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COMPARISON OF PASSIVE SOIL VAPOR SURVEY TECHNIQUES AT A TIJERAS ARROYO SITE, SANDIA NATIONAL LABORATORIES, ALBUQUERQUE, NEW MEXICO

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## ABSTRACT

Soil vapor surveys were performed to characterize the approximate location of soil contaminants at a hazardous waste site. The samplers were from two separate companies and a comparison was made between the results of the two techniques. These results will be used to design further investigations at the site.

## 1. INTRODUCTION

A passive soil vapor survey (SVS) is an inexpensive and accurate method for investigating potential soil contamination at hazardous waste sites. The Environmental Restoration (ER) Project at Sandia National Laboratories, New Mexico (SNL/NM) has performed several SVS investigations as part of fulfilling requirements under the Resource Conservation and Recovery Act (RCRA). SNL/NM has commonly used passive SVS to investigate the presence or absence of volatile and semi-volatile organic compounds (VOCs and SVOCs, respectively) at a site. SNL/NM recently compared the passive SVS methods from two independent companies. Company A donated their samplers and analysis for the purpose of a comparison with the Northeast Research Institute (NERI) Petrex samplers, which was under a previous contract to investigate the specific site of interest for this investigation. The results of comparing these passive SVS activities are summarized below.

## II. SITE HISTORY

The SVS investigations were performed at a former centrifuge dump site located along the floodplain and

associated escarpment of Tijeras Arroyo adjacent to one of SNL/NM's five Technical Areas (Figure 1). Throughout the site's history, dumping in this area has been uncontrolled and undocumented.

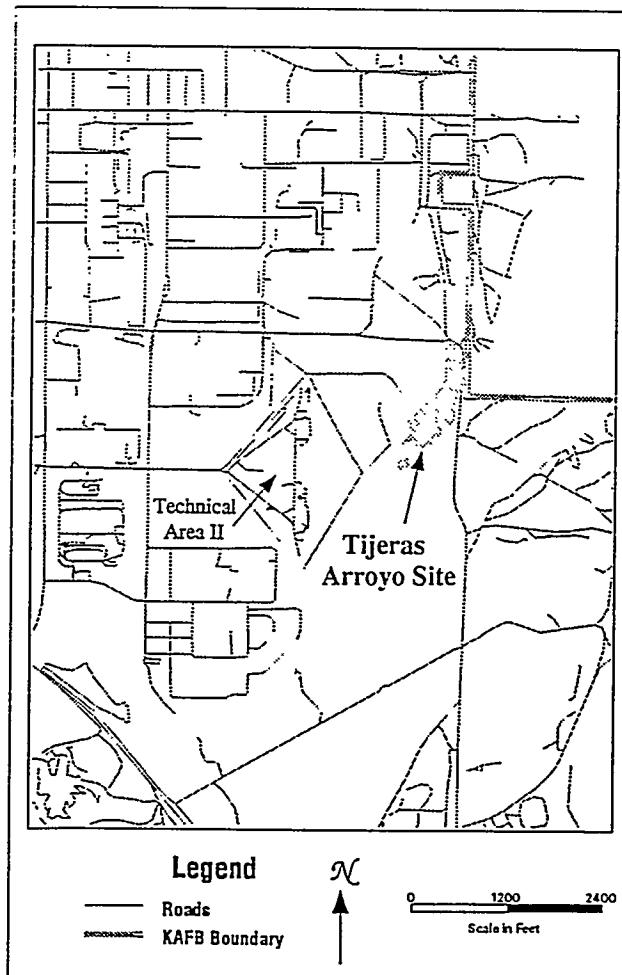


Figure 1. Location of Tijeras Arroyo Site at Sandia National Labs, Albuquerque, New Mexico

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For a distance of 200 feet parallel to the arroyo, debris is scattered from the top of the escarpment down to a point where the slope flattens into the broad terrace that forms most of the floor of the arroyo (Figure 2).

