of the organics present in NEN waste, specifically benzene and toluene, at all three burial sites should be investigated for possible adverse effects associated with increasing radionuclide mobility.

- With respect to monitoring, procedures outlined in Richland's burial site manual and those accompanying their license for the State of Washington appear adequate from the standpoint of radionuclide migration from NEN waste. Given the meager information available for Beatty with respect to both waste-soil interactions and past monitoring history, an assessment of the adequacy of the site's monitoring practices is not possible.

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APPENDIX A

RICHLAND SITE: STATE OF WASHINGTON RADIOACTIVE MATERIALS LICENSE

RECEIVED
DEC 1 1 1980

Amendment No. 13 in accordance with letters dated June 20, 1980, and July 23, 1980.

NECO/LOUISVILLE STATE OF WASHINGTON Page 1 of 26 Pages

RADIOACTIVE MATERIALS LICENSE

Pursuant to the Nuclear Energy and Radiation Control Act, RCW 70.98, and the Radiation Control Regulations, Title 402 WAC and in reliance on statements and representations heretofore made by the licensee designated below, a license is hereby issued authorizing such licensee to transfer, receive, possess and use the radioactive material(s) designated below; and to use such radioactive materials for the purpose(s) and at the place(s) designated below. This license is subject to all applicable rules and regulations promulgated by the State Department of Social and Health Services.

Licensee	3. License number WN-1019-2 is amended in its entirety to read as follows:
1. Name Nuclear Engineering Company, Inc. 2. Address 9200 Shelbyville Road, Suite 526 P.O. Box 7246 Louisville, Kentucky 40207	4. Expiration date 5. Reference number

6. Radioactive Materials (element and mass number)	7. Chemical and/or physical form	8. Maximum quantity licensee may possess at any one time
Any radioactive material except source material as in B and special nuclear material.	A. Dry packaged radioactive waste except as otherwise authorized in the license	A. 60,000 Curies
ce material	B. Dry packaged radioactive waste except as otherwise authorized in the license	B. 36,000 kilograms

CONDITIONS

9 Authorized use. (Unless otherwise specified, the authorized place of use is the licensee's address stated in Item 2 above.)

B Radioactive material may be received, transferred, stored, repackaged, and disposed of at a land burial site located in southeast corner of Section 9, Township 12 North, Range 26E, W.M. Benton County Washington and operated by Nuclear Engineering Company, Inc., Route 4 - USDOE Hanford Reservation, P.O. Box 638, Richland, Washington 99352, referred to hereinafter as the "Richland Site."

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10. Operations at the site shall be conducted by, or under the supervision of, Vernon D. Apple, Site Manager; Robert E. Phalen, Site Assistant Manager; Floyd A. Dickson, Site Radiological Control and Safety Officer; and other individuals designated by the licensee's Site Radiological Control Officer upon completion of the licensee's training program. The licensee shall notify the Washington State Department of Social and Health Services (hereinafter referred to as the Department), in writing within 30 days, regarding the appointment of a new site manager or radiological control officer.

11. All new permanent Nuclear Engineering Company (NECo) employees must satisfactorily complete, within three months or less, the licensee's training program as described in Chapter 7 of the licensee's Radiological Controls Manual and letter of October 16, 1979.

12. The transportation of radioactive material within Washington State by the licensee shall be in accordance with Washington State Rules and Regulations for Radiation Protection, Chapter 402-19-500, "Preparation of Radioactive Material for Transport."

13. Radioactive materials authorized by this license are to be received at the site in shipping containers which have been authorized by the U.S. Department of Transportation (DOT) and U.S. Nuclear Regulatory Commission (NRC), and the use of which the Department has not restricted by this license.

14. Changes, Tests, and Experiments:

    a) The licensee may, upon notification to the Department but without prior Departmental approval, and subject to the provisions of subparagraph (b) below:

        i) Make changes in the disposal facility described in the application;

        ii) Make minor changes in the procedures described in the "Radiological Control and Safety For Burial Sites Manual" (Radiological Controls Manual) and "Site Operations Manual for Low-Level Radioactive Waste Disposal At Richland, Washington." (Site Operations Manual).

        iii) Conduct tests or experiments not described in the application.

    b) Prior Department approval is required if the proposed change, test, or experiment:

        i) Involves a change in a license condition other than Condition No. 14(a)(ii).

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ii) Involves a reduction in the licensee's record keeping and reporting requirements:

iii) Increases the potential for release of radioactive material to unrestricted areas or otherwise causes a potential decrease in the protection of the health and safety of individuals in unrestricted areas, now or in the future; or

iv) Increases the potential for radiological exposure to site personnel, or otherwise causes a potential decrease in operational safety.

c) The licensee shall maintain a record of changes in the disposal facility and of changes in procedures made pursuant to this condition. Records of tests and experiments carried out pursuant to subparagraph (a) of this condition shall also be maintained. These records shall include safety evaluations which provide the basis for the determination that the changes, tests, or experiments do not involve conditions described in subparagraph (b) above. The licensee shall furnish the Department, within 30 days following the changes, tests, or experiments, a report containing a description of such changes, tests, or experiments, including a summary of the safety evaluation of each.

15. A monthly site receipt and burial activities report shall be submitted by the licensee, no later than the 10th day of the following month, to the Supervisor, Radioactive Materials Unit, DSHS - Health Services Division, M.S. LD-11, Olympia, Washington 98504. The report shall include but not be limited to the following information:

a. name and address of the shipper;

b. radionuclides and activity of each radionuclide in millicuries;

c. type and physical form of the waste (e.g., solidified liquids, compressed paper, etc.);

d. chemical form of the waste and solidification agent;

e. grams and total volume of special nuclear material as received under NRC license no. 16-19204-01; and

f. mass (in kilograms) and volume of source material received.

16. Upon the adoption by the Department of a State of Washington Radioactive Materials Shipment Record (RSR) form, the licensee shall furnish copies of all RSR forms received during the monthly period covered in the report as an attachment to the monthly site receipt and burial activities report.

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17. The licensee shall maintain all records pertinent to the receipt and burial of radioactive material at the Richland site unless authorization has been given by the Department to transfer or dispose of the records.

18. The licensee's corporate management audit program, described in Section 2.1.3. of the Site Operations Manual, shall be expanded to require comprehensive management audits of those site activities and requirements of the license which are not specifically listed in Section 4.0 of the Radiological Controls Manual and assigned thereby to the Chief Radiological Control and Safety Officer. These audits shall include, but not be limited to, audits of trench filling methods and inspection of shipping records, certifications, and incoming packages and containers. Comprehensive management audits will be made at least once in each calendar quarter and will include a direct observation of receipt, inspection, and burial of waste materials over a two work-day period. In addition, at least one unannounced site inspection shall be conducted by management every six (6) months. Audit information, inspection findings and corrective measures shall be documented.

19. The corporate management audits described above shall be made by an individual, or by individuals, other than the official designated as the corporate Chief Radiological Control and Safety Officer.

20. The site manager shall conduct and document a weekly inspection of the operating checklists and conduct a random sampling of supporting documents to verify that they are being completed properly.

WASTE TREATMENT, HANDLING AND PACKAGING CONDITIONS

21. Unless otherwise specifically authorized by the Department, the licensee is not authorized to open any package containing radioactive material at the facility, except for the following:

(a) For purposes of repairing, repackaging, or overpacking leaking containers or containers damaged in transport in the event the matrial is to be disposed of, or returned to the generator if required for the protection of the health and safety of the employees.

(b) For purposes of inspection in the presence of a state inspector for compliance with the Washington rules and regulations for radiation protection and conditions of this license;

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(c) For purposes of returning outer shipping containers; and

(d) For purposes of retrieving shipping documents.

22. If wastes contain both toxic chemicals (including pathogenic or infectious materials) and radioactive materials, the hazard of each shall be evaluated independently. If the chemical hazard exceeds the radiological hazard, the waste shall not be buried at the licensee's Richland site, except as specifically approved by the Department. Records of the hazard evaluation of such wastes shall be kept for inspection by the Department.

23. The licensee shall not store any package containing radioactive material or source material above ground at the Richland site for a period greater than six months from the date of receipt of the package. Above ground storage shall not exceed 10,000 Curies of radioactive material, excluding source material, unless specific approval by the Department has been granted. Possession of larger quantities (not to exceed the limits specified in license condition 8A and 8B) above ground for less than three work days does not constitute storage.

24. Except as provided in condition 25, the licensee shall not receive waste containing transuranic elements. However, waste containing less than 10 nanocuries total transuranic nuclides per gram of waste is acceptable provided transuranic nuclides are essentially evenly distributed within a homogeneous waste form. This license condition does not authorize receipt or burial of components or equipment contaminated with transuranic nuclides.

25. Household smoke detectors containing Americium 241 foils which may exceed the transuranic limit of 10 nanocuries per gram of material may be accepted for disposal provided the entire detector is disposed of.

26. After December 31 1980, radioactive waste containing more than one (1) percent oil by volume shall be either solidified as specified in 27(a), or absorbed with a quantity of absorbent material capable of absorbing twice the total volume of oil to be absorbed. The waste container shall be restricted to a metal container meeting DOT 7A performance specification and having a heavy duty closure device (examples of containers meeting this specification are listed in Appendix D) and it shall be lined with a minimum 4 mil plastic liner which shall be sealed. Only absorbents approved by the Department shall be used.

