LA-8177

# An Environmental Sampling Program for a Solar Evaporation Pond for Liquid Radioactive Wastes

University of California

LOS ALAMOS SCIENTIFIC LABORATORY
Post Office Box 1663 Los Alamos, New Mexico 87545

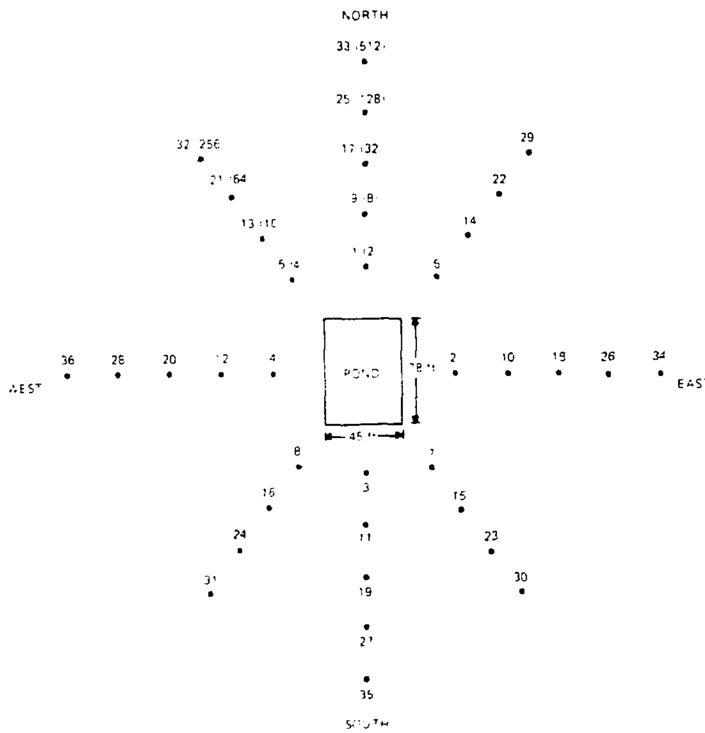


*Fig. 2.*

*Soil sampling grid (not to scale) used in the determination of initial radioactivity levels at the liquid radioactive waste solar evaporation pond site. The number in parentheses following the sample number is the distance (in feet) of the sampling site from a side or corner of the pond.*

then allowed to drop by some amount; after equilibration in the bell jar (to distribute the moisture uniformly through the soil), the resistance and mass were measured again. This cycle of drying, equilibration, and resistance and mass measurement was repeated until the soil was dry.

A mathematical relationship between the cell resistance x and the percent soil moisture y was established by regression analysis. The data were fitted to four regression models[7] to determine which model best fits the data, as indicated by the value of the correlation coefficient r. The four models and the corresponding correlation coefficients are listed in Table II.

The power curve

$$y = 2162x^{0.532}$$

or equivalently,

$$\log y = 3.33 - 0.532 \log x,$$

fits the data best. This calibration curve and the experimental data were plotted (see Fig. 3) using MAPPER[8] (a computer graphics package). Given any soil cell resistance reading, the percent soil moisture can be determined easily.

## TABLE I

## RADIOACTIVITY LEVELS OF SOIL SAMPLES

| Sample No. | Alpha Activity[a] | Beta Activity[b] |
|---|---|---|
| 1 | 39 | 299 |
| 2 | 43 | 291 |
| 3 | 38 | 300 |
| 4 | 49 | 310 |
| 5 | 45 | 287 |
| 6 | 38 | 266 |
| 7 | 47 | 274 |
| 8 | 29 | 287 |
| 9 | 36 | 262 |
| 10 | 44 | 248 |
| 11 | 43 | 294 |
| 12 | 35 | 301 |
| 13 | 42 | 303 |
| 14 | 49 | 287 |
| 15 | 48 | 292 |
| 16 | 34 | 285 |
| 17 | 48 | 271 |
| 18 | 46 | 279 |
| 19 | 47 | 301 |
| 20 | 42 | 261 |
| 21 | 26 | 251 |
| 22 | 41 | 284 |
| 23 | 49 | 255 |
| 24 | 33 | 259 |
| 25 | 36 | 276 |
| 26 | 28 | 287 |
| 27 | 33 | 280 |
| 28 | 49 | 264 |
| 29 | 45 | 237 |
| 30 | 33 | 284 |
| 31 | 47 | 256 |
| 32 | 48 | 269 |
| 33 | 39 | 261 |
| 34 | 50 | 284 |
| 35 | 44 | 293 |
| 36 | 41 | 257 |

[a]Measured with probe PN288185.

