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TITLE AN IN SITU MOISTURE MONITORING SYSTEM FOR A SOLID LOW-LEVEL RADIOACTIVE DISPOSAL PIT AT LOS ALAMOS NATIONAL LABORATORY, TECHNICAL AREA 54, AREA G

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An In Situ Moisture Monitoring System for a Solid Low-Level Radioactive Disposal Pit at Los Alamos National Laboratory, Technical Area 54, Area G

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INTRODUCTION

At the end of the 1950's, Los Alamos National Laboratory began to develop a Laboratory-wide, shallow-land, solid low-level radioactive waste disposal area on top of Mesita del Buey at TA-54, Area G. An in situ hydrologic monitoring system in the zone of aeration was developed in early 1990 to detect the presence of the infiltration of metecric water into Pit 37 at Area G. Monitoring the water movement through the pit cap into the waste with leaching and transport through the containment rock and possible contamination of the main aquifer is of primary concern.

GEOLOGY/HYDROLOGY

The Pajarito Plateau forms a broad apron around the eastern flank of the Jemez Mountains in Los Alamos County, New Mexico. The upper surface of the plateau is composed of Pleistocene Age rhyolitic ash flows of the Bandelier tuff. The Bandelier tuff is composed of three members: the lower Guaje member is a lump pumice; the middle Otowi member is a massive nonwelded ash flow; and the upper Tshirege member is a series of moderately welded to welded ash-flow tuff. The Bandelier tuff is underlaid by the Puye conglomerate

composed of mixed gravels and boulders in a matrix of sand. The Tesuque formation underlaying the Puye is composed of siltstones and sandstones. Interbedded with the Puye and Tesuque formations are basalt flows from volcanic centers to the east and west of the Pajarito Plateau.

The plateau is dissected by intermittent streams into a number of narrow southeast-trending mesas. Area G is located along the narrow eastern end of Mesita del Buey. Pajarito Canyon south of Area G has a large drainage area on the flanks of the Jemez Mountains. Spring and summer thunderstorms recharge a thin perched aquifer in the alluvium. To the north, Canada del Buey has a small drainage area insufficient to maintain perched water in the alluvium.

The top of the main aquifer at TA-54, Area G, is at a depth of 850 ft within the lower part of the Puye formation. No known perched water is between the top of the mesa and the main aquifer. Separating the disposal area and the main aquifer are 240 ft of Bandelier tuff and 610 ft of volcanic debris and basalt flows.

MONITORING STATION DEVELOPMENT

Disposal pits are cut parallel to the contours of the mesa, with depths not exceeding 10 ft above the floor of the adjacent canyons. The containment rock is ash flow Units 2b and 2a of the Tshirege member of the Bandelier tuff.

Pit 37 is rectangular: 730 ft long by 80 ft wide. The side walls are step-cut to a near vertical angle with the ramps cut to a depth of 60 ft (fig. 1). The pit cuts through Unit 2b and the upper four feet of Unit 2a of the Tshirege member. The eastern ramp of the pit has a slope of 10:1, and the western ramp has a slope of 3:1. The floor of the pit has a slope of 34:1 to the north.

The monitoring station was set up in the bottom of the pit 200 ft from the eastern end, along the north wall where the two ramps meet, at an elevation of 6681 feet.

Two six-inch bore holes were drilled into the pit floor 15 ft apart and 4 ft deep. Two 24-ft sections of 4-in. J5S oil field well casings were then inserted and cemented into the holes to form an upright. A crossbar was welded to the upright to provide support for the rest of the tubes in the system. The well cases also provided access to the split-spoon sampler (fig. 2).

Four ft to the inside of both pipes, two 4-in. holes were drilled to a elevation of 6667 ft. After an aluminium end cap was welded on, a 24-ft length of 2.50-in. OD seamless aluminium tubing with a 0.049-in. wall was inserted into the western hole . A medium-grain silica sand was uniformly packed around the annulus. This tube will be the guide for a Campbell Pacific model 503-DR hydroprobe. This device uses cesium-137 and americium-231 as a sealed high-energy neutron source with a slow thermal neutron detector.