27. The licensee shall not receive packaged radioactive waste at the site unless packaging is in accordance with applicable NRC, DOT, and State regulations, and the conditions of this license, including the following:

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7(a) Unless specified in this license, the licensee shall not receive any liquids which have not been absorbed or solidified. Solidified radioactive waste shall be certified by the generator to have no detectable free standing liquids. No detectable free standing liquid shall be defined as less than 1% liquid by volume until December 31, 1980. Effective January 1, 1981, no detectable free standing liquid shall be defined as trace quantities (not more than 0.5% or one gallon per container, whichever is less). Absorbed liquids shall be certified to be absorbed, according to DOT regulations, in enough absorbent material to absorb at least twice the volume of radioactive liquid contents. Only absorbents approved by the Department shall be used.

(b) Until December 31, 1982, liquid scintillation vials and fluids, and other organics with similar chemical properties, may be received and buried at the site providing the scintillation materials are packaged in sufficient absorbent material to absorb twice the total volume of liquid in the package. Materials treated for moisture resistance shall not be used. Waste containers shall be restricted to metal containers meeting DOT 7A performance specification and having a heavy duty closure device (see Appendix D) and shall be lined with a minimum 4 mil plastic liner. Only absorbents approved by the Department shall be used.

(c) Radioactive materials in individual units or vials, not to exceed 50 milliliters, used for clinical or laboratory testing, may be received in metal containers meeting DOT 7A performance specification and having a heavy duty closure device (see Apperdix D) lined with a minimum 4 mil plastic liner and buried at the site until December 31, 1982, provided the materials are layered in sufficient absorbent material to absorb twice the total volume of the liquid in the containers. Only absorbents approved by the Department shall be used.

(d) Biological (excluding animal carcasses) pathogenic, or infectious material or equipment (e.g. syringes, test tubes, capillary tubes) used to handle such material, shall be treated so that the material, if non-radioactive, could have been disposed of at a sanitary land fill. The waste container shall be restricted to a DOT 17H specification container and it shall be lined with a minimum 4 mil plastic liner which shall be sealed. The waste container shall be placed in a metal container meeting DOT 7A performance specifications with a heavy duty closure (see Appendix D) and having a capacity at least 40% greater than the inner container. The inner container shall be completely surrounded by an abosrbent. Only absorbents approved by the Department shall be allowed.

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(e) Liquids and wet sludges (e.g. evaporator bottoms, concentrates, filter media) which have been solidified with one of the solidification media specified below, and meet the requirements of Condition 27(a) of this license, may be received. Acceptable solidification media are:

i) Dow media

ii) Cement

iii) Urea-formaldehyde

iv) Asphalt

v) Delaware custom media

vi) Other solidification media and processes which have been reviewed and approved by NRC and/or the Department.

(f) Waste packages must be without significant package deformation, loss or dispersal of the package contents, or an increase in the maximum radiation levels recorded or calculated at the external surface of the package. Except for overpacks which are removed prior to burial, cardboard, fiberboard, and paper packages are prohibited. All wooden boxes shall be banded with metal bands. Void spaces within the packing container should be minimized.

(g) No pyrophoric or chemically explosive radioactive material that might react violently with water or moisture shall be accepted for disposal at the site without prior approval by the Department.

(h) Animal carcasses containing, or contained in, radioactive materials shall be packaged in accordance with the following minimal requirements: the biological material shall be layered with absorbent and lime and placed in a metal container meeting DOT 7A performance specification and having a heavy duty closure device (see Appendix D). The inner container shall be sealed and placed in a metal container meeting DOT 7A performance specification with a heavy duty closure device (see Appendix D) and having a capacity at least 40% greater than the inner container. The inner container shall be completely surrounded by additional absorbent material and the outer container must be sealed. Diatomaceous earth or other absorbent materials as approved by the Department shall be used.

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(i) After September 1, 1981 a refrigerated van shall be used to ship animal carcasses if the transit time will exceed 48 hours from the time the biological animal carcasses are first removed from cold storage until arrival at the disposal site.

(j) Ion exchange resins and filter media may be received in a dewatered form for transportation and subsequent burial until June 30, 1981 and shall contain no detectable free standing liquids. After June 30, 1981, resins and filter media containing radioactive material having a total specific activity of 1 uCi/cc or greater of materials with half-lives greater than 5 years must be stablized by solidification.

28. The licensee may bury radioactive gases, provided the following criteria are met:

(a) Burial containers must be approved by the U.S. Department of Transportation.

(b) Internal pressure of containers may not exceed 1.5 atmospheres.

(c) Total activity in each container shall not exceed 100 curies.

(d) Containers must be buried in an upright position with a minimum space of ten (10) feet between each container.

RECEIPT, ACCEPTANCE AND INSPECTION CONDITIONS

29. Waste shipments shall not be accepted at the site unless accompanied by the properly executed shipment records, certifications and permits required by state and federal laws and regulations, including a Washington State Patrol or Washington State Utilities and Transportation Commission vehicle inspection certificate, or a visible Washington State 90 day vehicle inspection seal.

30. The licensee shall ensure that each radiation shipment record (RSR) used to describe a radioactive material waste shipment be accompanied by certification, properly executed by a representative of the shipper/generator of the waste, in accordance with the requirements of executive order 79-09 issued on November 19, 1979, signed by Dixy Lee Ray, Governor of the State of Washington.

31. Surveys of incoming vehicles shall be conducted in accordance with conditions set forth in Appendix B of this license. Surveys also shall be conducted during off-loading and handling operations to assess radiation and contamination levels and to identify problem situations. Vehicles shall be surveyed before release

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to determine compliance with DOT, NRC, and license requirements. Maximum radiation levels detected in all surveys shall be documented and records maintained for inspection. The requirements set forth in Appendix B are intended to define minimum requirements and are not meant to limit survey activities.

32. The licensee shall maintain the capability for safely opening and inspecting the contents of waste packages received at the site, and overpacking damaged or leaking waste packages as required for disposal or return to shipper.

33. In the event that significant package deformation, loss or dispersal of package contents, or packages with maximum radiation levels in excess of DOT, NRC or State regulations are observed during waste receipt or an unloading operation, that operation shall be terminated. Appropriate safety measures as outlined in the Site Operations Manual or the Radiation Control Manual shall be instituted followed by notification to the department of the incident and a description of the problem areas.

The customer shipping the waste shall be advised of the situation and given 24 hours to send a representative to inspect the shipment. After 24 hours, or if an inspection is waived by the customer, and with approval of the Department, the shipment in violation shall be either off-loaded from transport vehicles and overpacked prior to disposal, or be returned to the shipper, provided that return of the shipment would not be in violation of DOT regulations. Shipments in violation of placarding, labeling or bracing requirements shall be off-loaded and disposed of. Future receipt of waste at the site from shippers in violation may be prohibited until corrective actions satisfactory to the Department and NRC have been taken.

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SITE OPERATIONS CONDITIONS

34. Wastes containing chelating agents in packages with amounts greater than 1% of package volume shall be segregated from other wastes, stored separately, and be disposed of either in separate trenches or in specifically segregated areas within an existing trench, and isolated from other wastes with 10 feet of soil.

35. Open burial trenches, until filled and capped, shall be surrounded by a chain link fence, eight feet high, and topped with barbed wire. Those trenches which have been filled and capped may be surrounded by a barbed wire fence. Filled and capped burial trenches shall be completely covered with at least six inches of large gravel and rock which shall extend at least ten feet beyond the edges of the trench. After capping, trenches shall be marked with a monument inscribed with the following information:

    (a) Total activity of radioactive material, in Curies, excluding source and special nuclear materials; total amount of source material in kilograms; and total amount of special nuclear material, in grams, in the trench;

    (b) Trench number

    (c) Date of filling and capping the trench; and

    (d) Volume of waste in the trench.

36. The licensee shall conduct operations in a manner which will minimize dispersal of excavated material and erosion of the filled and capped trenches by wind.

37. Excluding trenches 1 through 6, a minimum of eight feet of earth (compacted where possible) shall separate the radioactive wastes and the natural grade level of the trench opening. After final grading, the top of the trench shall be maintained at the natural grade level of the land prior to excavation.

38. A permanent record of the boundaries of each trench or other waste disposal area shall be kept. Boundaries of each future trench or disposal area shall be fixed by engineering surveys and reference made to a bench mark to be established by the licensee so that the boundaries can be accurately located at a later date.

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39. Type B wastes or those wastes having radiation readings, without shielding, in excess of 10 R/hr. but less than 100 R/hour at any package surface, must be placed at a minimum depth of 20 feet below the natural grade level of the land. Wastes with radiation readings in excess of 100 R/hour on the package surface shall be placed at a minimum depth of 30 feet. The intervening space between the top of the waste and the surface may be filled with other waste received for disposal provided that the requirements of this Condition and other conditions are met. Prior Department approval is required. Prior approval may be granted by telephone with a confirming letter within 72 hours.

40. Licensee personnel shall wear protective clothing (at a minimum, coveralls and gloves) at all times while handling or disposing of radioactive wastes. The licensee shall provide change rooms for the employees and maintain procedures for checking for contamination and for decontaminating personnel and clothing. In addition to the above, safety equipment (including respiratory equipment, fire extinguishers, and safety showers) must be provided and tested at least once every six months. Plans for meeting the conditions set forth in this section shall be submitted to the department for approval by July 1, 1980. Construction of this facility shall be completed by July 1, 1981.

41. Waste handling and disposal operations shall be conducted according to specific written procedures and site criteria promulgated by the licensee. At a minimum, procedures shall be written for (a) overpacking operations, (b) decontamination operations, including packaging and disposal of removed contamination, and (c) handling and disposal of radioactive waste material, including handling and disposal of solid low-activity waste, organic and biological waste, and high-gamma content waste requiring shielding, and (d) inspection of waste packages.

