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NAVAL SUPPORT ACTIVITY MEMPHIS
MILLINGTON, TENNESSEE

PASSIVE SOIL-GAS EVALUATION

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Prepared for:

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1.0 INTRODUCTION

To evaluate passive soil gas as a preliminary screening tool for placing monitoring wells at The Naval Support Activity (NSA) Memphis, EnSafe/Allen and Hoshall (E/A&H) compared three different passive soil-gas techniques. Specific objectives were to assess whether passive soil-gas sampling was viable at NSA Memphis and if so, which method would be better suited for further investigation. First, two conventional techniques from separate competitive vendors were compared. After both conventional methods failed to detect known contaminants at solid waste management unit (SWMU) 2, a third method developed by the U.S. Geological Survey (USGS) was tried.

Passive soil-gas samplers from two vendors — Quadrel Services Inc., and TEG — were installed in the alluvium at three locations around SWMU 2. One previously screened non-contaminated location near monitoring well MW002G11UA was used as a control point to determine background conditions. Two locations of known groundwater contamination near monitoring wells MW0GMG04UA and 002G03DA were used to investigate whether the method would detect contaminants and to compare results for each technique to previously detected concentrations. In addition to locations near SWMU 2, extra samplers from Quadrel were placed at two locations near monitoring well cluster BG5 to determine whether the method could detect contaminants previously identified in the fluvial deposits aquifer at this location.

The method provided by TEG is a conventional Vapor Tec passive soil-gas analysis. This method uses an activated sorbent, usually charcoal, in a 20-milliliter (ml) glass vial, which is then inserted into a borehole at least 1 inch in diameter and allowed to remain for a specific amount of time (usually 1 to 3 weeks), depending on the contamination source. The vial is then retrieved and shipped offsite for analysis.

Results are qualitative and of little quantitative value. They can be compared quantitatively to each other, but they do not represent accurate soil or groundwater concentrations.

The passive soil-gas method developed by Quadrel uses an activated charcoal collector similar to that of TEG but the deployment schedule is different. The Quadrel schedule is based on a gravitational phenomenon known as "earth tides" or fluctuations in the gravitational forces acting on the earth. Calculating earth tides allows Quadrel to capture peak soil-gas emissions for a specific geographic location. The high gravitational force exerted on the earth by nearby solar, lunar, and planetary bodies causes pores within the soil to open. The pores act as reservoirs that collect soil gas. The most favorable sampling time occurs when the gravitational force is relieved, the pores collapse, and soil gas is emitted from the closed pores. Two advantages of this system are reduced exposure times (three days) and semi quantitative results based on exposure duration. While the results are not directly comparable to soil or groundwater sampling results, they are theoretically more quantitative than those provided by the TEG method.

The USGS passive soil-gas method relies on the collection and analysis of ambient soil gas (USGS, 1996). An open empty sample container is simply sealed in a clear polyethylene bag and placed in a covered hole in the ground for 1 to 5 weeks. Eventually, volatile gasses moving through the soil pass through the polyethylene bag and reach equilibrium concentrations in the container. For retrieval, the container is collected and capped without removing the bag.

After retrieval, the soil-gas samplers were analyzed for selected volatile organic compounds (VOCs) from EPA Method 8021 including trichloroethylene (TCE) and related halogenated hydrocarbon compounds.

2.0 METHODOLOGY

Specific methods outlined by each vendor or the USGS were followed during installation, collection, and analysis of soil-gas samples.

2.1 Field Procedure for Installation of Samplers

The TEG method used a 20-ml glass vial to house the sorbent material instead of the 7-ml vial used by Quadrel. The Quadrel method also provides specific times for installation of the soil-gas vial. The USGS method used an empty 40-ml glass vial sealed inside a polyethylene bag.

The first step was to bore a hole less than 2 inches in diameter to at least 6 inches below ground surface to protect and conceal the vial. The cap and septum were then replaced with a screen in the Quadrel method, a poly bag in the USGS method, and nothing in the TEG method. A wire was placed around the vial for marking and retrieval, and the vial was turned with the open end facing down in the borehole. The hole was then backfilled with either tin foil, then native soil, or just native soil.

The Quadrel samples came with the components for a 5-point soil-gas survey, plus sufficient additional cartridges for one control sample (marked A) and one trip blank. The sample numbers, dates and times of installation and retrieval, and sample locations are listed in Table 2-1. The devices were deployed before 3 p.m. November 23, 1996, and retrieved during the morning of November 26, 1996.