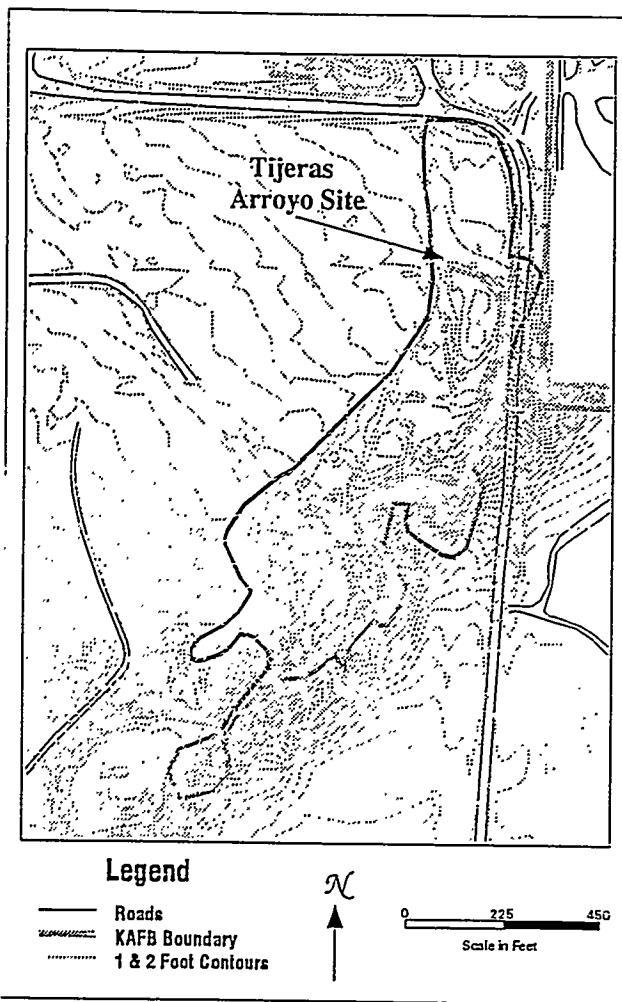


Figure 2. Topography of the Tijeras Arroyo Site

The visible debris is composed of construction materials and various unidentifiable metal objects. A review of aerial photographs taken in 1966 indicates that a large area of debris comprises a portion of the escarpment northeast of the centrifuge dump area. This debris is estimated to extend about 1400 ft long and is 250 ft wide perpendicular to the arroyo.

The undocumented dumping may have been associated, in part, with operations conducted at the former centrifuge site. It is also possible that liquid wastes were dumped at this site, since such activity is documented for nearby ER sites. Recent site visits and general process knowledge indicate that dumping unrelated to the old centrifuge may have occurred and continued until recently.

Potential contaminants of concern (COCs) are unknown because of the lack of documentation. Based on limited historical information, potential COCs may include VOCs, SVOCs, metals, depleted uranium and other radioisotopes.

### III. SAMPLING PLAN

Following initial site investigations by the SNL/NM ER Project staff, a more detailed study of the site was begun. First, visual analysis was conducted by traversing the site and documenting area features. Next, an aerial photograph interpretation was performed to determine whether historical data could provide evidence about the extent of the activities that occurred at the site. Interesting features at the site were recorded and digitized for use in the Geographic Information System (GIS). From there, locations were identified and designated for future sampling activities (Figure 3).

