TRITIUM IN THE ENVIRONMENT AROUND THE MAXEY FLATS RADIOACTIVE WASTE BURIAL FACILITY

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ABSTRACT

This study addresses the results of intentionally released tritium in the environment. The shallow land burial facility for "low-level" waste at Maxey Flats has received and buried about 830 kCi of tritium during its operational period. About 33 kCi have been released over an eight year period in a controlled manner from the treatment of leachate from closed disposal trenches utilizing a waste water evaporator. A summary of the tritium activity concentrations in the air and water around the facility will be reported.

Correlations between tritium buried, tritium released and environmental concentrations of tritium detected will be examined. Also, the radiological implications will be discussed.

INTRODUCTION

The Maxey Flats Radioactive Waste Disposal Site is located in the Knobs Region of Northeastern Kentucky. This area is an eroded plateau characterized by the presence of many knob-like erosional remants. From May 1963 until December 1977 a total of approximately 4.75 million cubic feet of waste containing 2.4 million curies were buried via shallow land burial. Tritium disposals accounted for 830 kilocuries of which 640 kilocuries were received in a single shipment in 1971.

The site, owned by the Commonwealth of Kentucky, is currently regulated by the Kentucky Department for Human Resources and is the maintenance responsibility of the Kentucky Department for Natural Resources and Environmental Protection. Day-to-day maintenance activities are carried out under contract by National Waste Management Services, Inc., a subsidiary of Dames and Moore.

DISCUSSION

After the first ten years of operation, slight increases in radioactivity were observed in the off-site monitoring samples and concern was expressed regarding the large quantities of water that had penetrated the clay trench caps and accumulated in the closed pits. Several attempts at solidifying the water that had accumulated proved unsatisfactory and it was determined that the best method for dealing with the large volume of liquids was to install and operate a submerged combustion evaporator to reduce the volume of the leachate and then solidify the concentrate for reburial.

While it was realized that most of the radioactive isotopes would remain in the evaporator concentrate, it was clearly understood that virtually all of the tritium involved would be released to the environment as water vapor. The evaporator was installed and began operation in 1973. A maximum release rate of 2 millicuries per second was placed on the evaporator to assure that exposures to the limiting receptor, a nearby farmer, would not exceed 10% of the non-occupational dose limit. Further, measurements confirmed that occupational exposures within the restricted area have generally not exceeded 1% of the occupational dose limits for tritium.

Based on a maximum feed rate of five gallons per minute, the highest allowable feedwater tritium concentration was calculated to be 6 microcuries per milliliter. Since the installation of the evaporator, about 4.5 million gallons of contaminated water cortaining an average of 2 microcuries of tritium per milliliter have been processed resulting in the release of 32.6 kilocuries of tritium. The tritium release is determined at a monitoring point just prior to leaving the evaporator stack. The total amount of tritium released through the evaporator for the years 1975 through 1979 was 5.0, 7.5, 3.4, 11.6, and 5.2 kilocuries respectively.

ENVIRONMENTAL MONITORING AND DATA

The facility is surrounded by a network of air monitors employing the gas washing method of tritium oxide collection to ensure that workers are not exposed to excessive levels of tritium. The nearest residence to the facility is also monitored by the same type tritium air monitor.

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As the limiting receptor, this residence is also included in the off-site environmental surveillance program. This off-site program is conducted by the Department for Human Resources Radiation Control Branch which routinely samples a number of surface streams and drinking wells in the Maxey Flats vicinity. This program consists of established sampling locations, as can be seen in Figure 1, in the vicinity of the site and up to 6 miles downstream.

The data on which this paper is based was tabulated from the Radiation Control Branch Environmental Surveillance records. The mean represents the average of the data points determined during any given calendar year.