42. During any disposal, decontamination, overpacking, or inspection operation, an employee whose sole responsibility is that of surveying, monitoring and recording radiation levels, and correlating waste packages with information contained in the shipment manifest documents shall be present. This employee shall be appropriately equipped with calibrated and operable survey and detection instruments in accordance with Condition 43.

43. Radioactive waste material receipt, handling, packaging, repackaging and disposal operations shall not be conducted unless, at a minimum, the following number of properly calibrated and properly functioning radiation detection instruments and samplers are available on-site. Radiation detection instruments, except pocket dosimeters, in order to be used under this license, shall be calibrated at intervals not to exceed six months. Each scale of the instrument shall be calibrated at approximately one-third and two-thirds of full scale. The licensee shall have available, at the site, instrumentation capable of measuring contamination levels equal to one-half of those stated in Appendix A, Part II (assuming smear samples are taken over an area 100 cm^2).

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(a) One continuous air sampler to be used in the area in which the disposal operations are taking place. In addition a sampler shall be available as required for collecting iodine vapors. Potentially contaminated air is to be sampled and air sample filters analyzed in accordance with site operating procedures.

(b) One continuous air sampler to be used during any waste package content inspection or overpacking operation for the purpose of assessing airborne concentration levels and identifying the need for respiratory equipment at the location where the operations are being conducted. As required, air sampling media shall be capable of collecting iodine vapor.

(c) At least two survey meters for measuring low levels of beta-gamma radiation shall be available at the site. At least one meter must be in use in the area in which receipt, handling and disposal operations are being conducted;

(d) At least two survey meters capable of measuring high levels of radiation shall be available at the site. At least one meter must be in use in the area in which the receipt, handling or disposal operations are being conducted when potential radiation levels require the use of such an instrument.

(e) At least two survey meters capable of measuring alpha radiation shall be available at the site. At least one meter must be in use in an operations area in which alpha contamination could be present.

(f) On or before December 31, 1980, one operational liquid scintillation counter for analysis of smear samples shall be available at the site.

ENVIRONMENTAL MONITORING AND SURVEILLANCE CONDITIONS

44. The licensee shall conduct an environmental monitoring program capable of detecting the potential contribution of radioactive material from the site to the environment. At a minimum, the program shall include collection of samples and analysis at frequencies listed in Section I of Appendix A to this license. Results of the sample analyses shall be forwarded to the Department within 30 days of receipt by the licensee.

45. In the event that action levels for gross radioactivity or individual radionuclide concentrations are exceeded in samples collected and analyzed in accordance with Condition 44, the licensee shall notify the NECO Chief Radiation Control Officer and the Department within 48 hours. In addition, the licensee shall implement Section 9.7 of the Radiological Controls Manual. The licensee shall submit a written report as directed by the Department. Specific contingency actions may be directed by the Department.

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46. The licensee shall conduct a site and personnel surveillance program to maintain contamination of skin, personal clothing, protective clothing, items for unconditional release, sole use vehicles, equipment, and site areas to levels as low as reasonably achievable. Contamination limits must be within those specified in Section II, of Appendix A, of this license. The licensee shall perform at least the minimum site radiological surveys listed in Section III, Appendix A, to determine compliance with the specified contamination limits. The results of the site survey shall be recorded on forms suitable for NECO management audits and state inspection. If decontamination operations are required to meet the limits of Section II, Appendix A, the survey record shall state the readings observed both prior to and after decontamination operations are complete. In addition, the licensee shall conduct at least the minimum personnel surveys listed in Section IV, Appendix A.

47. The licensee shall provide, at a minimum, a quarterly site inspection program and a site maintenance program to verify proper maintenance and upkeep of all fences, filled and capped trenches, caissons and all disposal areas. Records of inspections and any maintenance performed shall be maintained and submitted with the stabilization plan for final site closure. The records are to include, but not be limited to:

(a) The date of the inspection.

(b) The name of the inspector.

(c) Identification of fences, trenches, caissons or other disposal areas which have been inspected.

(d) Identification and location (marked on a scaled map of the site) of fences, caissons, trenches, or other disposal areas needing repair. (For example, trenches needing repair would be those exhibiting erosion, shrinkage, subsidence, settling, cracking, gullying, or loss or thinning of the gravel cap.) Maintenance of fences shall include, but not be limited to clearing away tumbleweeds and/or drifting sand.

(e) A graphic description of the condition requiring repair. (For example, details such as the size and extent of cracks or the depth of any sunken areas.)

(f) A description of the repairs made to the fence, trench, caisson, or disposal area (including a list of time and materials required to make the repairs).

48. In addition to the environmental monitoring program discussed in Condition 45, the licensee shall place passive monitoring devices (e.g., film badges, TLD's) at the boundaries of restricted areas. These monitoring devices shall be replaced and analyzed on a monthly basis. The results of the analyses shall be recorded on a form suitable for inspection by the Department.

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SITE CLOSURE AND STABILIZATION CONDITIONS

49. As material buried may not be transferred by abandonment or otherwise, in the absence of specific Department authorization, the expiration date on this license applies only to the above ground activities and to the authority to bury radioactive wastes at the licensee's Richland site. All requirements for environmental monitoring, site inspection and maintenance, and site security continue whether or not wastes are being buried.

50. The site closure and stabilization of the licensee's facility at the Richland site shall be accomplished in accordance with a site closure and stabilization plan prepared by the licensee and approved by the department. The site closure and stabilization plan shall be prepared in accordance with Department's performance objectives outlined in Appendix C, "Position-Low-Level Waste Burial Ground Site Closure and Stabilization," dated May 17, 1979, as revised, November 26, 1979.

51. By May 31, 1980, a preliminary plan for preparation of the licensee's Richland site for transfer to another person who would only passively hold the site shall be submitted for review. The plan shall be consistent with Conditions 49 and 50 and shall include demonstration that funds are being set aside or that other measures being taken are adequate to finance the site closure plan. The plan shall also include preliminary estimates of costs, environmental impacts, data needs, personnel needs, material and equipment needs, planned documentation and quality assurance, and a detailed plan for trench locations and elevations, expected capacities, planned surface contours, and buffer zones.

52. By November 30, 1980, a reassessment of current operating practices at the licensee's Richland site shall be submitted. The reassessment shall consider the objectives of the site plan specified in the preceding paragraph and any changes in operations at the site which would enhance implementation of the plan.

53. After January 31, 1982 the licensee shall submit an update of the plan and operational assessment required in Conditions 49, 50, 51, and 52 for the Richland site every five years, or at time of application for license renewal.

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54. One year prior to the anticipated transfer of the licensee's Richland site and buried radioactive waste to another person (including the state or an agency of the U.S. Government), the licensee shall submit a final version of the site preparation plan, including a schedule for implementation of all remaining plan elements prior to transfer, and a description of the mechanics of orderly transfer in coordination with the transferee.

55. On or before March 31, 1980, the licensee shall revise, update, and submit to the Department for approval, the Site Operations Manual for Low-Level Radioactive Waste Disposal at Richland, Washington (Site Operations Manual). On or before April 30, 1980, the licensee shall revise, update, and submit to the Department for approval, the Radiological Controls and Safety for Burial Sites Manual (Radiological Controls Manual).

56. Except as specifically provided otherwise by this license, the licensee shall possess and use radioactive material described in Items 6, 7, and 8 of this license in accordance with statements, representations, and procedures contained in the application dated July 22, 1977, signed by James N. Neel, and the licensee's supporting documents including their "Radiological Controls and Safety Manual" and "Site Operations Manual for Low Level Radioactive Waste Disposal At Richland, Washington", as revised in accordance with negotiations conducted in Richland, Washington on December 17, 18 and 19, 1979, between representatives of DSHS Radiation Control Program and Nuclear Engineering Company and Condition No. 55 of this license.

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Date December 5, 1980

By John C. Beare M.D.
John Beare, M.D., M.P.H.
Division Director

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APPENDIX A: ENVIRONMENTAL MONITORING AND SITE SURVEILLANCE

I. Environmental Monitoring Program

Samples	Location	Activity Detected	Frequency
aqueous	5 off-site wells*	as reported by U.S. DOE	quarterly or as performed by U.S. DOE
soil (split with DSHS at minimum one quarter of each year**)	4 site corners	alpha spectrum gamma spectrum gross alpha gross beta	quarterly
vegetation (split with DSHS at minimum one quarter of each year**)	4 site corners	alpha spectrum gamma spectrum gross alpha gross beta	quarterly
vegetation, if present	filled and capped trenches	gamma spectrum gross beta alpha spectrum	at least annually, each trench
TLD's (Split with DSHS**)	4 site corners	mR	quarterly
TLD's	1 at site perimeter in prevailing wind direction from operating trench and at closest point to burial operations being conducted.		

*Wells routinely sampled are identified by the following numbers: 699-31-53B; 699-32-62; 699-33-56; 699-34-51; and 699-36-61B.

** Department of Social and Health Services (DSHS) shall specify the quarterly samples that are to be split.

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II. Operational Contamination Limits

(a) Skin and personal clothing:

No detectable alpha or beta-gamma activity

(b) Protective clothing:

No detectable alpha activity

1000 dpm beta-gamma activity

(c) All items for unconditional release (e.g., waste transport vehicles):

Fixed contamination:

0.1 mrem/hr on any accessible surface

Removable contamination:

220 dpm/100 cm^2 beta-gamma
22 dpm/100 cm^2 alpha

(d) Sole use vehicles:

Fixed contamination:

0.5 mrem/hr at any accessible surface

Removable contamination:

2200 dpm/100 cm^2 beta-gamma
220 dpm/100 cm^2 alpha

(e) All site areas, facilities, equipment, or tools outside restricted (radiation controlled) areas:*

Fixed contamination:

0.1 mrem/hr

Removable contamination:

220 dpm/100 cm^2 beta-gamma
22 dpm/100 cm^2 alpha

*Until June 30, 1980, decontamination operations may be conducted outside of the licensee's restricted area.