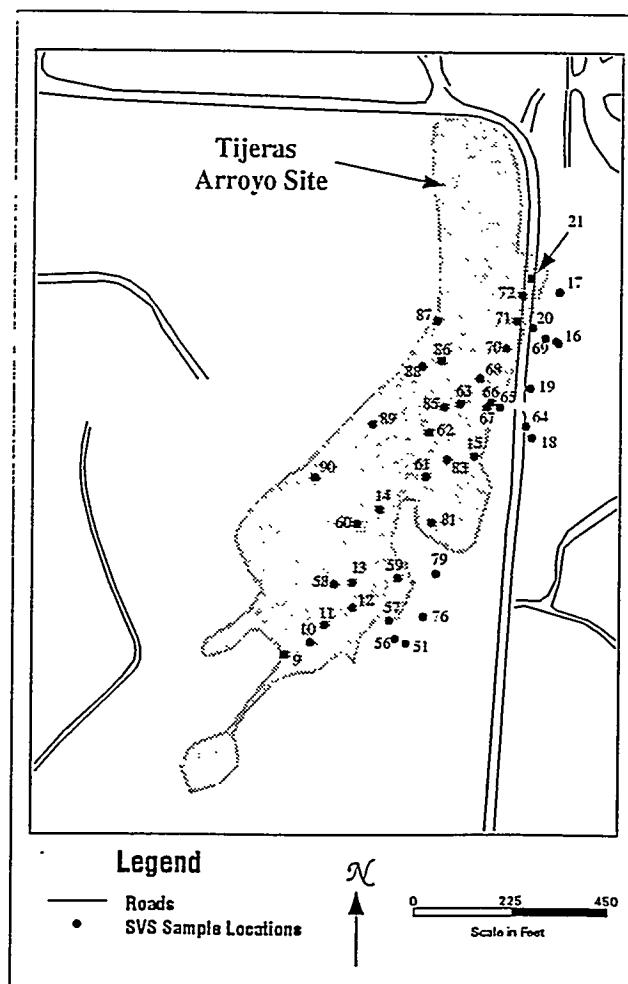


Figure 3. SVS Sample Locations at Tijeras Arroyo Site

Locational data were loaded into a Global Positioning System (GPS), which was then taken into the field with the sampling team, guiding them to the individual sample locations. The GPS also was used to record the locations of the 10 sampling points that were arbitrarily selected in the field to more evenly distribute sampling across the site.

#### IV. PASSIVE SVS RESULTS

TCE and PCE results from each survey technique were contoured and mapped by each respective company. The Petrex sampler from NERI is reserved for analysis by thermal desorption-gas chromatography/mass spectroscopy (TD-GC/MS) when further clarification of the TD-MS results are required. Mass spectrometer readings less than 200,000 tics were considered not environmentally significant and were mapped by NERI as non-detect. The NERI isoconcentration ranges for TCE are: 200,000 to 449,999 tics; 450,000 to 874,999 tics; and greater than 875,000 tics; values above 875,000 tics indicate TCE contamination.

NERI's passive SVS analysis technique is semi-quantitative and measures VOCs and SVOCs, among other analytes, in total ion counts (tics), which are typically analyzed by TD/MS followed by TD/GC/MS confirmation. In addition, NERI's TD/MS provides a high sensitivity and is not limited to specific analyses. The Company A passive SVS technique measures mass per soil gas collector for VOCs and SVOCs using TD/GC/MS, yielding analytes measured in micrograms ( $\mu\text{g}$ ) per collector. The result is the actual mass of analyte adsorbed on the sampler, whereas the ion counts are a machine response to the concentration of the compounds in the vadose zone vapor phase being mathematically transposed through the use of calibration curves.

No reliable method is available for converting NERI's ion count results to Company A's mass units due to differences in analytical instruments. Company A also utilizes standards to quantify the results: the two passive SVS techniques were compared using the isoconcentration contour maps generated from both companies, even though quantitative correlation was not possible.

##### A. Trichloroethene Values

Trichloroethene (TCE) concentration distributions for the centrifuge site varied slightly between the two passive SVS techniques. The TCE map generated by NERI shows an area of elevated TCE in the northwest

section of the site. An area of lower concentrations extends from north of Point 83 to Point 68 (Figure 4). The highest TCE concentrations occur at Points 86 and 87. These two points measured 888,267 and 1,106,040 tics, respectively.