TEG shipped a total of seven vials, which were to be placed at three separate locations. One vial was to be placed at a previously "clean" site and groups of three each at two other locations. The groups were deployed so that samples could be retrieved at three different time intervals. The three time intervals were intended to provide information on the optimum length of deployment. Table 2-2 lists each sample number, date of installation, date and time of retrieval, and sample location.

Table 2-1
Quadrel Services Samples

Sample Number	Date and Time of Installation	Date and Time of Retrieval	Sample Location
Sample # 1	11/23/96 at 1145	11/26/96 at 0930	18' West of 002G11UA
Sample # 2	11/23/96 at 1245	11/26/96 at 0925	16' Northwest of 0GMG04UA
Sample # 3	11/23/96 at 1220	11/26/96 at 0950	32' East of 002G03UA
Sample # 4	11/23/96 at 1420	11/26/96 at 1010	20' North of BG5 Cluster Well
Sample # 5	11/23/96 at 1435	11/26/96 at 1037	500' East of BG5 Cluster
Sample A	11/23/96 at 1148	11/26/96 at 1043	Collected near Sample # 1

Table 2-2
TEG Samples

Sample Number	Date of Installation	Date and Time of Retrieval	Sample Location
Sample # 1	11/23/96	12/17/96 at 0945	18' West of 002G11UA
Sample # 2a		11/26/96 at 1014	
# 2b	11/23/96	12/03/96 at 1530	16' Northwest of 0GMG04UA
# 2c		12/17/96 at 1013	
Sample # 3a		11/26/96 at 0952	
# 3b	11/23/96	12/03/96 at 1550	32' East of 002G03UA
# 3c		12/17/96 at 1022	

Standard laboratory-cleaned 40-ml vials were used to collect samples for the USGS method. Table 2-3 lists sample numbers, date of installation, date and time of retrieval and sample locations for USGS samples.

Table 2-3
USGS Samples

Sample Number	Date of Installation	Date and Time of Retrieval	Sample Location
Sample # 1	4/18/97	5/1/97 at 0812	Study Location 1
Sample # 2	4/18/97	5/1/97 at 0800	Study Location 2
Sample # 3a	4/18/97	5/1/97 at 0924	Study Location 3
Sample # 4a	4/18/97	5/1/97 at 0825	Study Location 4

Figures 2-1 and 2-2 show the locations where the passive soil-gas vials were installed.