FOR THE STATE DEPARTMENT OF SOCIAL AND HEALTH SERVICES

By _____

STATE OF WASHINGTON

RADIOACTIVE MATERIALS LICENSE

License Number WN-I019-2

(f) All site areas, facilities, equipment, or tools inside restricted (radiation controlled) areas:

Fixed contamination:

0.5 mrem/hr

Removable contamination:

1000 dpm/100 cm^2 beta-gamma
220 dpm/100 cm^2 alpha

III. Site Surveillance Program

	Inspection Frequencies	
Location	Removable Contamination	Fixed Radioactivity
radiation controlled facilities or buildings	daily	weekly
operational trench	N/A	daily
normal traffic areas outside operational trench area	N/A	weekly
site equipment	weekly	weekly
non-radiation controlled facilities or buildings	monthly	monthly
waste transport vehicles	arrival/ departure	arrival/departure

IV. Personnel Surveillance Program

Location	Removable Contamination	Fixed Radioactivity
skin and personnel clothing	N/A	departure from site
protective clothing, feet, and hands	N/A	departure from radiation controlled area

FOR THE STATE DEPARTMENT OF SOCIAL AND HEALTH SERVICES

Date _____ By _____

DHS 14-99A

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Location	Removable Contamination	Fixed Radioactivity
urine samples to be analyzed for H-3 and C-14.	N/A	quarterly and following major spills and decontamination operations for those involved.
(With a sensitivity greater than 10^{-3} microcuries per ml of urine for each isotope.)		
thyroid monitoring for iodine isotopes*	N/A	monthly for all operations personnel
(With a sensitivity greater than 50 nanocuries of I-125 per person.)		

* Study of thyroid depositions will be performed by the licensee and a report of findings shall be submitted to the department each quarter. February of 1980 shall be established as the beginning month for the study with the first quarterly report due on or before April 10, 1980.

FOR THE STATE DEPARTMENT OF SOCIAL AND HEALTH SERVICES

By _____

HS 14-99A

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License Number WN-I019-2

APPENDIX B: VEHICLE SURVEYS

Arrival Surveys:

Radiation levels shall be determined by monitoring all sides and the bottom of the transport vehicle at the vehicle surface, at six feet from the sides of the vehicle, and at the driver's position in the cab. Smears to check for the presence of removable contamination shall be taken at areas where contamination is most likely to occur, including cargo access doors and suspect areas as identified by visual inspections. At least two smears on each side of the vehicle, two from the exterior surface of the trailer door(s), and two from the deck or off-loading area shall be checked for alpha and beta-gamma contamination. Smears shall be analyzed for low energy beta and gamma emitters (e.g. C-14, H-3* and I-125).

Handling and Operational Surveys:

At least three smears to check for removable alpha and beta-gamma contamination shall be obtained from accessible packages before off-loading begins. Additional smears shall be taken when visual inspection warrants. At least three additional smears of waste packages shall be taken at random during off-loading. These smears shall be checked for alpha and beta-gamma contamination with appropriate portable equipment available at the unloading site. Beta-gamma surveys shall be performed continuously as wastes are off-loaded except when the employee so designated by Condition No.42 is conducting visual inspection, shipment record checks, or record examinations. At least one smear shall be analyzed for low energy beta and gamma emitters with an instrument capable of detecting isotopes of concern (e.g. C-14, H-3* and I-125).

Release Surveys:

Beta-gamma and alpha (if applicable) levels shall be determined on all interior and exterior vehicle surfaces by direct survey with appropriate instrumentation. Smears shall be taken to evaluate all hot spots in excess of levels stated in Appendix A. If decontamination is required, all surveys will be repeated until contamination is no longer detectable or is reduced to acceptable levels. Smears shall be analyzed for alpha (if applicable), and low energy beta and gamma emitters (e.g. C-14, H-3* and I-125).

*effective at time of installation of analyzing instrumentation.

FOR THE STATE DEPARTMENT OF SOCIAL AND HEALTH SERVICES

Date _____ By _____

STATE OF WASHINGTON

RADIOACTIVE MATERIALS LICENSE

License Number WN-1019-2

APPENDIX C

DEPARTMENT OF SOCIAL AND HEALTH SERVICES
POSITION - LOW-LEVEL WASTE BURIAL GROUND SITE CLOSURE AND STABILIZATION
(Revised November 26, 1979)

BACKGROUND

Events in the past few years have emphasized the need for long-range planning for the eventual closure and decomissioning of a wider range of nuclear materials facilities and those concerned with reactors and the fuel cycle.

Termination of operation at three commercial low-level waste burial sites, closing of a tritium facility in Arizona, and a number of situations leading to passage of the Uranium Mill Tailings Radiation Control Act have caused the regulatory agencies to recognize that the long-term health and safety matters associated with these facilities must be addressed early-on in the licensing process.

The staff has been involved in reassessing the terms and conditions of the license issued under Chapter 402 WAC, Rules and Regulations for Radiation Protection, for disposal of materials at a low-level waste burial ground. Until recently, neither the Nuclear Regulatory Commission (NRC) nor Agreement State licenses or leases for these burial grounds specifically addressed measures required to close and stabilize sites upon cessation of operations.

Originally, decomissioning of all types of nuclear facilities was addressed only in general terms, if at all. In recent years, decomissioning of fuel cycle facilities and stabilization of uranium mill tailings have received increased regulatory attention. Most licenses for fuel cycle facilities now specifically address decomissioning.

A Colorado State University report entitled, "Evaluation of Long-Term Stability of Uranium Mill Tailings Disposal Alternatives," was prepared in April 1979. The effectiveness and stability of various engineering designs for the tailings, embankments, liners and water diversion structures were assessed against failure modes such as wind erosion, floods, and settlements. Since the activities and the engineering are similar in many respects, work such as this, coupled with extensive experience in developing specific methods for uranium mill tailings management, contribute to both a conceptual and technical basis for formulating performance objectives for site closure and stabilization of shallow land burial sites.

FOR THE STATE DEPARTMENT OF SOCIAL AND HEALTH SERVICES

Date _____ By _____

The Office of Standards Development, NRC has a major effort underway to develop criteria and standards for decomissioning all types of fuel cycle facilities. A comprehensive technical information base is being developed by Battelle's Pacific Northwest Laboratory. Reports on each type of fuel cycle facility are being prepared. Similarly, a report on decomissioning of low-level waste burial grounds is being prepared in close cooperation with the three states which currently license this type of facility. Although the report of this work is not completed, information on alternative methodologies and procedures, and the cost required for site closure and stabilization has been developed.

In addition, the NRC is developing a specific regulatory program for management of low-level waste (LLW). On October 25, 1978, NRC published in the Federal Register its intent to develop a proposed new 10 CFR Part 61 for LLW and invited advice, recommendations, and comments on the scope of the Environmental Impact Statement for the new part. Site decomissioning is intended to be an integral part of the new regulations, currently scheduled to be published as a proposed rule in late 1980. Upon adoption of the new regulations, the State of Washington will revise Chapter 402 WAC to incorporate them as a matter of compatibility under the terms of the U.S. NRC - State of Washington agreement.

On October 4, 1979, the Governor of the State of Washington caused the Richland commercial low-level waste burial site to be closed due to evidence of infractions of U.S. Department of Transportation (DOT) and NRC regulations pertaining to packaging and transport of radioactive materials. The site was reopened on November 19, 1979, under the terms of Executive Order E079-09 of that date. The Richland site radioactive materials license for operation of a commercial low-level waste burial facility has been in a state of timely renewal since August 31, 1977. In view of the Governor's explicit directions concerning handling of radioactive waste, and proposed new regulations which have resulted from the aforementioned Executive Order, there is urgent need to update and renew the Richland site license. The urgency, however, has necessitated development of an interim position before the regulatory framework and technical base specific for burial grounds can be completed. Toward this end, the NRC staff has assisted the state in developing interim performance objectives for low-level waste burial sites, site closure, and stabilization, based on information available at this time. The State of Washington has incorporated these performance objectives into their position.

STATE OF WASHINGTON

RADIOACTIVE MATERIALS LICENSE

License Number WN-I019-2

PURPOSE

Site closure and stabilization plans, developed to meet the objectives outlined below, are intended to maintain the site in a constant state of readiness for transfer to a custodial government agency. Custody by such an agency, or agencies, will be necessary until such time as the site can be released for unrestricted use. At this time, restricted use is considered in terms of a few hundred years. The site operator's responsibility and the authority to possess buried waste continue until the state finds that the requirements of the license, based on the plan, have been satisfactorily compiled with in a manner which will reasonably assure protection of the public health and safety. The state may then take action to terminate the responsibility and authority under the license. Site closure and stabilization requirements will vary depending on site-specific or region-specific parameteres, such as geology, hydrology, and climate, as well as arrangements that may have been made between the licensee and the owner of the site. The history of the operations at a burial ground, the performance of a site as shown by records of maintenance and monitoring programs, the site inventory, and the anticipated use of the site in the future will also be important factors. The overall objective, however, is to operate the site in such a manner that the need for active on-going maintenance, after termination of the licensee's responsibility and authority, will be eliminated and that only passive surveillance and monitoring by the custodian will be required after termination.

POSITION

To achieve the overall objectives stated above, the low-level waste burial ground licensee shall develop a site closure and stabilization plan which, with due regard for site-specific conditions, will satisfy, at a minimum, the following performance objectives:

(1) To assure that all waste forms and types have been buried in accordance with the conditions of the license.