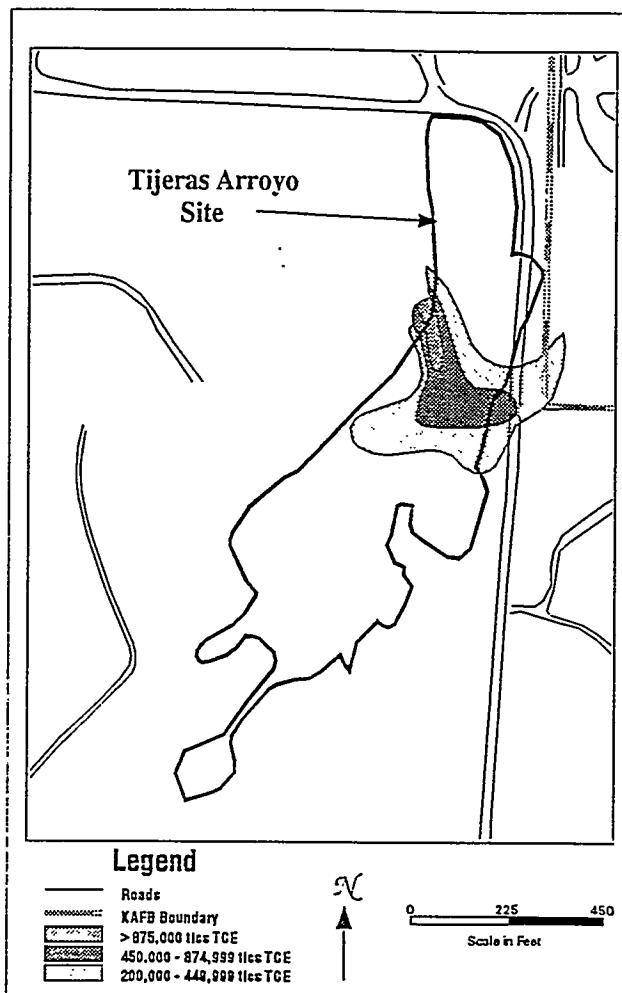


Figure 4. NERI interpretation of TCE Plume

The passive SVS isoconcentration contours for Company A are based on the highest concentrations found in the associated trip blanks. The highest detected value in the trip blanks is the lowest value to be contoured. This level is not shown on Figure 5, but was displayed on the original TCE isoconcentration maps as a gray polygon. For TCE, all sampler locations were contained in this area. The area with the highest TCE concentrations is in the northern part of the site, focused near Point 67 (Figure 5), with slightly higher concentrations at Points 86 and 87. This area with high TCE concentrations correlates well with NERI's results. However, the high concentrations centered on Point 59, located in the southern part of the site, were not identified in NERI's survey conducted at the same location.