Sampling stations MF 1, 3, 4A, 6, 7, 13, 19, 22, 32, 36, and 39 are surface stream locations. Of these locations MF 3, 4A, 6, 13, 32, 36, and 39 are directly associated with various drainage pathways from the site. Additionally, each location is influenced by emissions from the evaporator. Sample Station MF 13, located in the main drain on the east side of the site, is the last on-site sample station, and is also monitored by the off-site program. MF 4A is located in the site south drainage area but is off-site. MF 3 is situated near the mouth of Drip Springs Hollow, which is in the west drainage area for Maxey Flats but is also located off-site. A composite of the stream data is shown in Figure 2.

The remaining surface stream locations which are isolated from site runoff are MF 1, 7, 19, and 22. MF 1 is located west of the site on Unnamed Hollow Creek prior to its confluence with Drip Springs Hollow Creek. MF 19 is located northeast of the site on Crane Creek near Highway 32. MF 22 is located east of the site near the source of Rock Lick Creek. Tritium levels in excess of natural tritium concentrations are attributable to the evaporator. A composite of this stream data is shown in Figure 3.

The average annual tritium concentrations presented in Figure 3 do not correlate exactly to the total tritium controlled release owing to the variability in atmospheric conditions, primarily wind speed and direction. From a regional windrose, it was determined that the wind generally blows from all directions, but the predominant direction is from the south and southwest which is also the case for most heavy rainstorms. The rainout of the tritium from the plume would effect the tritium concentration at MF 7 more than other locations owing to its close proximity to the site and its preferential wind direction. A complete weather study at Maxey Flats and how it affects the tritium levels observed has not been performed.

Sample stations MF 4, 5, 12, 20, and 33 are drinking wells. MF 4 is located below the south drain of the site. MF 5 is the closest drinking well to the site along the main drain (east side). MF 12 is the limiting receptor at the site entrance on the north side. MF 20 is a remote drinking well near the source of Rock Lick Creek. MF 33 is located on the west drain of the site. All the drinking wells are shallow (about 1.5 to 4 meters) and all appear to be charged by local mantle flow rather than by regional water tables. A composite of this drinking well data is presented in Figure 4.

MF 13 is located in the main east drain and is actually on-site. MF 6 is the next sampling station, located to the east on the No Name Hollow Creek downstream from the confluence of the main drain. MF 39 is situated on Rock Lick Creek downstream from the confluences of Drip Springs Hollow and the south drain. All of the surface run-off tritium must pass by MF 39. The next location is MF 32, which is situated on Fox Creek downstream from the confluence of Rock Lick Creek and Fox Creek. A majority of the tritium that is rained out or is runoff passes MF 32. The last station, MF 36, is located about five miles downstream on Fox Creek from MF 32. USEPA data as published in the Environmental Radiation Data Reports for tritium concentrations in surface water at Wheeling, West Virginia is included for comparison. As expected, the concentration of the tritium in surface water decreases markedly with dilution. A composite of this stream data is shown in Figure 5.