(2) To dismantle, decontaminate as required, and remove all structures, equipment, and materials that are not to be transferred to the custodial agency.

(3) To document the status of arrangements for orderly transfer of site control and for long-term care by the custodial agency.

(4) To document any agreement on the part of the state or federal government to participate in, or accomplish, any performance objectives.

FOR THE STATE DEPARTMENT OF SOCIAL AND HEALTH SERVICES

By _____

Date _____

RHF 14-004A

(5) To address the matter of pre- and post-closure stabilization and monitoring costs and the funding of those costs.

(6) To assure that direct gamma radiation from buried wastes shall be essentially background.

(7) To assure, and be able to demonstrate, that the rate of increase of radionuclides through air and ground and surface water pathways are at or below acceptable levels. Acceptable levels for water are those set forth in Chapter 402 WAC (or 10 CFR Part 20, of Appendix A), at the site boundary, and EPA drinking water limits at the nearest water supply. Acceptable levels for air are those found in Chapter 402 WAC (or 10 CFR Part 20, Appendix A).

(8) To assure that the site has been rendered suitable for service activities during custodial care.

(9) To assure that final conditions of the site are acceptable to the custodial agency and are compatible with its plans for the site.

(10) To document that all trench bottom elevations are above the water table level, taking into account the history of seasonal fluctuation since recordkeeping began.

11) To eliminate the potential for erosion, or loss of site, or trench integrity due to factors such as ground water, surface water, wind, subsidance, and frost action.

12) To assure that all slopes are sufficiently gentle to prevent slumping or gullying.

13) To assure that the surface is stabilized with an appropriate agent such as rock, riprap, or other materials that may develop as the technology advances.

14) To assure the trench caps are stabilized so that erosion, settling, or slumping of caps is extremely remote.

15) To demonstrate that the trench markers are in place, stable, and keyed to benchmarks, and that identifying information is clearly and permanently marked.

16) To assure that the custodial agency will receive complete records of site maintenance and stabilization activities, trench elevations and locations, trench inventories, and monitoring data for use during custodial care in the event there is need to take unexpected corrective measures or to interpret data.

17) To assure that a buffer zone has been established surrounding the site which is sufficient to provide space to stabilize slopes, incorporate surface water

STATE OF WASHINGTON

RADIOACTIVE MATERIALS LICENSE

License Number WN-I019-2

management features to assure that future excavation on adjoining areas will not compromise trench or site integrity, and to provide working space for unexpected mitigating measures in the future.

(18) To provide a secure passive site security system (e.g., a fence), that will require minimum maintenance.

(19) To assure that the site is stabilized in a manner which will minimize environmental monitoring requirements for the long-term custodial phase.

(20) To develop a monitoring program based on a stabilization plan for implementation by the custodial agency.

(21) To document the investigation of increases of any statistical environmental radiation levels which have occurred during operation and stabilization.

2) To document that the causes of unusual or unexpected rates or levels of radionuclide migration in or with the ground water have been analyzed and that, if the migration has been found to originate from the LLW burial site, corrective measures have been taken.

(23) To assure that there is no need for active water management measures.

(24) To determine the impact of present and zoned activities on adjoining areas on the long-term performance of the site.

(25) To demonstrate that reasonable action was taken to minimize the effects enumerated in paragraphs #21 through #24, above, recognizing that such action would normally be limited to areas under control of the licensee.

IMPLEMENTATION

Existing licenses will be amended to add conditions requiring submittal of site closure and stabilization plans. This will include explicit requirements for satisfactory completion of the plan before the license can be terminated and before the materials which are buried at the site can be transferred to custodial government care.

New applicants will be required to submit preliminary site closure and stabilization plans as part of the initial application.

Finally, all objectives will be considered and satisfied to the extent practical, during the request for burial ground operating license termination.

FOR THE STATE DEPARTMENT OF SOCIAL AND HEALTH SERVICES

Date _____ By _____

STATE OF WASHINGTON

RADIOACTIVE MATERIALS LICENSE

License Number WN-I019-2

Appendix D

Examples of Containers Meeting 7A Performance Specification and Having a Heavy Duty Closure Device

Spec. 6B Steel Drum (30 gallon)

Spec. 6C Steel Drums (5 and 10 gallon)

Spec. 6J Steel Drum (55 gallon)

Spec. 42B Aluminum Drum (55 gallon)

Spec. 17C Steel Drum (5 gallon)

Spec. 17C Steel Drum (55 gallon)

Spec. 17H Steel Drum (30 gallon)

Spec. 17H Steel Drum (55 gallon)

Spec. 7A Steel Box (Argonne National Laboratory's Steel Bin)

Spec. 7A Steel Box (BCL-5 Shipping Container)

Spec. 7A Steel Box (Type A Steel Box)

Spec. 7A Steel Drum (Follansbee Drum-MS 24347-2)

Spec. 7A Steel Drum (4 gallon)

Other Metal Specification 7A Containers

Note: All metal drums with a capacity of 55 gallons or greater shall have a 5/8 inch or larger bolt for the closure device. All other metal containers shall have a heavy duty closure device.

FOR THE STATE DEPARTMENT OF SOCIAL AND HEALTH SERVICES

Date _____ By _____

RECEIVED

0 5 1981

Page 1 of 1 Pages

STATE OF WASHINGTON

RADIOACTIVE MATERIALS LICENSE

License Number WN-1019-2

Amendment Number 14

U.S. Ecology, Inc.
9200 Shelbyville Road, Suite 526
P.O. Box 7246
Louisville, Kentucky 40207

Attention: T. S. Baer, Vice President

In accordance with letter dated December 11, 1980, License Number WN-1019-2 is amended as follows:

Effective January 1, 1981, the name of the licensee in Item 1 is changed from Nuclear Engineering Company, Inc. to U.S. Ecology, Inc.

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FOR THE STATE DEPARTMENT OF SOCIAL AND HEALTH SERVICES

Date December 29, 1980

By John A. Beare M.D.

John A. Beare, M.D., M.P.H.
Division Director, Health Services Division

APPENDIX B

BEATTY SITE: STATE OF NEVADA RADIOACTIVE MATERIALS LICENSE

25 copies

Nevada 10-P

file

STATE OF NEVADA
DEPARTMENT OF HUMAN RESOURCES
DIVISION OF HEALTH
CAPITOL COMPLEX
CARSON CITY, NEVADA 89710

NEVADA STATE BOARD OF HEALTH

RADIOACTIVE MATERIAL LICENSE

Pursuant to Nevada Revised Statute 459.040 and State of Nevada Rules and Regulations for Radiation Control and in reliance on statements and representations heretofore made by the licensee, a license is hereby issued authorizing the licensee to receive, possess, and dispose of by land burial radioactive materials. This license is subject to all applicable rules, regulations, and orders now or hereafter in effect and to any conditions specified below.

1.	Licensee:	Nuclear Engineering Company, Incorporated
2.	Address:	9200 Shelbyville Road, Suite 526 Post Office Box 7246 Louisville, Kentucky 40207
3.	License Number:	13-11-0043-02
4.	Expiration Date:	June 30, 1980
5.	Reference:	NRC License No. 04-03766-01

CONDITIONS

6. Radioactive material shall be disposed of by burial at a site in Nye County, Nevada, within the boundary of the land area described as follows:

NW 1/4 NE 1/4; NE 1/4 NW 1/4 of
Section 35, Township 13 South, Range 47
East, Mount Diablo Baseline and Meridian

7. The licensee shall comply with the provisions of Article 3, "Standards for Protection Against Radiation" of the Nevada Rules and Regulations for Radiation Control, "Radioactive Materials".

8. The licensee shall not possess at any one time unburied radioactive material in excess of:

   A. 50,000 curies of radioactive material excluding source and special nuclear material. Radium 226 shall be limited to 1 curie.

   B. 25,000 pounds of source material.

   C. 350 grams of Uranium 235; 200 grams of Uranium 233; 200 grams of Plutonium; or any combination of them in accordance with the following formula: For each kind of special nuclear material, determine the ratio between the quantity of that special nuclear material and the quantity specified above for the same kind of special nuclear material. The sum of such ratios for all kinds of special nuclear materials in combination shall not exceed unity.

   D. Notwithstanding the provisions of 8.C above, the average concentration of radioactive materials with atomic numbers greater than 92, including Plutonium, shall not exceed 10 nanocuries per gram of waste in any container. Also, the authorization contained in this license for possession of special nuclear material does not become effective until NRC Radioactive Material License No. 04-03766-01 has been terminated.

9. A. Any radioactive liquids received for disposal shall not exceed the concentration limits specified for the U. S. Department of Transportation transport groups listed below:

Transport Group I	- 0.01 microcuries per milliliter
Transport Group II	- 0.5 microcuries per milliliter
Transport Group III and IV	- 30 microcuries per milliliter

   B. All liquid radioactive wastes shall be solidified prior to burial.

   C. Notwithstanding the requirements of 9.B, small quantities of liquid waste may be disposed of without solidification provided that the concentration, quantities, and packaging of these liquids is in accordance with Section 5 of the licensee's "Site Operations Manual".

   D. Certification of the concentration of all liquid wastes shall be obtained by the licensee and records thereof maintained.

   E. No special nuclear material will be received in liquid form.

10. The licensee is authorized to possess and dispose of gaseous waste, Krypton 85 and/or Hydrogen 3, provided that:

A. Each primary container does not exceed 1000 curies.

B. Each primary container containing 100 curies but less than 1,000 curies be encased in concrete with at least six (6) inches of concrete surrounding the primary container in every direction from the outside surfaces of the primary container.

C. Each primary container containing less than 100 curies may be buried in its U. S. Department of Transportation approved shipping container as received.

