GEOPHYSICAL SURVEYS AT A SUPERFUND SITE, WESTERN PROCESSING, WASHINGTON

Rowland B. French *

Thomas R. Williams **

Allan R. Foster

* ERT, A Resource Engineering Company
14715 NE 95th Street
Redmond, WA 98052

Consultant,
Seattle, WA

ABSTRACT

Western Processing is a former industrial waste processing and recycling facility which handled wide variety of products including animal by-products, industrial solvents, acids and cyanide solutions. In 1982 the site was placed on the National Priorities List. Surface cleanup was initiated a that time. A geophysical investigation was conducted in 1987 in order to plan subsurface remedia actions.

The geophysical investigation included magnetometer/gradiometer, electromagnetic induction ground penetrating radar surveys. Most of the 13 acre site was surveyed on a 10 foot grid. A foot radar line spacing was used. Both in-phase and quadrature phase data from the EM-31 were utilized. The objective of the geophysical survey was to locate buried tanks, drums, utilities, process lines and other areas of waste disposal. The survey successfully identified 39 anomalous regions Geophysical results were used to focus the subsequent boring and sampling program.

INTRODUCTION

This project was typical of many Superfund sites. The geophysical approach was not very sophisticated, yet it proved very effective in meeting the objectives of the survey. The objectives were no subtle geologic changes across the site, but rather to locate areas of subsurface disturbance, disposal areas. The site was relatively small (13 acres), but great detail was desired over that area There was also cultural interference from overhead high voltage power lines, from a chain link surrounding the area, and from a few buildings on site. Despite these obstacles, the combination o geophysical methods worked well and the desired objectives were met.

BACKGROUND

The Western Processing facility operated from 1961 to 1983 as an industrial waste processing an recycling facility. During that time, a number of waste recycling and disposal operations carried out with varying Impact on the environment. Those operations included reprocessing solvent and handling of acids, cyanide solutions, flue dust, battery chips and animal by-products. A plan view of the twelve acre site is shown in Figure 1, as it was in the final years of operation. the she Included a fertilizer plant, a solvent recovery plant, piles of scrap metal, piles of flue dust, and several lagoons for various waste products.

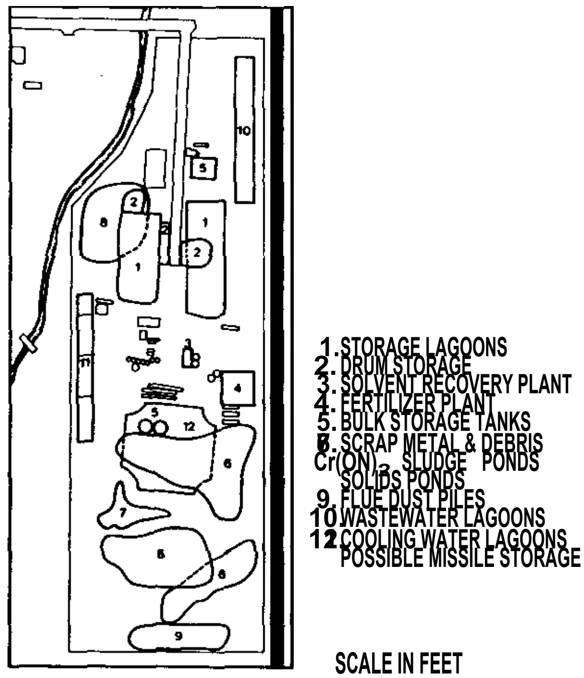

FIGURE 1: Summary of waste handling components.

In 1982 the she was placed on the EPA National Priorities List. At that time the EPA issued an administrative order to cease all operations at the site, and initiate remediation procedures. As the first part of the emergency response the impounded liquids and drums were removed from the site. Grossly contaminated sediments were stockpiled and surface water runoff was restricted by placing a berm around the site. In 1984 the remaining surface facilities were removed. The site was graded and a fill layer placed over the area and portions of the site were paved.

