TASC Soil Gas Analysis Technique

CASE HISTORY THREE

Turner Valley Gas Plant Site Assessment

This case history presents a summary of the results of a 1994 environmental investigation in which the TASC technique was used as part of a detailed investigation to assess and delineate unknown organic contamination at the Turner Valley gas plant near Turner Valley, Alberta. The project was conducted for the Province of Alberta government by the Alberta Community Development department. Klohn-Crippen Consultants Ltd. was the prime consultant.

The key features of the site included:

- The Turner Valley gas plant is the oldest sour gas processing facility in Canada
- The site was in operation from the 1913 to 1985
- The site history suggested mixed contaminants in various areas
- Extensive underground utility and service lines including pipelines within the area
- Low overhead pipe racks resulting in limited drill rig access
- Large site size

The TASC technique identified the presence of several distinct volatile organic hydrocarbon plumes in the subsurface.

The use of TASC in conjunction with conventional geophysics and drilling investigation techniques allowed accurate delineation of the volume and nature of the site contamination.

1. Background

The Turner Valley gas plant, constructed 1913, was the first petroleum production facility in western Canada. Shortly after decommissioning in 1985, the plant was acquired by the Alberta government for the purpose of historical preservation.

Several environmental site assessments were conducted between 1987 and 1991 to identify surficial and subsurface contamination. The studies concluded that contamination consisted primarily of hydrocarbons in soil and groundwater, and sulphur contamination in the vicinity of the former sulphur storage area.

In 1994, Alberta Community Development commissioned a subsurface site characterization. The purpose was to identify the full extent of contamination and to develop a remediation plan. The resulting investigation consisted of:

- a visual site investigation

- application of surface geophysical techniques

- soil gas sampling

- drilling and monitoring well installation

- chemical analysis of groundwater samples

The geophysical study was conducted by Associated Mining Consultants Ltd. of Calgary, Alberta. It comprised of ground penetrating radar (GPR) and seismic refraction methods to map bedrock topography for subsequent hydrogeological studies. In addition, electromagnetic induction techniques were employed to identify contamination of soil and groundwater from the sulphur storage area, and to delineate buried pipes, tanks and other services.

The passive soil gas survey using the C5 Plus Group Ltd. TASC technique was conducted over the entire 12.5 ha area of the site. Its purpose was to characterize and delineate the extent of the organic contamination at the site.

The subsequent drilling, sampling and laboratory analysis programs were optimized based on the results of the geophysical investigation and the TASC investigation. The following sections summarize the site conditions and describe the TASC soil gas characterization program which was conducted at the site. A complete description of the program is presented in the report "Hell’s Half Acre Subsurface Assessment Program, Klohn-Crippen, February 1996".

2. Site Description

The Turner Valley Gas Plant is located on the left bank of the Sheep River (facing in a downstream direction), in the Town Of Turner Valley, Alberta, Canada. Turner valley is located in the foothills of the Rocky Mountains approximately 50 km south west of the City of Calgary, Alberta. The plant encompasses an area of approximately 12.5 ha.

The main physiographic features of the site are the Sheep River, a plateau, an upper terrace, and a lower terrace. The two terraces have been eroded out of the plateau by the Sheep River which bounds the south and east sides of the property. The bedrock outcrops from the plateau on the south end of the site. Springs emerge from the slopes at numerous points on the terraces. Most of these flow in the spring and early summer.

The geologic stratigraphy of the sites, from bottom to top, can be stated as follows:

- BedrockLowersand and gravel deposit
- Clay Till
- Upper sand and gravel deposit

Bedrock is the Alberta Formation which is a fissile dark grey silty shale, with some cherty sandstone beds, thick quartzite sandstone beds, carbonaceous shale, coal and glauconitic sandstone. Out crops at the site reveal that the rock is highly weathered and fractured. The axis of an anticlinal fold in the bedrock parallels the river. The elevation of the bedrock ranges from about 1205 m on the south west to 1190 m beneath most of the upper terrace and north end of the site.

The lower sand and gravel deposit is approximately 1 m to 2 m thick. It is present beneath both terraces and the plateau, with the exception of the upper terrace on the south east portion of the site.

The till deposit is a silty clay with some sand, gravel and cobbles. The thickest deposit, (approximately 12 m) is below the terrace. In the upper terraces it is about 1 m to 6 m thick and it has been eroded from the lower terrace.

The upper sand and gravel has been draped over the upper terrace and plateau and is about 1 to 3.5 m thick. The deposit is similar in appearance and texture to the lower unit and the two may merge on the lower terrace.