Data will be recorded in neutron counts and then converted to volumetric moisture using an appropriate calibration curve.

Into the eastern hole a nest of Model 1940 Soilmoisture pressure vacuum lysimeters was placed at elevations of 6668 ft, 6672 ft, and 6677 ft. Should the volumetric moisture levels exceed 20% in the tuff, a water sample can be retrieved by evacuating the device to 50 centibars for roughly one week and pulling a sample in through the ceramic filter cup of the lysimeter (fig. 3). A sample can then be collected by pressurizing the device and forcing the sample to the surface through a collection tube.

Located 3.5 ft to the inside of the neutron access tube and the lysimeter nest, in the middle of the monitoring station, a 2-ft wide by 3-ft deep trench was cut 34 ft across the width of the bottom of the pit. A 4-in. section of perforated PVC pipe was installed here and terminated in a T with a collection sump at the bottom. A 4-in. section of vertical pipe will allow access to the surface for sample collection by submersible pump. The trench was then backfilled with 2 in. of washed

aggregate and covered with 8 in. of crushed tuff.

Two 4-in. PVC pipes 1 ft to the inside of the well casings were then placed 6 in. into the pit floor and cemented in place. These pipes will be used with the well casings as split-spoon access tubes to obtain gravimetric moisture samples at the pit floor and below the pit floor.

Two stations will be set up 500 ft from the western edge (30 ft deep) and 630 ft from the western edge (10 ft deep) on the entrance ramp. They will have the same instrumentation as the first station but without the collection drain. Additional pipes will be added in lifts to the stations as the pit begins to fill with wastes. The piping will run through the pit cap to allow evaluating the moisture penetration into the cap and mapping out zones of moisture in the wastes.

EXPECTED OUTCOME

Annual precipitation at TA-54, Area G, is 18.5 inches a year. Because the life expectancy of the pit open to the elements is two years and because disposal rates are variable, layers of waste and fill may have variable moisture content. Snowmelt and spring thundershowers cause primary moisture pulses in the pit. Correlating these pulses with the disposal activities of the pit allows comparing the moisture of the pit layers with time exposure.

At final closure, the pit cap is composed of crushed tuff that is mounded slightly above the topography. The cap will vary in depth because of pit design. At the deepest, it will be 17 ft on the western edge, diminishing to 10 ft on the eastern ramp.

A soil cover 4-8 in. deep and seeded with natural vegetation will aid in evapotranspiration of water away from wastes. Precipitation may infiltrate to a depth of 10 ft through the crushed tuff. The moisture ranges of the crushed tuff vary from 2-8% by weight and decrease with depth. Below 10 ft,

the moisture content ranges from 0.5-2% by weight, showing that the moisture is redistributed by diffusion. Moisture from a single storm may reach a depth of 6 ft, but in the weeks after the storm it is returned to the atmosphere by evaporation.[1] The hydrologic characteristics of the unsaturated tuff that forms the Pajarito Plateau can retain or arrest the movement of water-soluble contaminants originating from liquid or solid wastes stored in the tuff. A sufficient and nearly continuous water supply must be available before water-soluble contaminants could be rapidly mobilized to completely penetrate the unsaturated tuff. A seasonally pulsating water supply that recharges the unsaturated tuff might be sufficient to mobilize contaminants, but its migration rates would be slower than that from a continuous water source.[2]

Further development of monitoring stations should aid in showing that there is insufficient moisture present to free radioactive contaminates and move them into the containment rock. If the data collected is as expected the monitoring stations will help demonstrate that the main aquifer 840 ft below the site is protected from contamination of disposal activities at TA-54, Area G.