During that early phase of remediation 73 contaminants were found in soil samples including 20 metals and 53 organics. Forty-six priority pollutants were found in the groundwater, Including both metals and organics.

The final phase of remedial planning was a subsurface investigation initiated by HDR Infrastructure, Inc. That Investigation included extensive use of geophysics to guide the drilling and sampling effort. Electromagnetic and magnetic methods, and ground penetrating radar were used.

GEOLOGIC SETTING

The Western Processing site is in the city of Kent, between Seattle and Tacoma, Washington. The site is near the center of the Duwamish Valley, once a marine embayment, which is now filled with up to 500 feet of Recent fluvial and lacustrine deposits (Luzier, 1969). Groundwater In the valley typically occurs at less than ten feet, while low areas may be completely saturated during wet periods. Sediments at the site are generally silty sands and sandy silts, with local discontinuous silty clay layers.

GEOPHYSICAL APPROACH

The objectives of the overall study were to evaluate the precise nature and extent of contaminated materials to be removed from the site, and to assist in determining the extent of remedial actions necessary in adjacent areas. Specific objectives of the geophysical survey were to:

1) Locate buried drums, tanks, utilities and process lines on the site, and

2) Determine the locations of all abandoned or active utilities, process lines or other pipes leaving the site and crossing into adjacent areas.

Three geophysical methods were selected to accomplish those objectives:

1) Electromagnetic Induction (EM) utilizing the Geonics EM-31. Both inphase and quadrature (conductivity) data were collected.

2) Magnetic methods utilizing an EDA Omni IV magnetometer. Total magnetic field and the vertical gradient of the total field were collected. The total field data were corrected to a base station maintained at the site.

3) Ground penetrating radar (GPR) utilizing a GSSI System 8 with a 120 MHz antenna.

We will not go into details of these techniques or instruments, as the have been amply covered in the invited papers for this seminar.

GEOPHYSICAL RESULTS

A survey grid with 10 foot line spacing was established over the entire site. EM and magnetic data were collected along the lines at ten foot intervals. GPR data were collected with a 20 foot line spacing.

Electromagnetic Results

EM methods proved the most effective of the three techniques in locating buried objects and also yielded information about soil character, or conductive groundwater contaminants. Figure 2 shows an example of inphase conductivity data over an anomalous area. The anomalies indicated were later confirmed by excavation to be groups of 55 gallon drums. Generally, a strong negative inphase value (< -10 ppt) was thought to be suggestive of the presence of near-surface metallic objects.

Figure 3 is a map of the site showing the 100 mmho/m contour. A large area In the northern part of the site has conductivities above 100 mmhos/m. That high conductivity zone corresponds to an area which formerly contained several surface Impoundments, and which presently contains the surface water collection impoundment. The high conductivities are interpreted as areas of ground-water contamination. It should be noted that the high conductivity area extends to the west of the site to Mill Creek, a surface water drainage conduit.

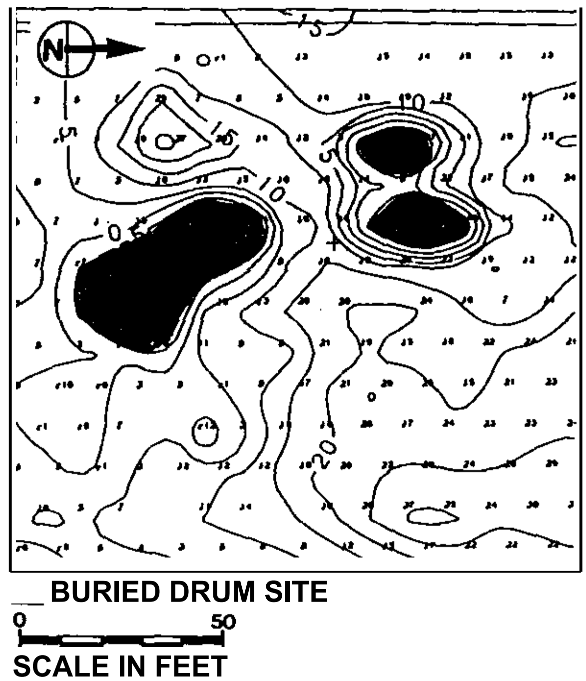

FIGURE 2: EM-31 inphase component map; Multiple burled drum site.