[b]Measured with probe PN252455.

## TABLE II

## REGRESSION ANALYSIS RESULTS

| Regression Analysis Model | Curve Equation | Correlation Coefficient r[a] |
|---|---|---|
| Power | $y = bx^m$ | −0.99 |
| Exponential | $y = be^{mx}$ | −0.97 |
| Logarithmic | $y = b + m \ln x$ | −0.84 |
| Linear | $y = b + mx$ | −0.77 |

[a]An r value near +1 indicates a high positive correlation, an r value near −1 indicates a high negative correlation, and an r value near zero indicates that the two data sets are not related.

Before the pond was filled, 12 calibrated soil cells were buried under the liner around the sides and at the bottom of the pond (see Fig. 4). The soil cell resistance and temperature values were determined when the pond was filled (see Table III); subsequent values will detect leaks in the liner.

### B. Air Monitoring

Four Paxton air pumps,* installed one on each side of the pond, collect representative samples of airborne particulates. Each pump can pull approximately 0.165 $m^3/s$ (350 cfm) through a Microsorban filter medium with a total sampling surface of 0.232 $m^2$ (360 $in^2$). The filters rest on a pleated filter holder of stainless steel wire cloth.

The pumps are at ground level adjacent to the banks and are housed in weather-tight units. The filter heads are attached to snorkels that rise above the pond banks. Initially, the filters will be analyzed for gross alpha and beta activity; analysis for particular radioisotopes such as $^{238}$Pu, $^{239}$Pu, $^{241}$Am, $^{137}$Cs, and $^{90}$Sr is possible. The filters will be analyzed at a frequency such that a particulate mass sufficient for accurate analysis is accumulated.

The pumps have been modified to sample at ground level if desired. They also may be rotated to

*Manufactured by Paxton Products Inc., 929 Olympic Blvd., Santa Monica, CA 90404.

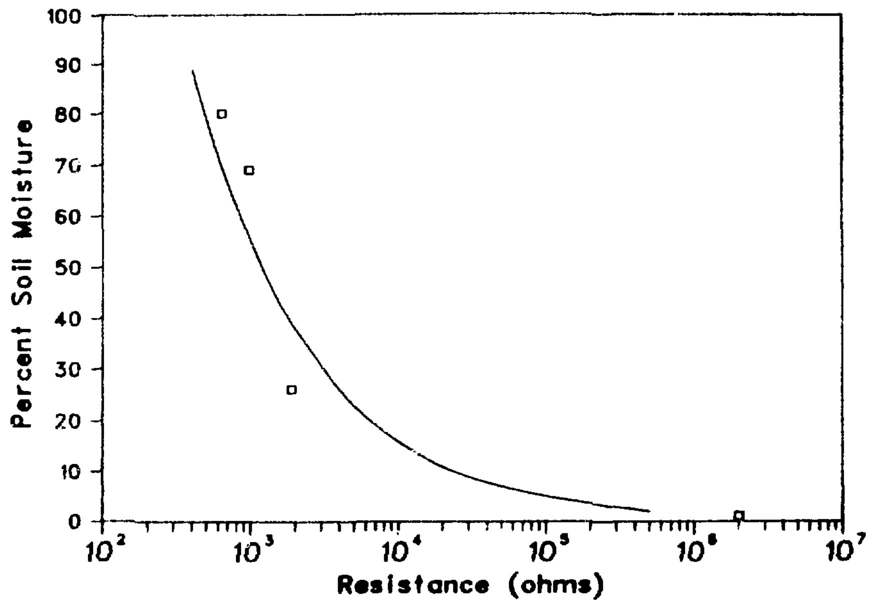


*Fig. 3.*
*Calibration curve for the soil cells used to detect leaks in the solar evaporation pond liner. The squares are experimental data; the solid line is the curve determined to be the best fit to the data.*

sample in the direction of prevailing winds. At present, the pumps sample above the pond banks in the four major compass directions.