2.2 Exposure Time

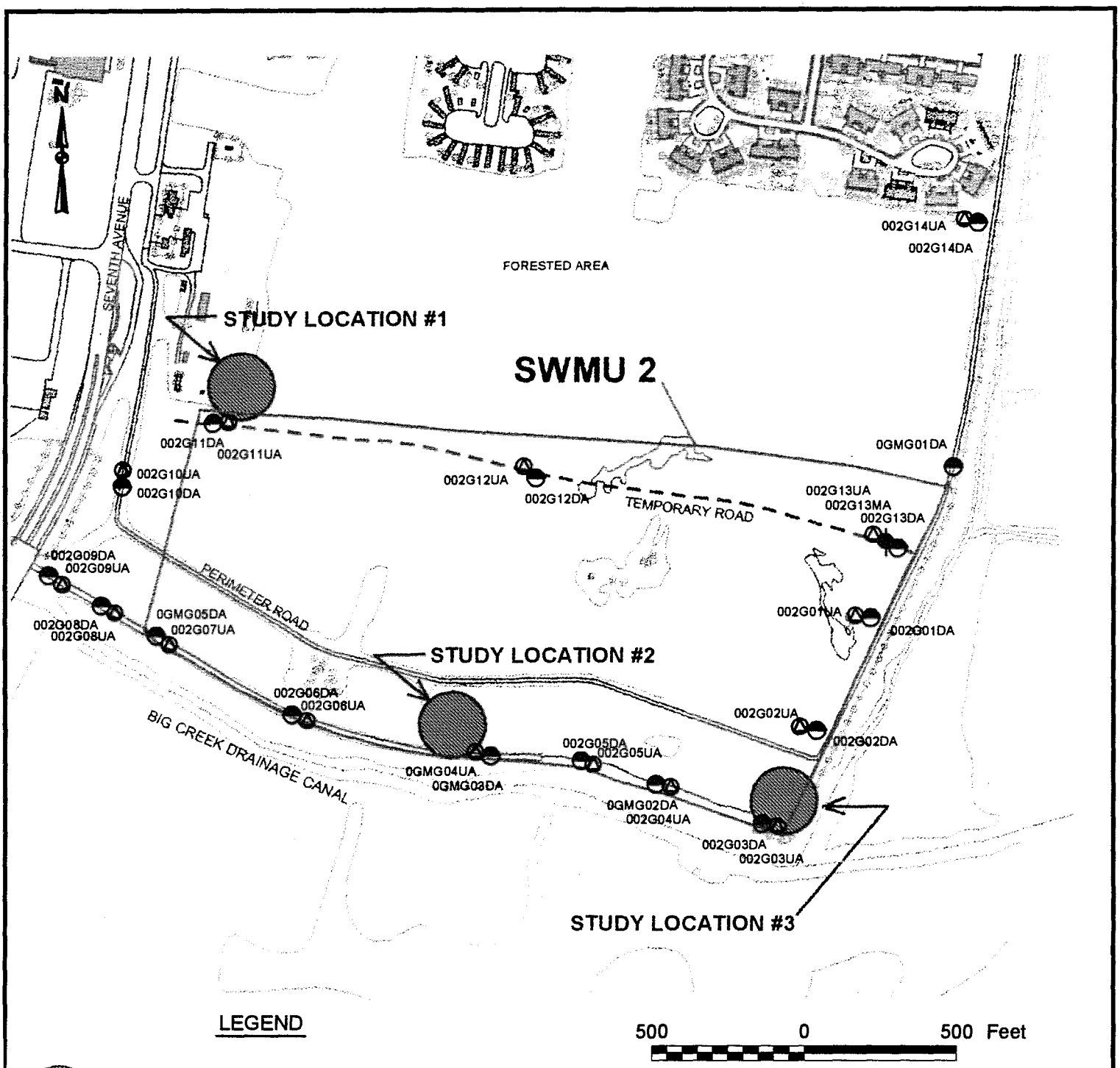
With the TEG method the following exposure times are recommended:

- Underground storage tanks, surface contamination — 1-3 days
- Soil or shallow groundwater (≤10 meters) — 3-10 days
- Deep groundwater (≥10 meters) — 10-30 days

For the Quadrel method, the vial is left in the ground for 72 hours. A one- to five-week installation is recommended for the USGS method.

2.3 Retrieval Methods

After the proper exposure time, the vials were withdrawn from the borehole and sealed by replacing the caps. The tube was then sent to the appropriate vendor or laboratory for analysis. A control sample for the Quadrel samples was exposed to ambient surface air at the time of installation and retrieval.