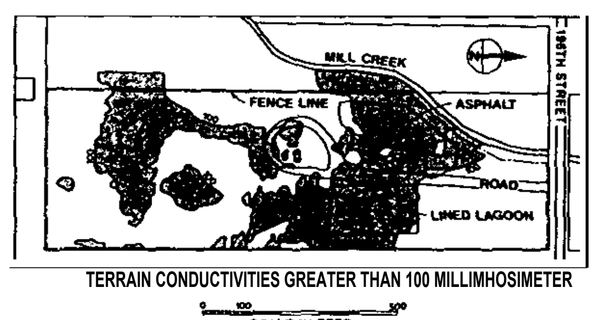

FIGURE 3: Areas of anomalous terrain conductivities;
Conductive soils and groundwater plumes.

Choice of the 100 mmho/m contour Is of course somewhat arbitrary. The boundaries of a contaminant plume will be gradational, as will the terrain conductivity. Other soils In the site had conductivities ranging from 5 to 50 mmhos/m, but there was considerable variation due to burled metallic objects. The 100 mmho/m contour was subjectively selected as one which would best Illustrate the suspected form of the anomalous area.

Magnetometer/Gradiometer Results

Magnetic methods offered better resolution of metallic objects than the EM, and was perhaps sensitive. The gradient data clearly resolved some features which had been poorly defined anomalies. However, the high voltage powerline down the eastern border of the property, strong interference and effectively wiped out a 50-60 foot swath of data. Power line varied markedly from day to day.

Figure 4 is a magnetic gradient plot over the same drum dusters for which EM data was shown figure 2. In addition to the cluster of drums, also seen on the EM data, the magnetic gradient shows several other minor features. This gave a noisy character to the data, but the small variation can probably be attributed to small, near surface metallic objects.

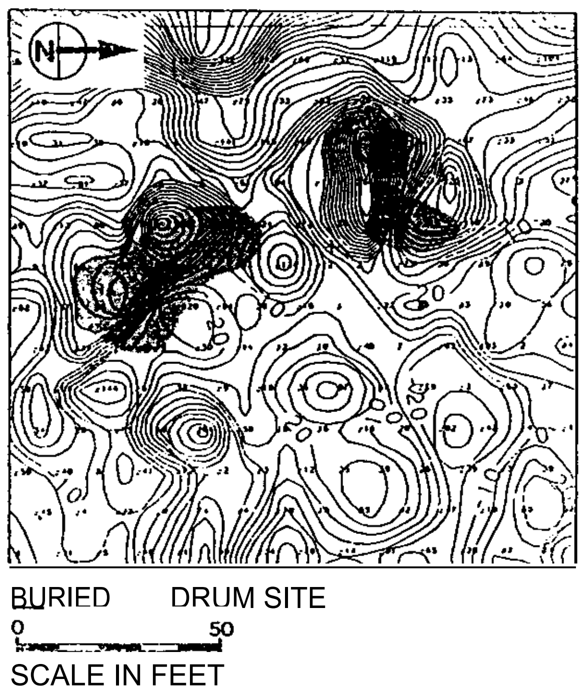

FIGURE 4: Vertical magnetic gradient map; Multiple buried drum site.

Ground Penetrating Radar Results

Due to the relatively high soil conductivities on the site, penetration of the radar signal was to ten feet or less in most areas. A large number of radar 'targets' were observed along the GP profiles, although identification of the nature of the subsurface objects was not possible from the radar signatures. The locations of these anomalous radar targets were posted on a map of the sit and were incorporated in a composite geophysical anomaly map. Due to the abundance of radar 'targets' and their ill defined character, more emphasis was placed on the EM and magnetic data ft the final interpretation.