### C. Vegetation Sampling

Representative samples of the most common vegetation at the site were collected before construction using a sampling grid surrounding the pond. Listed below are the common names and the genus-species names of the vegetation sampled.

- Blue grama grass (*Bouteloua gracilis*)
- Indian paintbrush (*Castilleja integra*)
- Chamisa (*Chrysothamnus nauseosus*)
- Big sagebrush (*Artemisia tridentata*)
- Gambel oak (*Quercus gambelii*)
- Birchleaf mountain mahogany (*Cercocarpus montanus*)
- One-seed juniper (*Juniperus monosperma*)
- Piñon pine (*Pinus edulis*)
- Ponderosa pine (*Pinus ponderosa*)

These samples are being analyzed for gross alpha and beta contaminants and for tritium to establish background levels for comparison with results from samples collected when the pond is operative. The samples will be stored so that other analyses can be made at a future date.

### D. Meteorological Data Collection

A portable weather station* installed at the site collects meteorological data. Wind direction and

*Manufactured by Meteorology Research, Inc., 464 W. Woodbury Rd., Altadena, CA 91001.

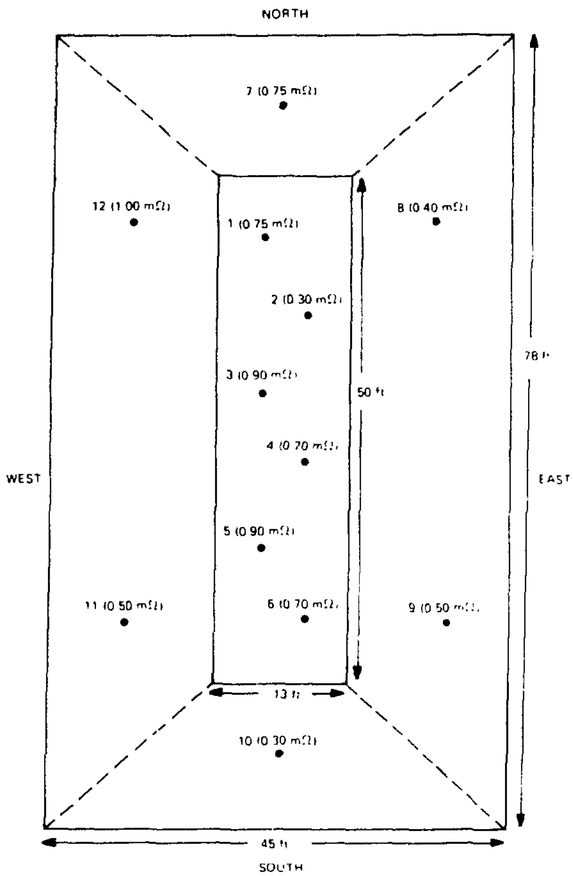


*Fig. 4.*
***Locations and resistances of the soil cells used to detect leaks in the liner of the liquid radioactive waste solar evaporation pond. The resistances are those measured before the pond was filled.***

speed, air temperature, and precipitation are measured with an accuracy of ±2% and are recorded on a spring-driven strip chart recorder. The station, housed in a weather-tight unit, can operate for 120 days on battery power and can be mounted on an extendable tripod or a solid pipe. The unit is located on the southwestern bank of the pond away from wind-disturbing obstructions.

Meteorological data will be gathered on a routine basis and analyzed to determine whether a correlation exists between weather conditions and results from air, vegetation, and soil sampling.