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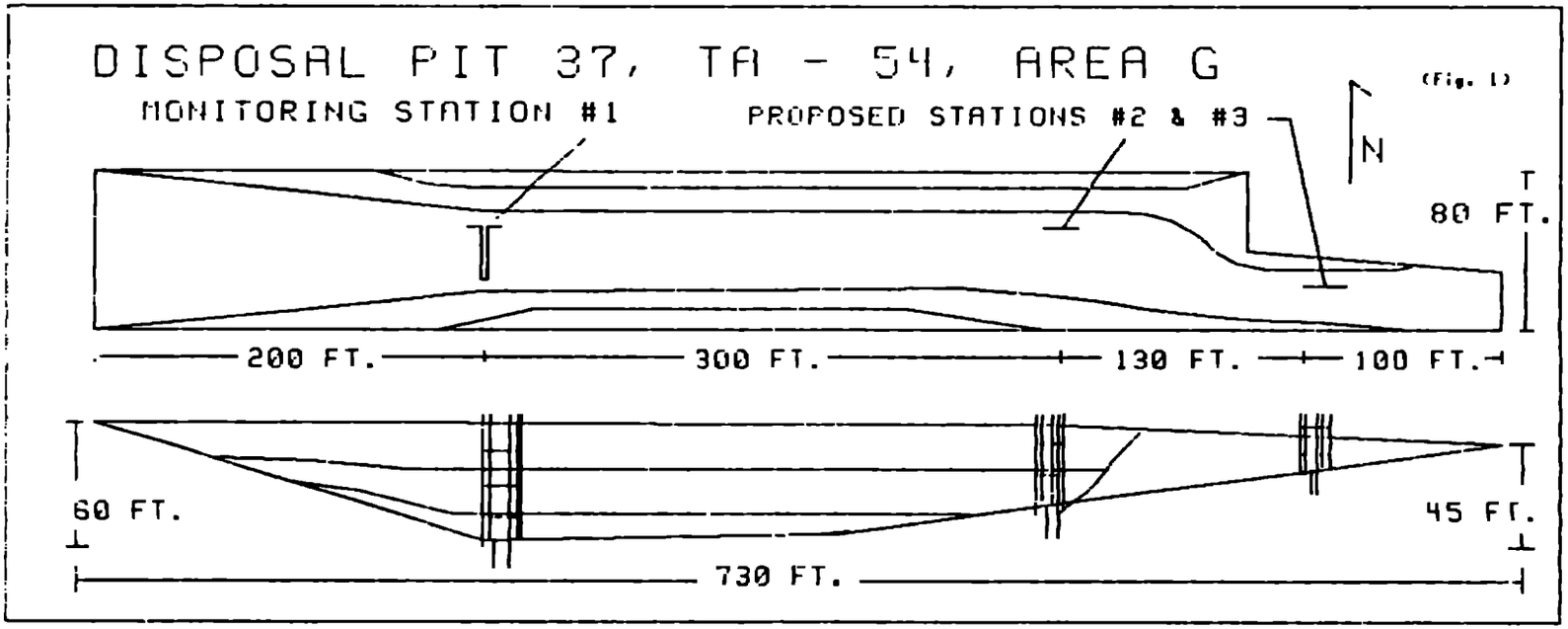
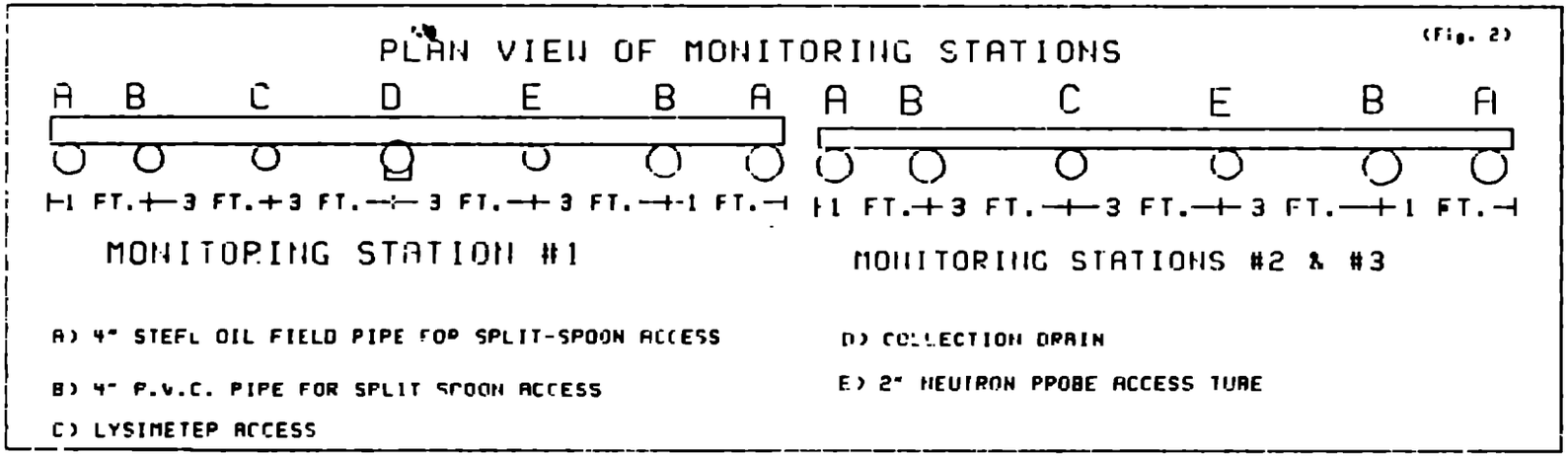
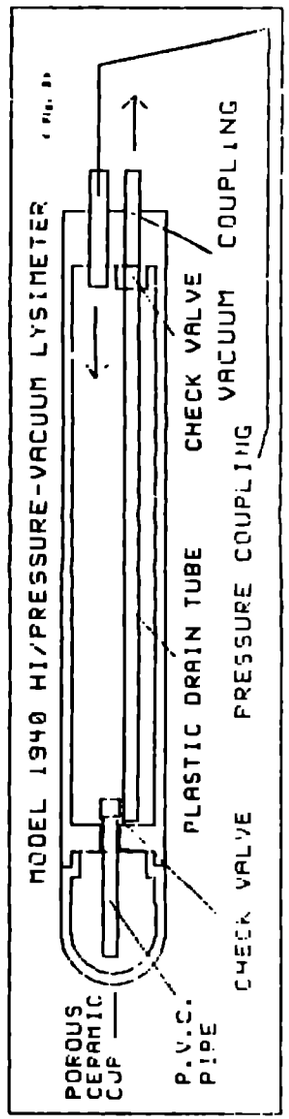
1. W.D. Purtymun and W.R. Kennedy, "Geology and Hydrology of Mesita del Buey," Los Alamos National Laboratory report LA-4460-? (Nov. 1970).