D. No container of gaseous waste shall be received or buried if the pressure within the container exceeds one atmosphere.

11. All waste shall be placed in a disposal trench or hole within three (3) working days of receipt, except in the event of an equipment breakdown or other emergency. A report of such breakdown or emergency shall be given within 24 hours to the Radiological Health Section, Nevada Division of Health.

12. All radioactive waste shall be disposed of by the licensee within sixty (60) days from the date of receipt. Disposal shall mean that the containers of waste have been covered by backfilling with three (3) feet of earth or have been completely covered by random placement of other waste. Certification of disposal shall be made on the "Radioactive Shipment Record" by authorized management personnel.

13. The licensee may seal or place in undamaged containers such packages received by the licensee which have been damaged in transit. Damaged packages shall not be opened.

14. The licensee shall not remove solid radioactive waste from shipping containers except as follows:

A. Any inner containers with not more than 1600 curies of Cobalt 60 or radiation equivalent may be removed from shipping casks provided that the inner containers are immediately buried without interim storage or processing. The 1600 curie limit may be exceeded only if prior written approval has been obtained from the licensee's Chief Radiation Control and Safety Officer and the Radiological Health Section, Nevada Division of Health.

B. Any sealed source with not more than 50 curies of Cobalt 60 or the equivalent of 50 curies of Cobalt 60 in terms of radiation may be removed from shipping casks provided that the sealed sources are immediately disposed of in the special burial wells without interim storage or processing. The 50 curie limit may be exceeded only if prior written approval has been obtained from the licensee's Chief Radiation Control and Safety Officer and the Radiological Health Section, Nevada Division of Health.

15. Radioactive waste having hazardous properties other than radiological hazards shall not be accepted for burial by the licensee until the licensee has evaluated all hazards and has determined that safe long-term burial can be effected. Records of hazard evaluation of all such wastes performed by the licensee shall be maintained for inspection by the Radiological Health Section, Nevada Division of Health.

16. Within twenty (20) days following the end of each calendar month, the licensee shall submit to the Supervisor of Radiological Health, Nevada Division of Health, Capitol Complex, Carson City, Nevada, 89710, a report indicating the total volume in cubic feet, and activity of radioactive material, other than source and special nuclear materials, in curies; the total amount of source materials in pounds (or kilograms); and the total amount of special nuclear materials in grams buried during the referenced month. The report shall also indicate the cumulative totals for the above.

17. After the excavation of each burial trench has been completed, and prior to commencement of burial in a trench, the boundaries of the trench shall be located by engineering survey referenced to bench marks or other permanent features such that the boundaries can be accurately relocated by future engineering surveys. The trench shall then be depicted on a scale drawing of the disposal site (plot plan) showing its location with respect to other trenches and other physical features of the site such as buildings, fences, and sampling wells. A copy of this scale drawing shall be submitted to the Radiological Health Section, Nevada Division of Health, within sixty (60) days of completion of the engineering survey.

18. Upon completion of burial operations in a burial trench, the licensee shall backfill the trench so that there is a minimum of three feet of earth between the last layer of buried waste and the surface of the ground. The licensee shall then mound earth over the trench to a minimum height of two feet at the trench centerline in such a manner as to drain runoff water away from the trench over which the earth is mounded and away from any trench in the process of being filled. The radiation levels of completed trenches shall not exceed 0.5 mR/hour at ground level. Once a trench has been completed and mounded, the licensee shall not conduct any activities, other than those necessary for maintenance, which disturbs the mounding over the trench and the drainage patterns around the trench.

19. Within thirty (30) days of completion of burial operations in a trench, concrete monuments shall be installed on the centerline at each end of the trench. A permanent brass sign with the following information clearly engraved or stamped into it shall be permanently affixed to each monument:

    A. The number assigned to the trench.

B. The date of start and completion of burial operations in the trench.

C. The total activity of radioactive materials in curies, excluding source materials and special nuclear materials; the total amount of source materials in pounds (or kilograms); and the total amount of special nuclear materials in grams.

D. The total volume in cubic feet of waste buried in the trench.

E. The dimensions of the boundaries of the trench.

The information required by this condition, in addition to being referenced on the permanent trench monuments, shall be filed by written report to the Supervisor of Radiological Health, Division of Health, Capitol Complex, Carson City, Nevada, 89710, within thirty (30) days after closing of a trench.

20. All radioactive materials accepted for disposal shall be packaged in accordance with current U. S. Department of Transportation (D.O.T.) regulations for the transportation of radioactive material, and shall be disposed of in these D.O.T. containers unless otherwise specified by this license. Improperly packaged radioactive materials shall not be disposed of by the licensee unless specific authorization for disposal is granted by the Radiological Health Section, Nevada Division of Health.

21. Except as specifically provided otherwise by this license, the licensee shall receive, possess, and dispose of radioactive materials in accordance with statements, representations, and procedures contained in the following documents:

A. Nevada State Board of Health Form NRC-5, "Application for Radioactive Material License", signed by James N. Neel, dated December 8, 1976.

B. "Relicensing Application and Geotechnical and Waste Management Studies for the Beatty Nuclear Disposal Site, Nye County, Nevada December 1976".

C. "Nuclear Engineering Company, Inc., Radiological Controls and Safety for Burial Sites Manual".

D. "Site Operations Manual for Low Level Radioactive Waste Disposal at Beatty, Nevada".

JOHN H. CARR, M.D., STATE HEALTH OFFICER
FOR THE NEVADA STATE BOARD OF HEALTH

Date June 29, 1977

By W. C. Horton

W. C. Horton, Supervisor, Radiological Health

LICENSE #[illegible]-02

AMENDMENT NO. 1

All radioactive material received for burial shall be in approved Department of Transportation containers. These containers shall be constructed, as a minimum, of wood. No containers constructed of fiberboard, cardboard or other similar materials containing radioactive materials shall be accepted for disposal. The only exceptions are as noted in Section 5.0 of the Site Operations Manual for Low Level Radioactive Waste Disposal at Beatty, Nevada, as submitted December 8, 1976.

APPROVED THIS____day of

_____, 1979

DEPARTMENT OF HUMAN RESOURCES

_____
ROBERT LIST
Governor
State of Nevada

_____
RALPH R. DiSIBIO, Ed.D.
Director

NUCLEAR ENGINEERING COMPANY, INC.

_____
JAMES N. NEEL, President

NEVADA STATE BOARD OF HEALTH

RADIOACTIVE MATERIAL LICENSE

SUPPLEMENTARY SHEET

License Number 13-11-0043-02
Amendment No. 2

James N. Neel, President
Nuclear Engineering Company, Inc.
9200 Shelbyville Road, Suite 526
Post Office Box 7246
Louisville, Kentucky 40207

License No. 13-11-0043-02 is hereby amended to add License Condition 22:

22. The licensee will notify the Radiological Health Section, Nevada Division of Health, upon delivery at the Beatty site of any shipment of material not accompanied by shipping papers or for which no shipping papers have been received. Such shipments shall be temporarily stored above ground in a secure area until their contents can be determined by inquiry, or until otherwise directed by the Radiological Health Section.

JOHN H. CARR, M.D., STATE HEALTH OFFICER
FOR THE NEVADA STATE BOARD OF HEALTH

By _____

John Vaden, Supervisor, Radiological Health

Date August 21, 1979

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Form NRC-4 (7-74)

NEVADA STATE BOARD OF HEALTH

RADIOACTIVE MATERIAL LICENSE

SUPPLEMENTARY SHEET

License Number 13-11-0041-02

Amendment No. 3

Mr. James N. Neel, President
Nuclear Engineering Company, Inc.
Post Office Box 7246
Louisville, Kentucky 40207

Amendment No. 1 to License No. 13-11-0041-02 is hereby deleted.

John H. Carr, M.D., State Health Officer
FOR THE NEVADA STATE BOARD OF HEALTH

By /S/ J. V.

John Vaden, Supervisor, Radiological Health

Date September 4, 1979

dcm

NEVADA STATE BOARD OF HEALTH

RADIOACTIVE MATERIAL LICENSE

SUPPLEMENTARY SHEET

License Number 13-11-0043-02
Amendment No. 4

Mr. James N. Neel, President
Nuclear Engineering Company, Inc.
9200 Shelbyville Road, Suite 526
Louisville, Kentucky 40207

Amendment No. 4 to License Number 13-11-0043-02, is hereby issued to add Condition 23 to the license:

Condition 23. Liquid radioactive waste solidified by the urea-formaldehyde process shall not be received by the licensee for burial at the Beatty, Nevada site. The licensee shall notify all its customers of this license condition and shall immediately inform all power companies known to them to be using the urea-formaldehyde process for solidification of liquid radioactive waste that any such packaged waste now on hand cannot be received at the Beatty, Nevada site.

jas

JOHN H. CARR, M.D., STATE HEALTH OFFICER
FOR THE NEVADA STATE BOARD OF HEALTH

By J. Vaden

J. Vaden, Supervisor, Radiological Health

Date October 8, 1979

NEVADA STATE BOARD OF HEALTH

RADIOACTIVE MATERIAL LICENSE

SUPPLEMENTARY SHEET

License Number 13-11-0043-02

Mr. James W. Neel, President
Nuclear Engineering Company
Post Office Box 7246
Louisville, Kentucky 40207

Amendment No. 5 to License Number 13-11-0043-02 temporarily modifies Condition 18 of the license to permit the U. S. Geological Survey personnel, contractors, and equipment to drive over the tops of trenches 2 and 4 to conduct radar profile surveys. This modification shall expire on November 16, 1979, unless extended in writing.