RADIOLOGICAL IMPLICATIONS

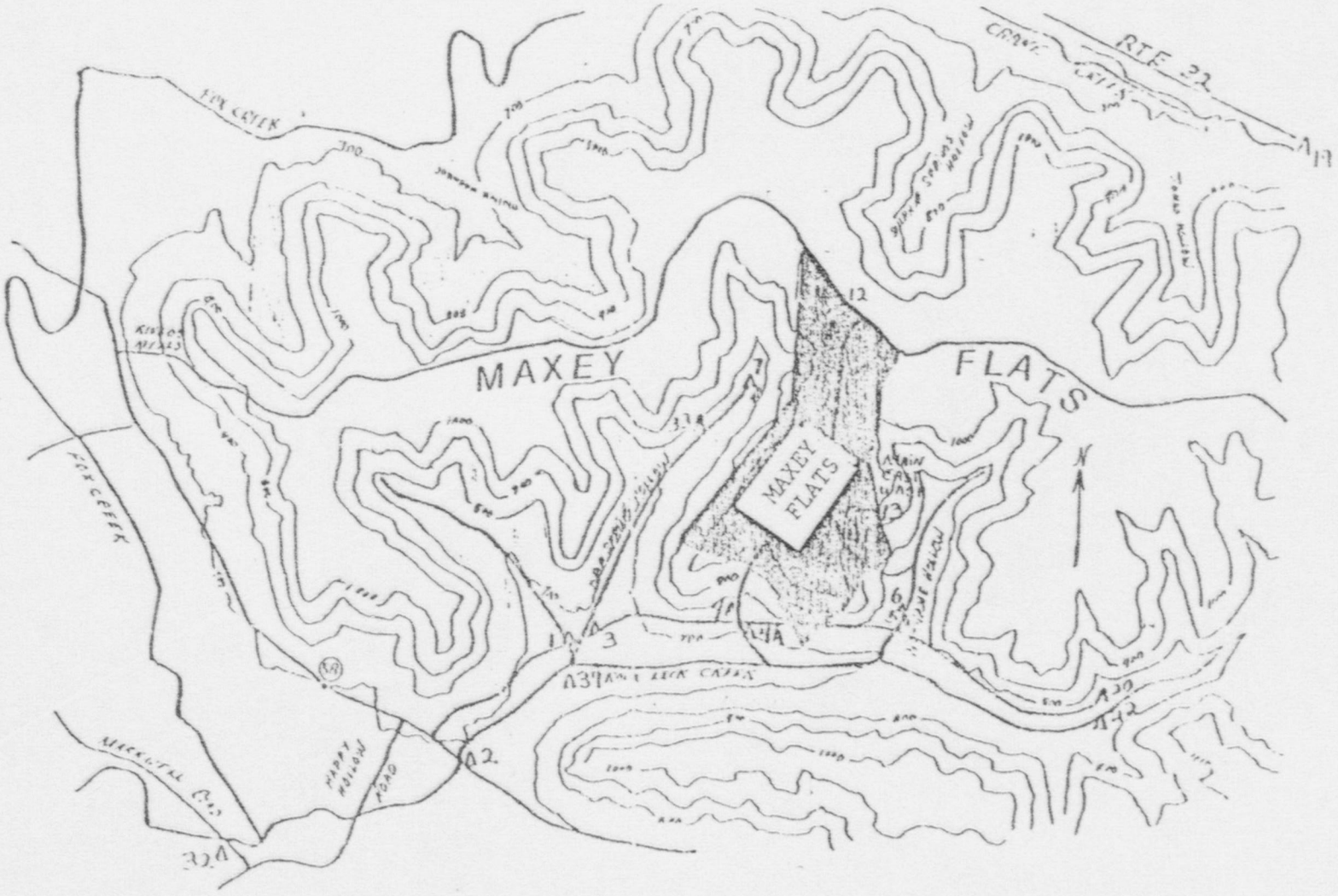
The EPA drinking water standard for larger populations is set at 20 picocuries per milliliter which is estimated to result in an dose of 4 mrem per year. The Maxey Flats private drinking water wells are about 15% of this standard. Tritium levels determined in surface streams when compared with the Maximum Permissible Concentration of 3000 picocuries per milliliter in unrestricted areas indicates that the levels observed are generally less than 0.2% of this standard. Further investigation by the USEPA resulted in their estimation that the tritium dose to the limiting receptor is less than 3 mrem per year based on the current 120 hour per week evaporator operating schedule.[1]

SUMMARY

Even though substantial releases of tritium are made in the operation of this site, the individuals living in the vicinity of the Maxey Flats Burial Site are not exposed significantly. Considering the small radiation doses computed and the limited population involved, observations of apparent health effects would not be expected.

