

**RADIOACTIVE SUBSTANCES AND STREAM WATER:
AN EARLY WARNING SYSTEM**

**Kathleen Murphy, Ph.D.
Chemistry Department
Daemen College**

This grant proposal is for the purpose of investigating the feasibility of constructing two early warning systems for potential contamination of stream water, by highly radioactive substances, located in West Valley, New York. West Valley, New York is located about 45 south of Buffalo, New York. It is an area surrounded by creeks (see Figure I) that feed into the Cattaraugus Creek, a tributary of Lake Erie. In 1962, Nuclear Fuel Services (NFS) built a plant for the purpose of reprocessing nuclear fuel in west Valley .A high level radioactive waste burial ground, licensed under the Atomic Energy Commission (referred to as the NDA) was also established. The plant reprocessed fuel rods to reclaim the fissionable uranium and plutonium. The waste products of the processing were buried in the NDA. NFS operated the plant for a total of six years, from 1966-1972. In total, the plant reprocessed 640 metric tons (1400 tons) of spent fuel rods.

In 1963, NFS was issued a second permit to bury low-level radioactive waste from the state of New York in another area near the plant, now referred to as the SDA (see Figure I). It was licensed to accept both the on-site and all off-site nuclear low-level wastes generated within the state during the plant's period of operation. It was one of the six existing sites that used shallow land burial. The trench bottoms extended into a silty clay layer that was largely impermeable to water and were projected to be 6 meters above groundwater level. Therefore only extremely slow migration of the fission products or nuclides was expected. About 1,000,000 curies have been buried in the two burial grounds. The main chemical constituents of the nuclear wastes in both the SDA (state-licensed) and NDA (NRC-licensed) burial grounds are similar, but the SDA has about two-thirds the number of buried curies as the NDA (430,000 versus 679,000), as characterized in a 1995 DOE study. The SDA occupies approximately 15 acres, compared to 5-6 acres for the NDA, but the SDA has almost as much (85%) "greater than class C" waste than the NDA. The waste in the SDA is largely buried in trenches, while

the NDA waste is buried in holes. The trenches in the northern section of the SDA were dug (1-5 in Figure I) in 1963 and quickly filled with water due to the "bathtub" effect. There was great difficulty in keeping the trench caps stable because the waste was not well compacted and the caps not thick enough to avoid cracking in dry months and eroding in wet months. NFS tried to rework the caps several times. However in 1975, the water inside trenches 4 and 5 broke through the caps and from then on both trenches had to be pumped continuously. The water problems became so severe that the SDA was closed by the state of New York in 1975.

A different trench design was used for the new southern trenches in 1968, but by 1978, the water level in the southern trenches also started to rise. U.S. Geological surveys conducted in 1978 and 1979 indicated little if any groundwater contribution to the water in the trenches. The rise correlated to precipitation and therefore infiltration through cracks in the cap and settling of the waste. Migration of radionuclides from the NDA was not apparent during the 1970's, but did appear in the 1980's. Throughout the 1980's, trench water levels in the SDA continued to rise. The New York State Energy Development Agency (NYSERDA) experimented with several new types of membranes and plantings to reduce water infiltration. A slurry wall and a water treatment facility were added in 1985 to prevent groundwater infiltration and to treat water pumped from trench 14 (Figure 1). In 1996, NYSERDA completely covered all the trenches with a membrane to prevent infiltration from rainwater and melting snow. Since then the water levels have largely stabilized within the trenches. Two additional areas of contamination of the groundwater were detected in the northern portion of the site (where the plant and high level waste tanks are located) called the "Northern Plateau." The northern plateau is composed of alluvial sand and gravel, not silty clay as in the SDA and NDA areas. A routine survey in 1986 of the swampy areas of the plateau nearest the creeks showed an unusual increase in Strontium-90 (Sr-90) concentration. Further investigation indicated an underground plume of contamination in the groundwater with the probable source the old processing building. The current area affected is very large with the edge of the plume extending almost to northernmost (Buttermilk Creek) boundary of the plateau. The contamination is severe, with concentrations of Sr-90 in the millions of picocuries per liter within the plume. The study clearly demonstrated that Sr-90 is moving with the groundwater. Large amounts of Cesium-137 (Cs-137) would also have leaked from the old plant, but as the observed level of Cs-137 is very low in the plume, it is assumed that the Cs-137 is still bound in the soil under the plant. The second, much smaller plume contains Cs-137 not successfully removed by the excavation after the filter blowout in 1968. The