JOHN H. CARR, M.D., STATE HEALTH OFFICER
FOR THE NEVADA STATE BOARD OF HEALTH

By John Vaden
John Vaden, Supervisor, Radiological Health

Date October 26, 1979

APPENDIX C

RICHLAND ENVIRONMENTAL AIR MONITORING PROGRAM

Subject: RICHLAND ENVIRONMENTAL AIR MONITORING PROGRAM Procedure No. RW-003

Technical Concurrence: Robert E Rusher Page 1 of 5

Approval Authorization: William H. Rutledge

Rev.	0	1			
Date	6/77	5/78			

1.0 INTRODUCTION

This procedure is being promulgated to implement the requirements of Section 9.0, "Environmental Monitoring" of the Nuclear Engineering Company, Inc. Radiological Controls and Safety for Burial Sites Manual for the environmental monitoring program at Richland, Washinton. This procedure also establishes the guidelines for the analysis of the environmental air samples.

2.0 DISCUSSION

This procedure has been developed from considerations of the requirements outlined in 10 CFR, Part 20 as it regards Section "B".

This procedure also establishes guidelines for emergency air sampling as well as normal air monitoring on a day to day basis.

3.0 PARTICULATE AIR SAMPLING

Normally particulate air sampling will be conducted in the liquid area at the Richland Facility. This is the most probable area of release of radioisotopes to the atmosphere, especially during evaporation operations.

A continuous air sampler shall be utilized which has the capability of collecting at least one (1) standard cubic foot per minute of air.

A fiber filter will be utilized which has a high efficienty (approximately 99%) for the removal of particulate matter from the air. The filter will be changed on each working day.

The daily sample will be based on about a 24 hour run (except weekends and holidays) with the filter paper pulled each workday morning and then analyzed after a sufficient period of time (greater than 4 hours) to allow for the decay of natural emmitters.

3.1 Particulate Air Sampling Procedures

The procedures to be followed for both daily and emergency air samples will be located in the front of the air sample log book. All results obtained by these procedures are to be recorded on the Richland Facility Air Sample Record Sheet (Fig. RW-003.1)

3.1.1 Air Sample for Particulate Activity (Normal)

1. The normal air particulate activity sample will be done on a daily basis.

2. Follow Section II of the Eberline MS-1 technical manual for daily warmup, operational check, and operations.

3. The daily sample will be removed during the first four (4) hours of the working day and counted at least four hours later. This is to allow for the decay of natural background Radium which has very short half lives.

4. Prior to counting the daily sample a background count will be done. This will normally be of twenty (20) minutes duration. Record the background counts per minute in the Richland Facility Air Sample Log (Fig. RW-003.1)

5. Place the daily air sample filter in the holder and count for two (2) minutes. Record the gross counts in the Richland Facility Air Sample Log. Divide the gross counts received by two (2) minutes to get gross counts per minute and record. Subtract the background counts per minute from the sample counts per minute. Substitute this value for GCPM in the air sample equation.

6. Record the time and date that the sample was started. Record the time and date the sample was stopped. Find the total number of hours the sample was being taken and record in the Richland Facility Air Sample Log. Enter the number of hours into the air sample equation in the time space.

7. Using the air sample equation calculate the air particulate activity and enter this value in the sample activity space.

8. Using an alpha detecting instrument ascertain if any alpha has been collected. This will be done on a daily basis on the following work day from which the air sample was obtained. This will insure any alpha detected is from other than Radium.

3.1.2 Air Sample for Particulate Activity (Emergency)

1. In the event there is a suspected release of radioisotopes to the atmosphere a low volume sample will be run.

2. A portable air sampler will be utilized which has an air flow indicator.

3. A determination of particulate activity can be done by either of two methods.

4. The first method is to utilize the Eberline MS-1 with HP-210 probe and substituting in corrected counts per minute (2 minutes) and volume (liters) into the following equation:

$$uc/_{ml} = \frac{CCPM}{Volume\ (liter)} \times C.F.$$

$$C.F. = 4.5 \times 10^{-9}$$

5. The second method is to utilize the RM-14 with HP-210 probe (or equivalent) and using the conversion 100 counts per minute above background is equal to 1000 disintegrations per minute.

6. In either case (Part 4 or 5) the air sample should be for at least 20 minutes. This yields .3 cubic meters of air and provides a minimum sensitivity of 1×10^{-9} uc/ml for a particulate activity.

4.0 LIMITATIONS

4.1 Alpha Activity

Any detectable alpha above background will be cause for immediate notification of the Site Radiological Control and Safety Officer.

4.2 Particulate Air Sample

Any particulate air sample which exceeds 1×10^{-9} uc/ml will be cause for immediate notification of the Site Radiological Control and Safety Officer.

5.0 CALCULATIONS

5.1 Normal Air Sample Activity Calculations

The equation to be used on the daily air particulate activity calculation is as follows:

$$uc/ml = \frac{ccpm}{hrs} \times \text{correction factor}$$

ccpm = corrected counts per minute
hrs. = time in hours that the sample was taken

$$\text{correction factor} = 2.65 \times 10^{-12} \frac{\text{hr - uc}}{\text{ccpm - ml}}$$

$$2.65 \times 10^{-12} \frac{\text{hr - uc}}{\text{ccpm - ml}} = \frac{1 \text{ hour}}{60 \text{ min}} \times \frac{1 \text{ min}}{1 \text{ ft}^3} \times \frac{1 \text{ ft}^3}{28317 \text{ ml}} \times \frac{10 \text{ dpm}}{1 \text{ ccpm}} \times \frac{1 \text{ uc}}{2.2 \times 10^6 \text{ dpm}}$$

1 min/ft^3 is based on the flow rate of the air sampler

10 dpm/ccpm is based on a minimum 10% efficiency of an HP-210 probe for Betas at 50 KEV. This is the lowest efficiency for the probe based on a 2 geometry ^{14}C, all other efficiencies are of a higher value. Therefore to bias all readings to a higher value the 10% efficiency will be utilized. This will insure that all readings will be actually lower than calculated and thusly safer for NECO employees.

5.2 Emergency Air Sample Activity Calculations

The equation used for short time samples (grab samples) will be those utilized in Section 3.1.2. These equations are based upon the same detector efficiencies as in Section 5.1 of this procedure.

NUCLEAR ENGINEERING COMPANY, INC.

Richland Facility Air Sample Log Sheet

FIG. [illegible]-033.1

Counting Date-Time	Sample Start Date-Time	Sample Stop Date-Time	Hours	Gross Count	UCPM	BCPM	CCPM	Corr. Factor $\times 10^{-12}$	Sample * Activity (uc/ml)	Alpha ** Check	Init.	Remarks

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UCPM - Uncorrected Counts Per Minute
BCPM - Background Counts Per Minute
CCPM - Corrected Counts Per Minute

* Notify SRC/SO if greater than $1 \times 10^{-}$ [illegible]
** Notify SRC/SO if greater than b[illegible]

$$\text{Sample Activity} = \frac{\text{CCPM}}{\text{Hrs.}} \times \text{Correction Factor} \times 10^{-12}$$

[illegible]ar

APPENDIX D

RICHLAND ENVIRONMENTAL MONITORING PROGRAM

Subject: RICHLAND ENVIRONMENTAL MONITORING PROGRAM Procedure No. RW-006

Technical Concurrence: [signature] Page 1 of 5

Approval Authorization: [signature]

Rev.	0	1			
Date	3-77	5/78			

1.0 INTRODUCTION

This procedure is being promulgated in order to implement the requirements set forth in Section 9.0 of the Nuclear Engineering Company, Inc. Radiological Control and Safety for Burial Sites Manual.

2.0 DISCUSSION

This procedure has been developed in accordance with recommendations from the State of Washington, Department of Social and Health Services, Radiation Control Program, and as such, prior to approval of additions or deletions thereto, such changes shall first be reviewed by the Chief Radiological Control and Safety Officer with the State of Washington, Supervisor of the Radiation Control Program. This procedure does not cover the Environmental Air Sampling Program for the Richland Burial Facility. That program is covered in a separate procedure (RW-003).

3.0 SAMPLING MEDIA

The sampling media for this procedure shall consist of aqueous, soil and vegetation samples.

4.0 SAMPLE LOCATION

Figure RW-006.1 and RW-006.2 illustrate the general location of the aqueous, soil and vegetation sampling locations which are utilized in the Richland Environmental Monitoring Program.

4.1 Aqueous Samples

Aqueous samples will be taken from deepwater well located around the Site.

4.2 Soil and Vegetation Surface Samples

Soil and vegetation surface samples are taken on the licensed disposal site at four (4) locations. The locations are within fifteen (15) feet of the southeast, southwest, northwest and northeast corners of the disposal site to insure sample re-producibility.

5.0 SAMPLING FREQUENCY

Aqueous, soil and vegetation samples will be collected and analyzed on a quarterly basis.

6.0 SAMPLE COLLECTION

The Site Radiological Control and Safety Officer shall direct the sample collection for environmental monitoring. The generalized sample collection procedure is as follows:

6.1 Aqueous

6.1.1 Aqueous samples are currently being done by Battelle Northwest Laboratories on an E.R.D.A. contract. A sample of water is then left at the Richland Burial Facility office for analysis.

6.2 Vegetation

6.2.1. Vegetation will be collected in new polyethylene bottles (glass or plastic may be utilized); bottles will be labeled as to time, date, and location.

6.2.2 Samples will be from live plants and shall consist of approximately 300 grams of foliage.

6.3 Soil

Soil will be collected following the same basic steps as for vegetation samples. Approximately 300 grams will be collected for analysis.

7.0 SAMPLE ANALYSIS AND ACTION LEVELS

The following represents the various types of sample analysis to be performed on different samples and the respective action levels which will be used for establishing notification and resampling requirements.