**TABLE III**

**INITIAL SOIL CELL RESISTANCE AND TEMPERATURE VALUES[a]**

| Soil Cell No. | Resistance (MΩ) | Temperature (°F) |
|---|---|---|
| 1 | 0.75 | 70 |
| 2 | 0.30 | 72 |
| 3 | 0.90 | 70 |
| 4 | 0.70 | 70 |
| 5 | 0.90 | 72 |
| 6 | 0.70 | 70 |
| 7 | 1.00 | 72 |
| 8 | 0.40 | 70 |
| 9 | 0.50 | 70 |
| 10 | 0.30 | 72 |
| 11 | 0.50 | 70 |
| 12 | 1.00 | 74 |

[a]The soil cell resistance and temperature values are those measured on August 6, 1979 when the pond was filled.

## E. Biological Vector Control

Aquatic and terrestial biological vectors for the export of radioactivity from the pond will be studied. Aquatic vectors include algae, aquatic insects and gastropods, and organic floc generated by decomposing plant material. Terrestial vectors include birds (particularly waterfowl), mammals, and insects.

If observations indicate that small wildlife are gaining access to the pond, several options to repel them will be explored. Commercial sonic devices, such as those used in orchards, can be installed to keep rodents and birds away. Electronic insect traps can be installed around the pond banks. If necessary, an algicide can be used to suppress algae growth. Nets can be secured over the pond to prevent waterfowl (especially bottom-feeders such as coots) from landing on its surface. Studies indicate[a] that ducks feed most heavily on the organically rich floc covering pond sediments.[3] This floc also contains most of the contaminants.

## F. Photographic Survey

A photographic survey of the pilot pond was carried out during construction to document how the pond was built and how the surrounding environment was disturbed. Another survey will be taken during the operational phase.

## IV. SUMMARY

A pilot pond for solar evaporation of liquid radioactive wastes has been constructed at LASL to address two problems. The first concerns the economy and suitability of solar evaporation compared with, for instance, an evaporator fired by fossil fuels. The other, and more important, problem is whether such a pond can be controlled and monitored in a manner that prevents escape of radioactivity to the environment. To attack the latter problem, we have designed an environmental sampling program to detect the transport of radioactivity to the soil, air, and vegetation in the vicinity of the pond and are studying measures to control the export of radioactivity by biological vectors.

## REFERENCES


1. T. E. Hakonson, J. W. Nyhan, and W. D. Purtymum, "Accumulation and Transport of Soil Plutonium in Liquid Waste Discharge Areas at Los Alamos," Transuranium Nuclides Environ., Proc. Symp., San Francisco, California, November 17-21, 1975 (International Atomic Energy Agency, Vienna, 1976), pp. 175-189.
2. F. Terry Rees, J. M. Cleveland, and W. C. Gottschall, "Dispersion of Plutonium from Contaminated Pond Sediments." Environ. Sci. Technol. **12** 1085 (1978).
3. Richard M. Emery, Donald C. Klopfer, and M. Colleen McShane, "The Ecological Export of Plutonium from a Reprocessing Waste Pond," Health Phys. **34** 255-269 (1978).
4. C. J. Umbarger and M. A. Wolf, "A Battery Operated Portable Phoswich Detector for Field Monitoring of Low Levels of Transuranic Contaminants," Nucl. Instrum. Methods **155** 453-457 (1978).
5. M. A. Wolf, "Portable Survey Instrument for Low Levels of Transuranic Contaminants," Los Alamos Scientific Laboratory report LA-6860-MS (July 1977).
6. *Soil Moisture-Temperature Meter and Soil Cells* (Soiltest, Inc., Evanston, Illinois, 1975).
7. *Applied Statistics* (Texas Instruments, Inc., Dallas, Texas, 1977).
8. D. A. Dahl, "Mapper: High Quality Illustrations for Presentations and Reports," Los Alamos Scientific Laboratory Program Library write-up J5AJ (March 1979).
9. B. E. Vaughan, "Ecological Distribution and Fate of Plutonium and Americium in a Processing Waste Pond on the Hanford Reservation," Battelle-Pacific Northwest Laboratories annual report BNWL-2001, PT2 (1976).