3. TASC Soil Gas Program

Fifty five (55) TASC soil gas samplers were provided to Klohn-Crippen Consultants Ltd. for installation at the gas plant. Two of the samplers were used as trip blanks and three samplers were field blanks. The samplers were installed in early November, 1994 and left in place for about 2.5 weeks. Forty nine samplers were returned to C5 Plus Group Ltd., along with a table of survey coordinates and an electronic drawing file, describing the site and the location of each sampler.

All of the samplers were analysed using the standard TASC soil gas survey protocol adopted by C5 Plus Group Ltd. This protocol is intended to identify the range and relative distribution of total and specific volatile organic compounds, which are present in the subsurface soil gas. The technique allows the precise indication of the presence of 30 US EPA Priority Pollutant chemicals.

4. RESULTS

A total of 258 different volatile organic compounds were found. 30 US EPA Priority Pollutants were examined for possible presence in the samples. They included:

benzene

toluene

ethyl benzene

o-xylene

m-xylene

p-xylene

o-dichlorobenzene

m-dichlorobenzene

p-dichlorobenzene

1,2,3-trichlorobenzene

1,2,4-trichlorobenzene

1,3,5-trichlorobenzene

1,2,3,4-tetrachlorobenzene

pentachlorobenzene

hexachlorobenzene

acetone

methyl isobutyl ketone (MIBK)

methyl ethyl ketone (MEK)

dichloromethane

1,1-dichloroethane

chloroform

1,2-dichloroethane

1,1,1-trichloroethane

carbon tetrachloride

1,2-dichloropropane

trichloroethylene

(cis) 1,3-dichloropropene

(trans) 1,3-dichloropropene

1,1,2-trichloroethane

perchloroethylene

17 US EPA priority pollutants were detected including:

benzene	p-xylene	1,2,3-trichlorobenzene	1,1-dichloroethane
toluene	o-dichlorobenzene	pentachlorobenzene	1,2-dichloroethane
ethyl benzene	m-dichlorobenzene	acetone	1,1,1-trichloroethane
m-xylene	p-dichlorobenzene	dichloromethane	carbon tetrachloride
			perchloroethylene

C5 Plus Group Ltd. assessed the possible presence of normal alkanes, in the C6 to C15 range. All these normal alkanes were detected. The results suggest that lighter hydrocarbons may also be present.

5.0 Distribution of Subsurface Contamination

In previous TASC soil gas surveys, the relative abundance of hydrocarbons found in the TASC samplers correlated well with precise quantification of contaminants in the underlying soil and groundwater media. For example, high relative abundance corresponded with locations where high concentrations were found. Consequently, C5 Plus Group Ltd. presents the data in the form of contour maps. However, it should be recognized that high relative abundance in soil gas does not necessarily imply that the concentration of that compound, in the subsurface environment, exceeds any regulatory limits. Detailed sampling of that media would be required for actual quantitation. In addition, the accuracy of the areal distribution as presented, is dependent on the number of sample locations.

In this case, a broad scan was used to identify apparent areas of high and low concentration and a relatively wide data point distribution was used. Therefore, the exact contour boundaries may vary from those presented.

The compounds that were found were divided into four groups, based on chemical properties and common regulatory guidelines. These groups are:

- Total Compounds
- BTEX
- Chlorinated Compounds
- Acetone

Figures 1 to 4 are contour maps showing the relative abundance distribution of each group. The data are corrected for the field blank effects and, due to the wide range of abundance encountered, are presented in a log scale. The following paragraphs present a brief discussion of each figure.

5.1 TOTAL COMPOUNDS (Figure 1)

Total compounds ranged over three orders of magnitude at the site. The highest concentration appears to be associated with the south end of the horizontal tank farm at coordinates 5614600 N, -18900 E. Secondary concentrations appear near the sulphur plant (5614825 N, -18875 E), lab building (5614900 N, -18970 E) and the line trending from south-west to north-east from approximately 5614700 N, --19100 E to 5614900 N, -18850 E. Both extremities of this trend have data points beyond the bold property line.

5.2 BTEX (Figure 2)

With the exception of an apparent increase in BTEX compounds on the south-west property line at 5614550 N, -19150E, benzene, toluene, ethylbenzene and xylenes (BTEX) appear to follow a similar pattern to the total compounds discussed above

5.3 CHLORINATED COMPOUNDS (Figure 3)

Three areas of high relative abundance of chlorinated compounds are apparent. The highest abundance is again near the horizontal tank farm. Other areas of high abundance appear near the north side of the lab building at 5614925 N,-18975 E and beyond the property line to the west at about 5614750 N, -19075 E as well as at 5614550 N, -18900 E near the south property line. The chlorinated compounds identified in section 2 are common solvents and may have been used routinely at the site.