7.1 Aqueous Samples

When aqueous samples are taken they shall be analyzed for Tritium and Gross Alpha. The initial action level for Gross Alpha shall be 20 picocuries per milliliter.

7.2 Soil Samples

Soil will be analyzed for Gross Alpha or Plutonium and Gross Beta activity. In the event soil samples exceed 20 picocuries per gram Gross Alpha or 0.1 picocuries per gram Plutonium or 90 picocuries per gram Gross Beta the sample will be given a specific gamma isotopic analysis.

7.3 Vegetation Samples

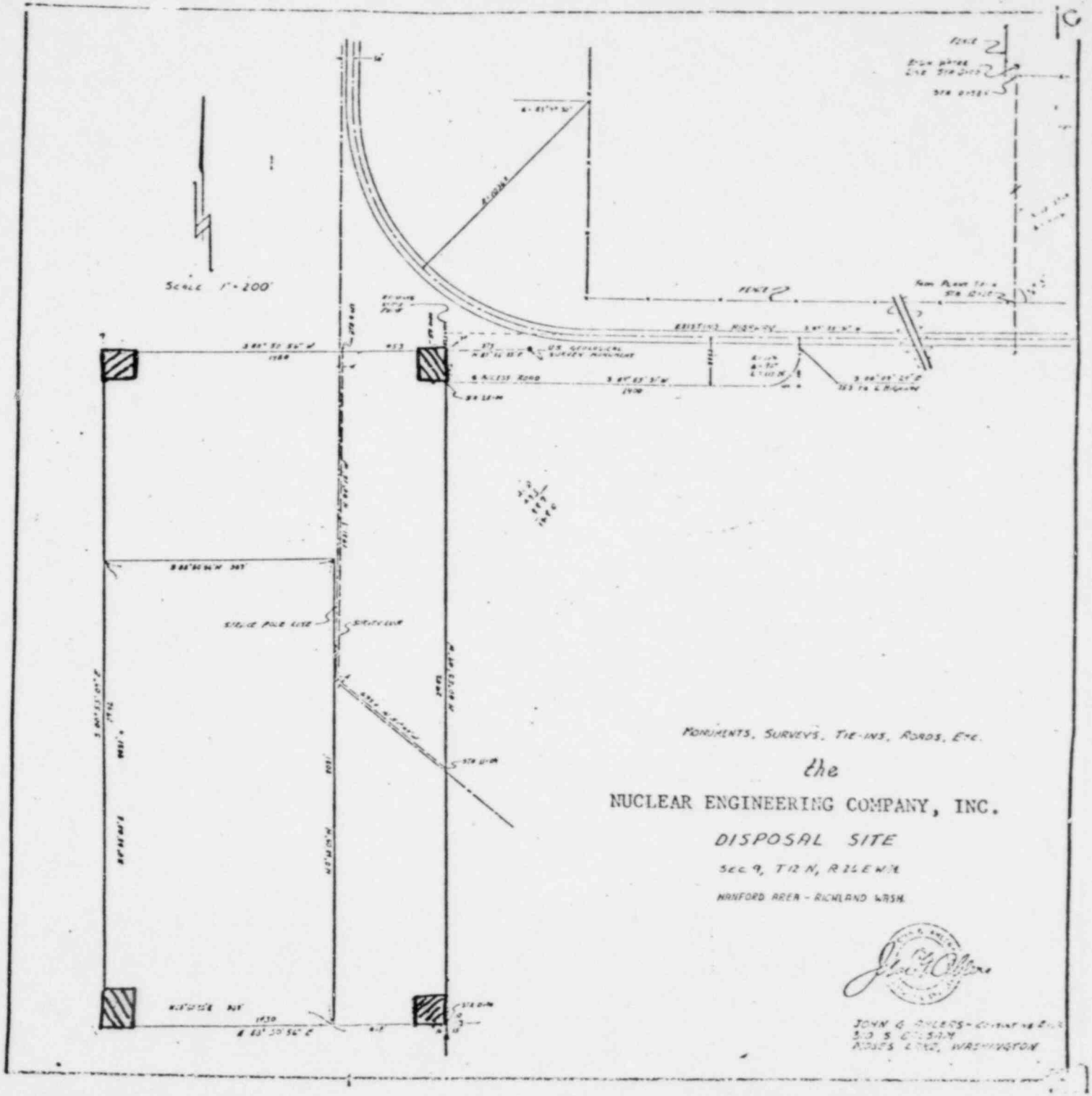
Vegetation shall be analyzed for gross alpha and gross beta. In the event gross alpha exceeds 20 picocuries per gram or gross beta exceeds 200 picocuries per gram a specific gamma isotopic analysis shall be performed.

7.4 Notification for Action Levels

In the event initial action levels are exceeded the Chief Radiological Control and Safety Officer shall be notified and he will in turn notify the State of Washington, Radiation Control Program, Department of Health Services.

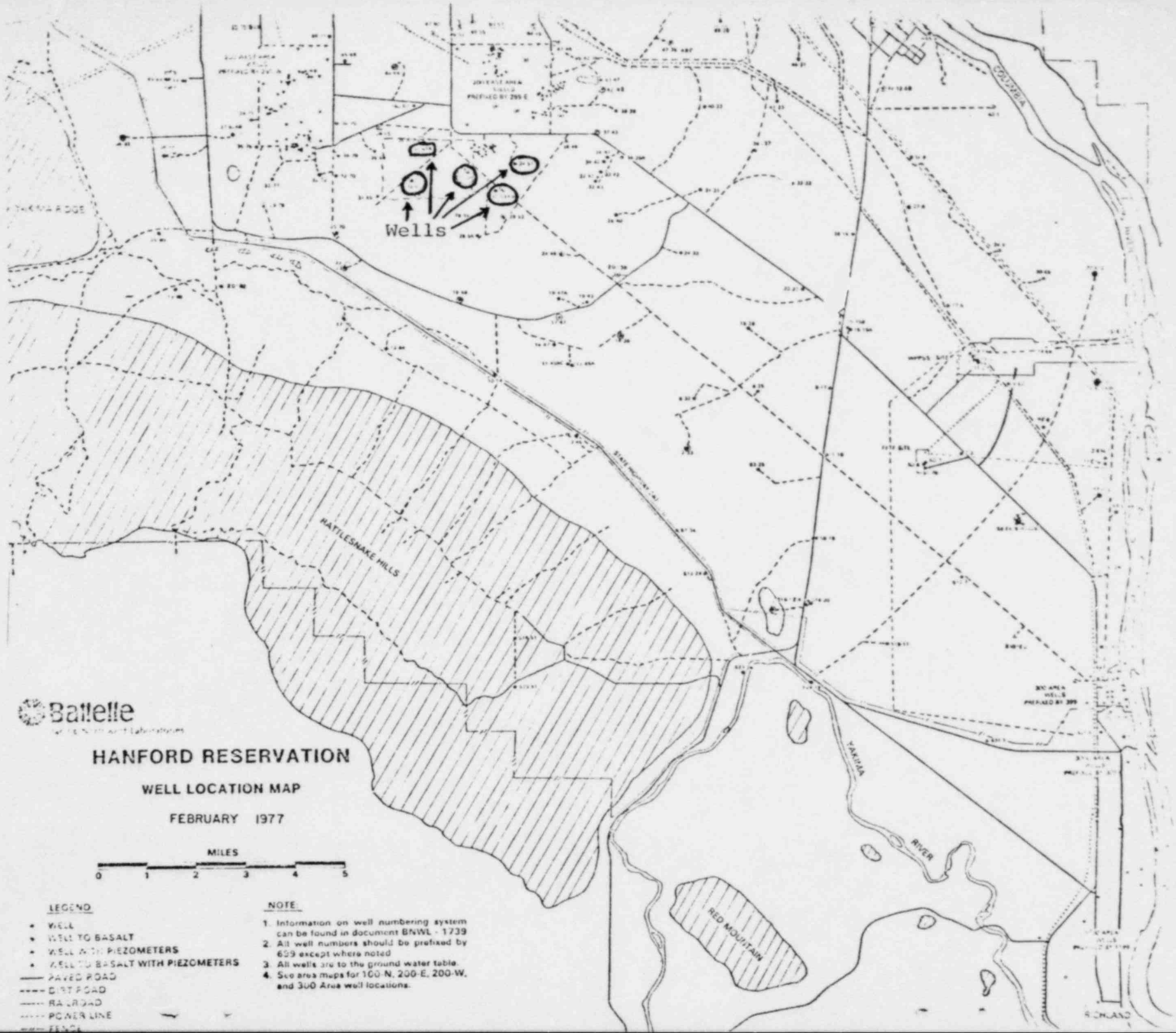
8.0 RECORDS

All records of the results for aqueous, soil and vegetation samples shall be maintained at the Richland Burial Facility for a minimum period of three (3) years.



Locations of Sample Sites

SOIL AND VEGETATION SAMPLE LOCATIONS


Wells
RATTLESNAKE HILLS
YAKIMA RIVER
RED MOUNTAIN
COLUMBIA
RICHLAND
Battelle
HANFORD RESERVATION
WELL LOCATION MAP
FEBRUARY 1977
MILES
0 1 2 3 4 5
LEGEND
WELL
WELL TO BASALT
WELL WITH PIEZOMETERS
WELL TO BASALT WITH PIEZOMETERS
PAVED ROAD
DIRT ROAD
RAILROAD
POWER LINE
FENCE
NOTE
1. Information on well numbering system can be found in document BNWL - 1739
2. All well numbers should be prefixed by 699 except where noted
3. All wells are to the ground water table.
4. See area maps for 100-N, 200-E, 200-W, and 300 Area well locations.