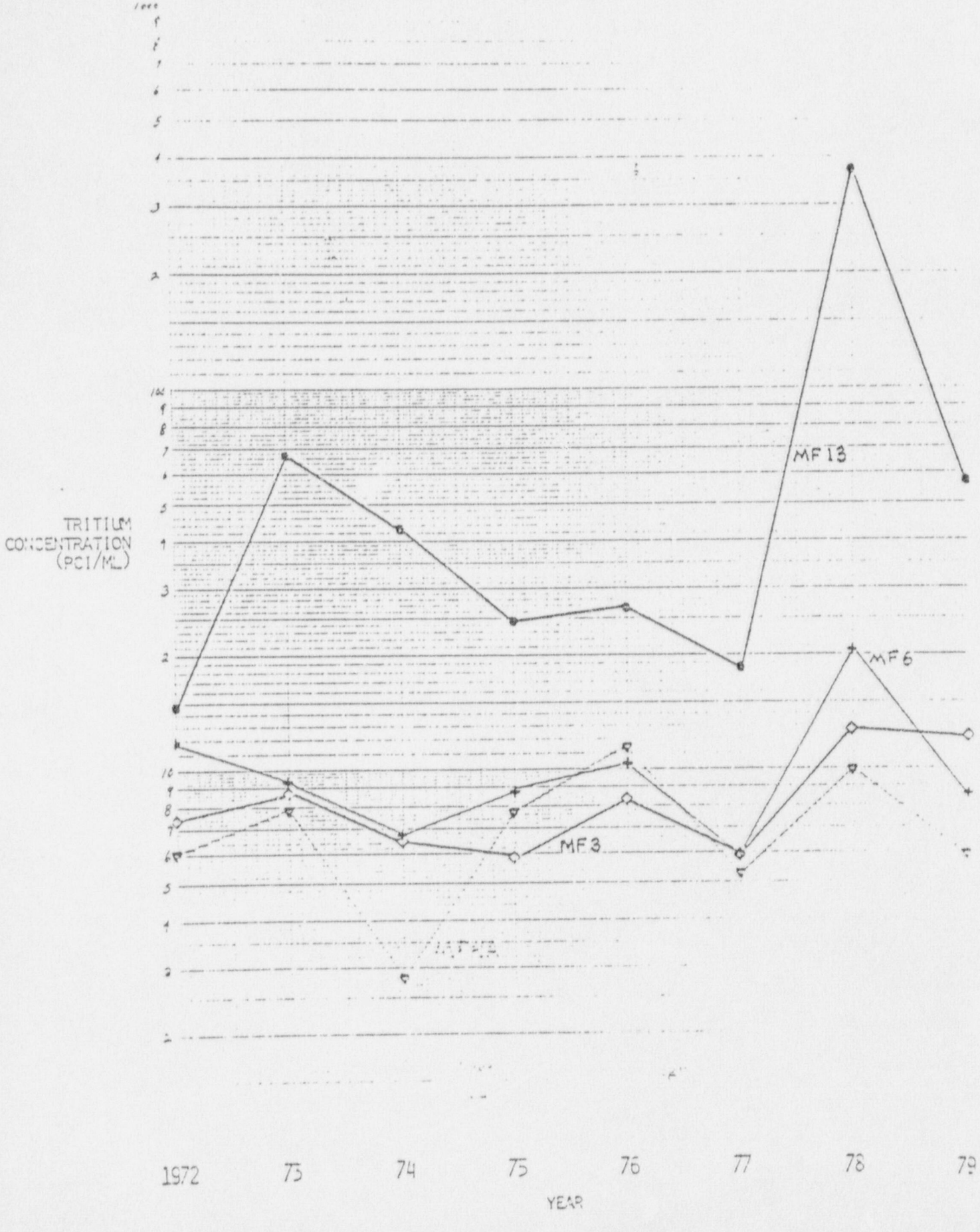
REFERENCE

[1] Supplementary Radiological Measurements at the Maxey Flats Radiation Waste Burial Site, 1976 to 1977, U.S. EPA Report, #EPA-520/5-78-011.