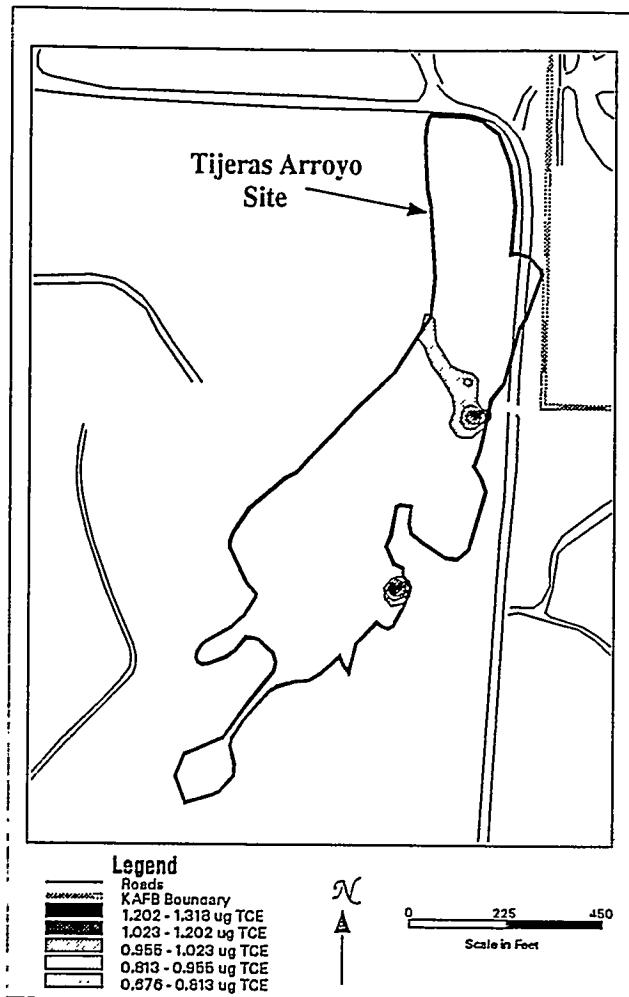


Figure 5. Company A interpretation of TCE Plume

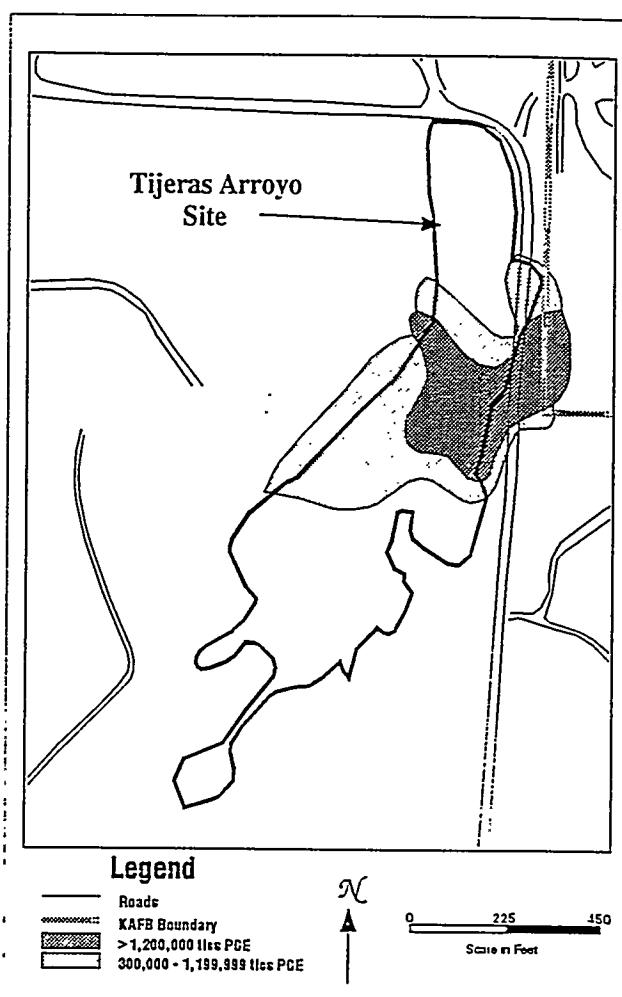


Figure 6. NERI interpretation of PCE Plume

#### B. Tetrachloroethene Values

NERI's tetrachloroethene (PCE) isoconcentration map displays a broad area of contamination in the central one-third of the centrifuge site. This area trends east-west over the entire sampled area. The reported range of PCE for the Petrex passive samplers was 300,000 to 1,199,999 tics for the lower range, with values greater than 1,200,000 tics for the maximum values. The hand-contoured PCE isoconcentration maps display values above 300,000 tics extending from Point 90 (Figure 6) to a location southeast of Point 83 thereby defining the southern boundary. Values above 1,200,000 tics were found from north of Point 87 east to include Point 21, but excluding Point 71. PCE values greater than 1,200,000 tics also occur in the center of the area (centered on Points 65, 66, and 67).

The PCE isoconcentration maps contoured by Company A are similar to the NERI PCE maps, but they appear to show much greater detail than NERI's map. This is a result of the greater number of colored gradations (i.e., concentration ranges) used for contouring (Figure 7). Apparent hot spots include Points 89 and 90 and the vicinity of Point 17. Elevated PCE concentrations are also centered on Points 87, 70, and 19. However, one significant difference between the NERI and Company A maps are the elevated concentrations centered around Point 59. This is consistent with the Company A TCE map and establishes some level of consistency between TCE and PCE at this location. However, the significance of this single point detection is uncertain. It may be interpreted as a false negative by NERI or a false positive by Company A's sampling method.