5.4 ACETONE (Figure 4)

Acetone forms a U-shaped signature surrounding the horizontal tank farm. The highest abundance of acetone appears to be associated with low abundance of other compounds. This signature may be associated with areas of active aerobic biodegradation of organic compounds since acetone is an intermediary product of this process. The areas of low acetone abundance may reflect either excessive hydrocarbon concentration or other conditions limiting aerobic decomposition.

6. CONCLUSIONS

The TASC soil gas technique was found to be effective in delineating hydrocarbon contamination at the site.

The drilling and sampling program conducted subsequently to the soil gas survey confirmed the location and distribution of all compounds detected, including chlorinated solvents.

Klohn-Crippen concludes:

"Chlorinated organic compounds were detected with a passive soil gas survey and subsequent analysis of groundwater for absorbable organic halogens (AOX) confirmed that dissolved halogenated compounds may be present in the groundwater. The concentration of AOX ranged from 0.35 mg/L to 0.62 mg/L where it was detected."

In this case the TASC technique proved effective for optimizing both the drilling and detailed analysis programs at a complex industrial site.

Figure 1 Total Organic Compounds Detected

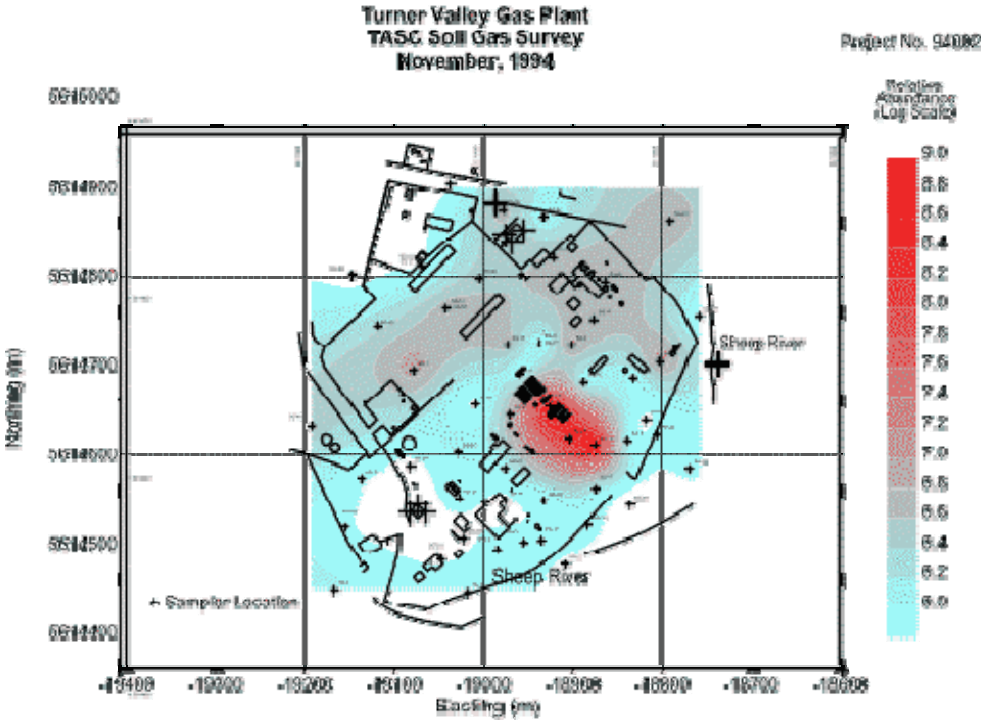

Figure 2 BTEX

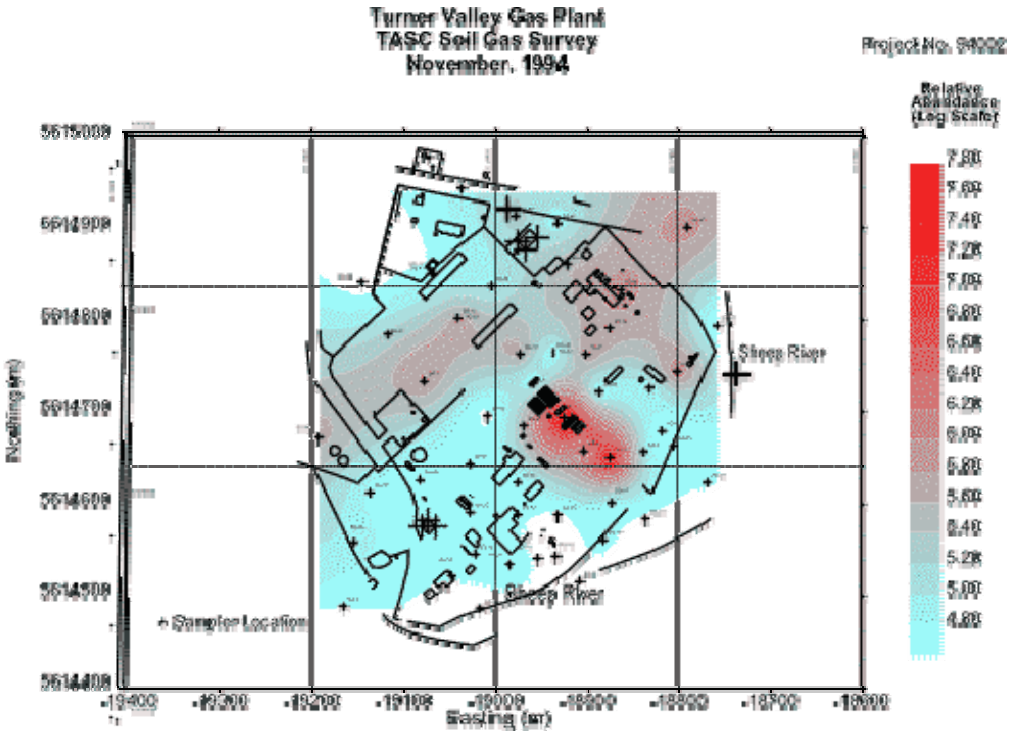

Figure 3 Chlorinated Compounds

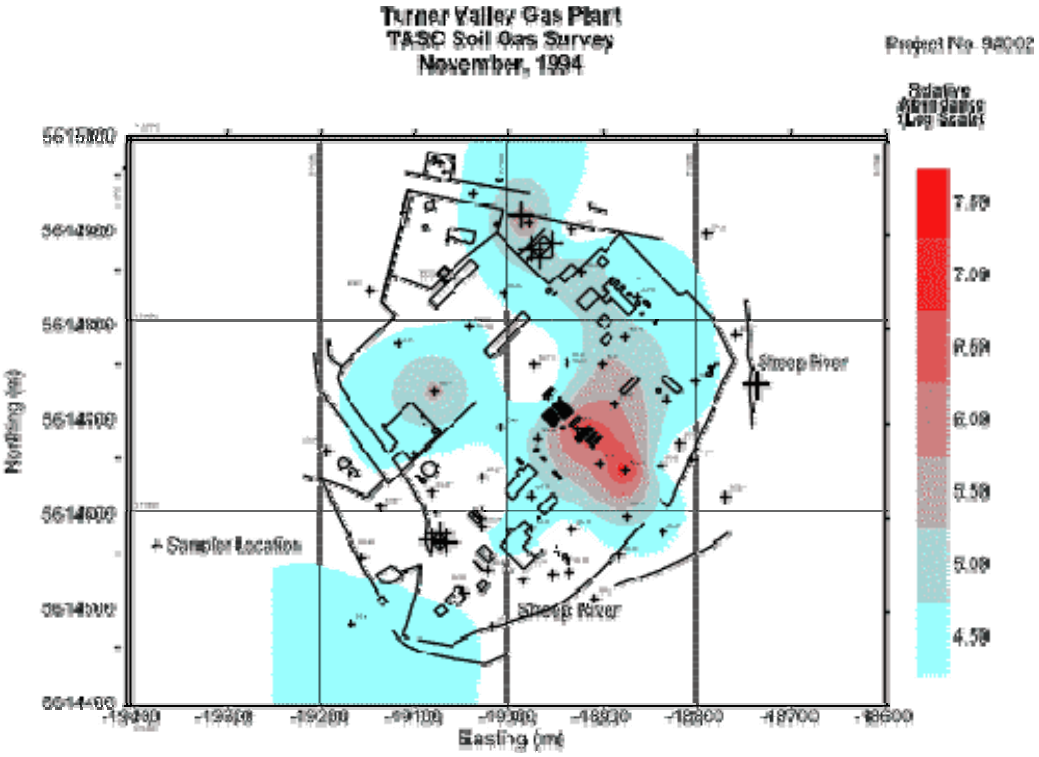

Figure 4 Acetone

Turner Valley Gas Plant
TASC Soil Gas Survey
November, 1994

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