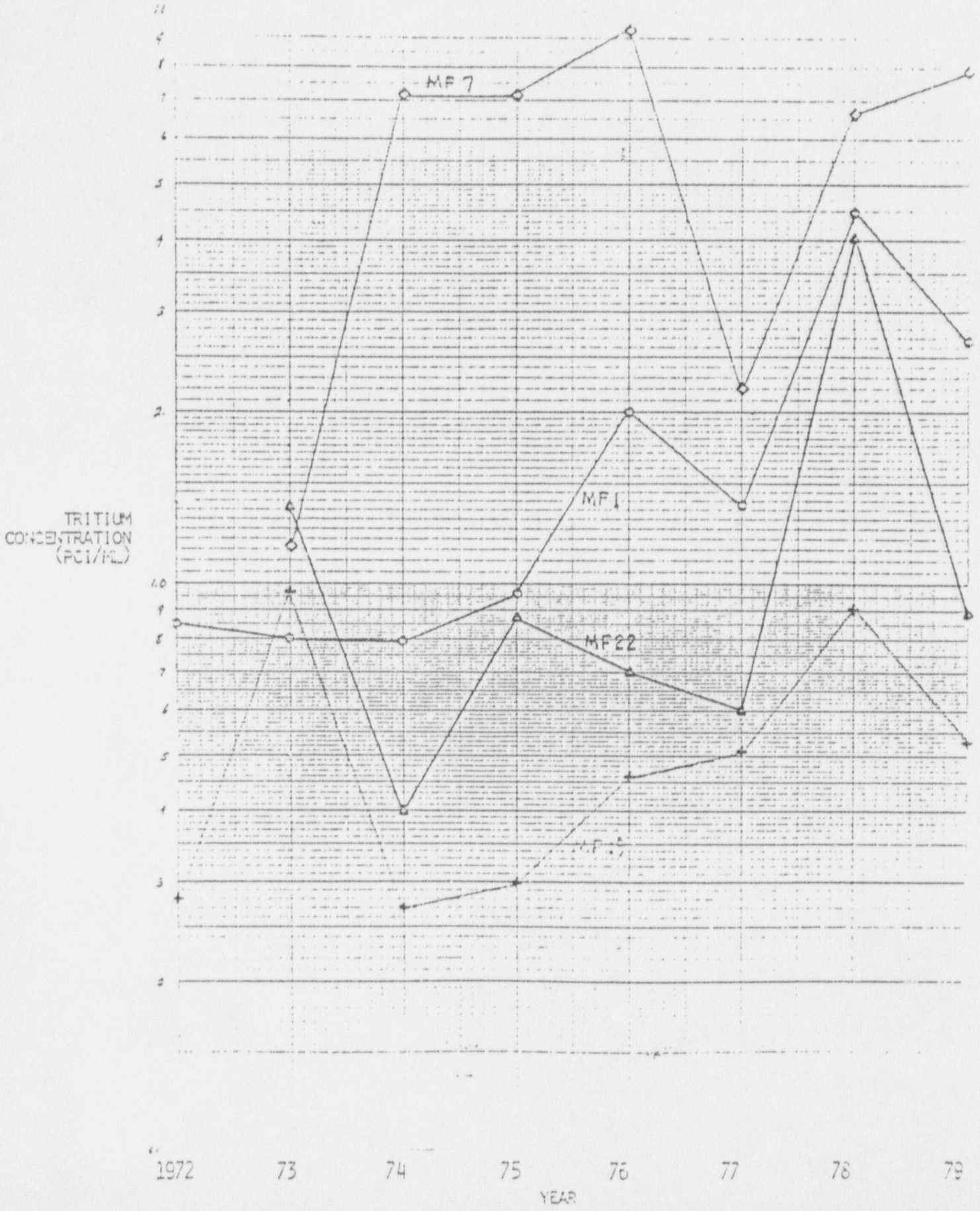


Map of Maxey Flats area showing many of the sampling stations and their relationship to the site drainage.