2. W.D. Purtymun, E.A. Enyart, and S.G. McLin, "Hydrologic Characteristics of the Bandelier Tuff as Determined Through an Injection Well System," Los Alamos National Laboratory report LA-11511-MS (Aug. 1989).


DISPOSAL PIT 37, TA - 54, AREA G
(Fig. 1)
MONITORING STATION #1
PROPOSED STATIONS #2 & #3
N
80 FT.
200 FT.
300 FT.
130 FT.
100 FT.
60 FT.
45 FT.
730 FT.


PLAN VIEW OF MONITORING STATIONS
(Fig. 2)
A B C D E B A
A B C E B A
1 FT. 3 FT. 3 FT. 3 FT. 3 FT. 1 FT.
1 FT. 3 FT. 3 FT. 3 FT. 3 FT. 1 FT.
MONITORING STATION #1
MONITORING STATIONS #2 & #3
A) 4" STEEL OIL FIELD PIPE FOR SPLIT-SPOON ACCESS
B) 4" P.V.C. PIPE FOR SPLIT SPOON ACCESS
C) LYSIMETER ACCESS
D) COLLECTION DRAIN
E) 2" NEUTRON PROBE ACCESS TUBE


MODEL 1940 HI/PRESSURE-VACUUM LYSIMETER
(Fig. 3)
VACUUM COUPLING
CHECK VALVE
PRESSURE COUPLING
PLASTIC DRAIN TUBE
CHECK VALVE
POROUS CERAMIC CUP
P.V.C. PIPE