Composite Interpretation

Results of the survey were summarized in a 'composite geophysical anomaly map'. That map outlined regions which appeared anomalous on either the EM or magnetic data sets. Those anomalies were numbered and tabulated. The table indicated which data sets contained that anomaly and other comments on ft's geophysical signature. Air photos of the old facilities and other historic information were also used to identify possible causes of the anomalies. A number of the anomalies were excavated to identify the features and to remove possible sources of contaminants.

One notable feature was a utility corridor, which is most evident on the conductivity contour plot (Figure 5). That corridor contained several pipes from former process lines, and extended off site to the east. There was no surface expression of the utility corridor, and its presence had not been suspected. It was subsequently excavated and samples taken from the region surrounding the pipes, as well as samples of the pipe contents.

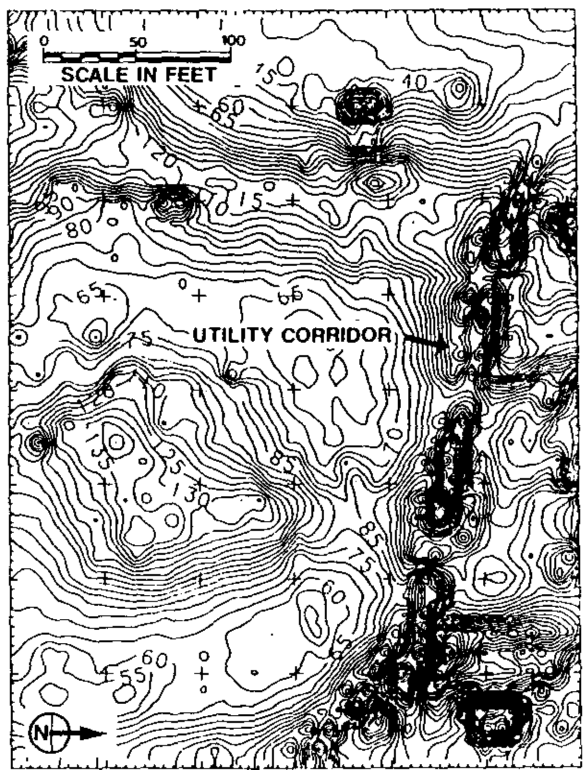

FIGURE 5: EM-31 terrain conductivity signature; Buried utility corridor.

SUMMARY

The geophysical program undertaken at the Western Processing site successfully identified several areas of concern for the remediation program. Those areas included both areas of high soil conductivity, and isolated geophysical 'targets'. The results of the geophysics were used to direct an extensive sampling program which followed the geophysical work.

ACKNOWLEDGEMENTS

We would like to acknowledge HDR Infrastructure, Inc. who was the prime contractor on project, and particularly Ken Lepic who was the HDR project manager. We also thank The Company for allowing release of the data.

REFERENCES

CH_2M Hill, 1984, Remedial Investigation Data Report, Western Processing, Kent, Washington: EPA Hazardous Site Control Division, Document # EPA WA 37-OL16.1, Dec. 17, 1984.

Luzier, J.E., 1969, Geology and groundwater resources of southwestern King County, Washington. Washington Department of Water Resources, Water Supply Bulletin No.28.

BIOGRAPHICAL SKETCH

ROWLAND FRENCH has worked the last ten years in engineering, mining and petroleum He joined ERT in 1987 where he is currently responsible for the geophysical programs for waste and geotechnical applications for 13 company offices nationwide.

Before joining ERT, Rowland worked for Sohio Petroleum in their gravity, magnetic and methods group, and for Geo-Physi-Con Co.Ltd. He received an A.B. from Dartmouth College and Ph.D. in Geology (geophysics) from the University of Michigan.