continued monitoring and treatment of leachate since 1980 has kept the migration of the waste away from the creeks. The DOE conducted additional surveys of the Sr-90 plume in 1997 and 1998 to better characterize the plume movement, location and size of the source which indicate that the "pump and treat" remediation of the plume appears to be preventing the Sr-90 from reaching the creeks. In 1986, a routine geological survey found significant concentrations of plutonium in the area north of the NDA. Further testing and excavation determined that the plutonium had leaked from two burial holes in the NDA. Because the migration was so extensive, an interceptor trench and pumping system was added along the north side of the NDA to trap and remove the migrating plutonium (Figure 1). The soil was also excavated from around the holes.

In 1980, the federal government enacted West Valley legislation that authorized the Department of Energy (DOE) to demonstrate the solidification and preparation of high-level radioactive waste for permanent disposal. In addition, the DOE was responsible for the proper disposal of low-level waste produced during the solidification process and the decontamination of project tanks, facilities and hardware. In 1981, the DOE named a Westinghouse subsidiary, West Valley Nuclear Services Co., Inc. (WVNS) the prime contractor. The DOE and WVNS assumed operational control in 1982. The DOE has completed its assigned mission and is in the process of deliberations with the state of New York for agreement on how to close the site. Because the valley is surrounded by creeks, the potential for significant erosion of the site in the next hundreds of years cannot be dismissed. If the wastes remain buried, it is highly probable that constant monitoring and corrective action can cease. In addition, the agency responsible for the monitoring must be prepared for a sudden large influx of dollars if a catastrophic event causes a breach in the SDA trenches or NDA holes. Consequently, the negotiations for closing the site are ongoing and have been protracted. There is a well-informed, long-standing, community-based citizen group, called the West Valley Coalition, which has monitored the DOE activities and remains very active.

The purpose of the grant is to investigate the feasibility of developing two early warning systems that would be comparatively inexpensive to set-up and continue, with volunteer help if necessary. Two types of projects will be developed with the help of student researchers as part of the grant activities. The first would begin to address the erosion issue by constructing a database, using GPS and ArcView software, of the current position of the creek edges surrounding the site and any detectable alterations during the seasonal changes that appear within the period of the grant. Currently, the region is comparatively "dry", as the

Great Lakes are at a historical low level, since precipitation in the region has been below normal for several years. Therefore, it is an opportune time to collect data for a "dry period". This database would then be made part of the public record and accessible to all interested parties, so it could be used as reference in later years, or decades.

The second part of the grant proposal is to study the kinetics of strontium and cesium uptake by selected fresh water stream species that are indigenous to the site, using a model system constructed at Daemen College, in our chemistry laboratories. It is likely that these substances would be the most likely to appear in the streams in significant concentrations if the current remediation systems are either discontinued or fail in future years. The chemical data on the uptake of the substances is very sparse with few, if any, local species having been investigated. Nonradioactive isotopes of these elements will be used, as the kinetics depends on the chemical properties of the substances, which are identical between the radioactive and nonradioactive isotopes.

Research Plan

Prior to the start of the grant period, the necessary permission would be obtained from both the West Valley DOE and NYSERDA agencies to conduct site border activities. The grant activities will be divided into 4, three-month periods.

Goals first tri-monthly period:

- Identify student researchers
- Develop preliminary map of creek location and edges. Identify points for continuing survey
- Begin survey of creeks surrounding West Valley site.
- Analyze samples of stream water to develop a profile of the major mineral species, ionic strength, and pH in the water.
- Obtain samples of stream water species, identify likely species, and establish appropriate aquaria for maintaining species in a simulated natural environment in the Daemen College laboratory.
- Construct a log of weather information pertinent to site using Internet weather sources.

Goals of second tri-monthly period:

- Monitor the creeks edges using survey sites. Continue log of weather data.

- Begin construction of map using Arc View software
- Develop calibration techniques for reproducible and accurate measurement of strontium and cesium levels in the aquaria.
- Begin the experiments to measure the kinetics of the uptake of strontium and cesium.

Goals of third tri-monthly period:

- Continue the monitoring of the creeks edges using survey sites. .Continue log of weather data and mapping.
- Continue the kinetics experiments.

Goals of fourth tri-monthly period:

- Continue the monitoring of the creeks edges using survey sites.
- Develop a database of maps and weather data for creeks on site.
- Summarize results of kinetics experiments
- Construct the final report for the grant.