SURFACE STREAM SAMPLING LOCATIONS INFLUENCED BY
THE EVAPORATOR AND AFFECTED BY SURFACE RUNOFF



SURFACE STREAM SAMPLING LOCATIONS INFLUENCED
ONLY BY THE EVAPORATOR



DRINKING WELL SAMPLING LOCATIONS

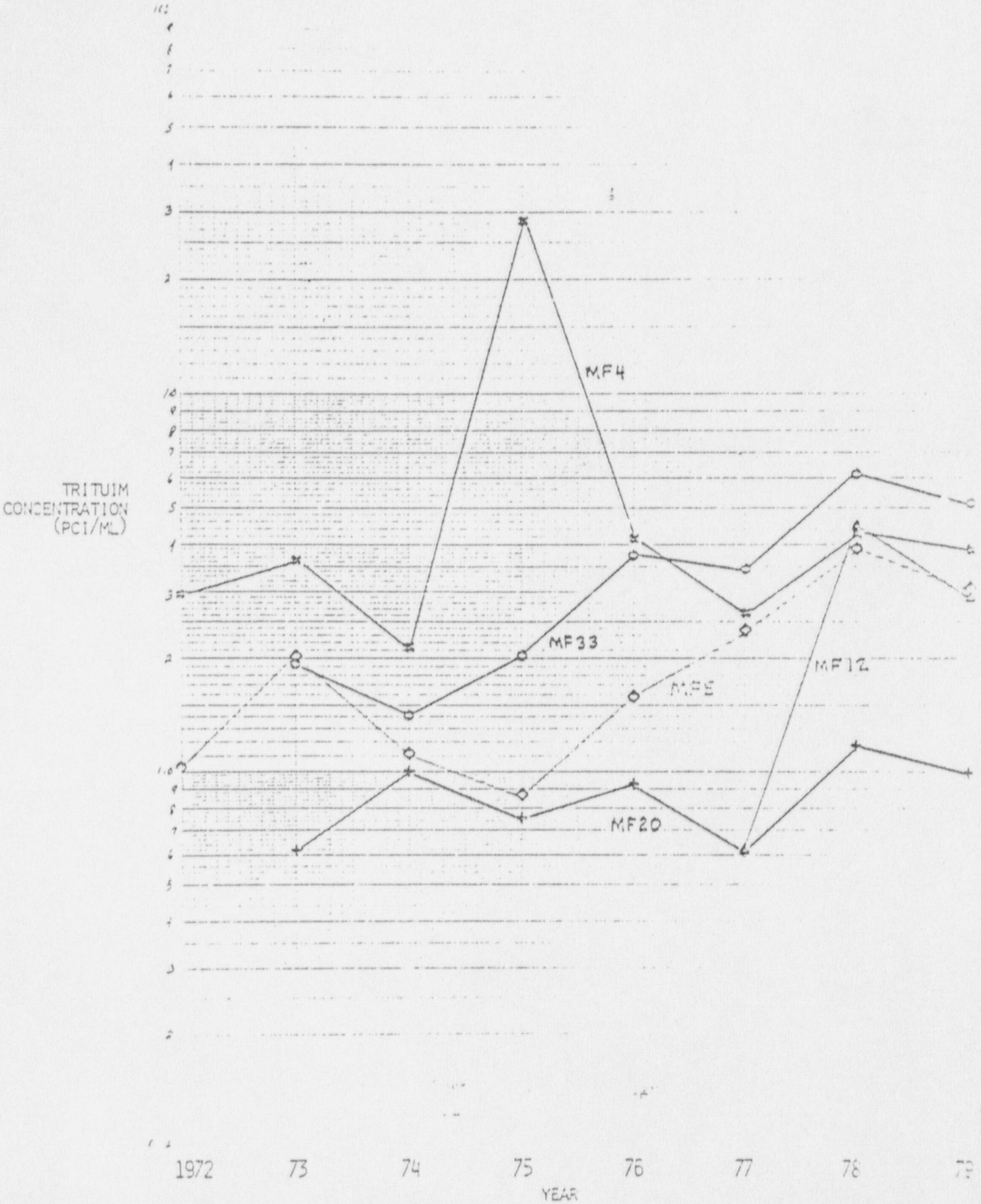


Figure 3

COMPARATIVE TRITIUM CONCENTRATIONS FOR SELECTED SAMPLING LOCATIONS