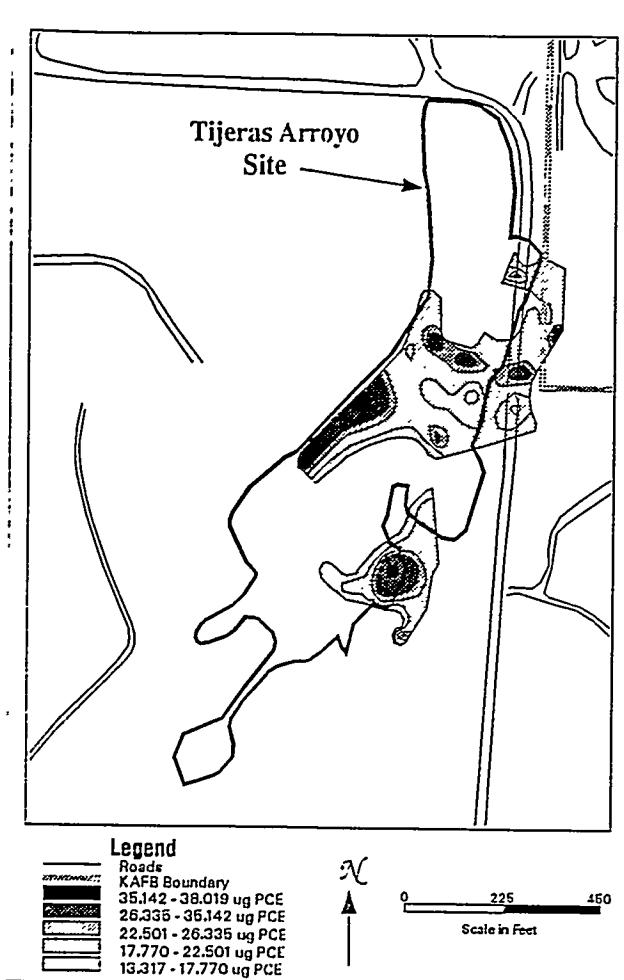


Figure 7. Company A interpretation of PCE Plume

## V. SUBSURFACE SOIL INVESTIGATION

A follow-up investigation of the site was conducted by SNL/NM ER Project staff to verify the findings of the SVS investigation. Soil samples were collected at the points of elevated concentrations found in the SVS sampling project and analyzed for VOCs and SVOCs. The samples were collected at one-foot intervals, to a total depth of five feet, using a boring tool that is lined with a synthetic casing. The samples were sealed inside of the casing, which was then cut into one foot lengths and delivered to the laboratory for analysis. None of the subsurface soil samples contained VOCs or SVOCs above their respective method detection limits, even though those areas were of interest from the soil vapor survey. The absence of these compounds in the soil samples could be explained by a soil vapor plume that is migrating in the vadose zone, but which was not sampled as part of the soil investigation.

## VI. SUMMARY AND CONCLUSIONS

In general, the analytical results reported by the two companies were similar in geographic distribution. Both companies provided isoconcentration maps that allowed easy interpretation of the sample results. The maps from Company A were generated using a greater number of concentration gradations. Furthermore, Company A's samplers identified organic vapors in one locality not identified by the Petrex samplers. This may be due to a false positive from Company A's method or a false negative by NERI. In either case, this area should be considered for a second, smaller phase of SVS investigation for verification.

Results of this comparison show that the use of various SVS methods can be a reliable means of identifying potential areas of environmental contamination. The technique is very sensitive to constituents in the soil gas and can be used to flag potential areas of concern, as well as delineating areas free of contamination. As shown by comparing the SVS data to the subsurface sample data, the sensitivity of SVS is much greater than that of soil matrix sampling. This is advantageous to the investigation because SVS is less expensive to install and analyze than obtaining and analyzing traditional soil samples, and can quickly focus the geographic area for a follow-up investigation. Because soil-vapor methods are typically used as field screening tools for environmental site investigations, mapping the relative distribution of compounds detected in soil vapor provides reliable data for initial characterization of a site.

## ACKNOWLEDGMENTS

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