LEGEND

500 0 500 Feet

SOIL GAS STUDY AREA

002G11UA — UPPER ALLUVIUM MONITORING WELL LOCATION AND DESIGNATION

002G13MA — MIDDLE ALLUVIUM MONITORING WELL LOCATION AND DESIGNATION

002G03DA — DEEPER ALLUVIUM MONITORING WELL LOCATION AND DESIGNATION

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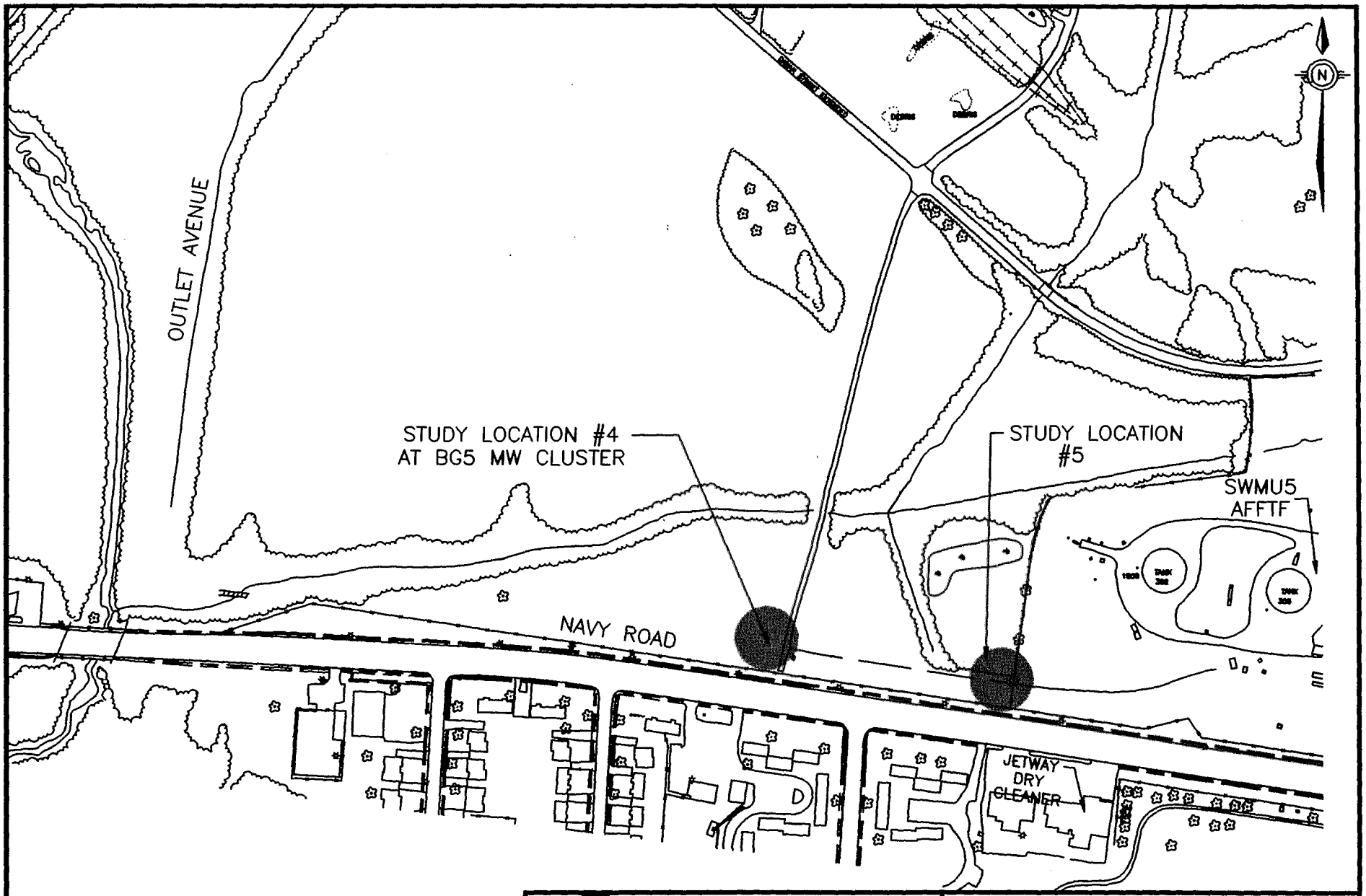
FIGURE 2-1
STUDY LOCATIONS #1, #2, AND #3
SOIL GAS SURVEY EVALUATION



300 0 300
SCALE FEET

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FIGURE 2-2
STUDY LOCATIONS #4 AND #5
SOIL GAS SURVEY EVALUATION

DWG DATE: 01/27/97 | DWG NAME: 094VSGSE

3.0 RESULTS

Soil-gas results were compared to results from soil boring, monitoring well, and direct push technology (DPT) samples collected at each study area to determine if the soil-gas numbers correlated with actual contaminant concentration data.

3.1 Comparison of Results for Study Locations # 1, #2 and #3

Study Location #1 served as a background test area because no TCE or related compounds were detected in the soil or groundwater samples from monitoring wells 002G11UA and 002G11DA and DPT sample 002G0023. As expected, no TCE or related compounds were detected by any of the three test methods at this location.

Table 3-1 compares sample results from wells 0GMG04UA and 0GMG03DA (Study Location #2) to the Quadrel sample #2 results. The three samples retrieved at separate intervals from TEG and the USGS sample from this location are not presented on the table because no detectable concentrations of contaminants were identified in them. Additionally, the Quadrel sample contained no detectable quantities of TCE or related compounds.

Table 3-2 compares sample results from Quadrel sample #3 with the results from wells 002G03UA and 002G03DA (Study Location #3). Again, the three samples retrieved at separate intervals from TEG and the USGS sample from this location are not presented on the table because they did not contain detectable concentrations of contaminants.

Table 3-1
Location #2 — Comparison Between Conventional Data and Quadrel Soil Gas Results

		1st Event Groundwater			2nd Event Groundwater*	
Detected Compound	**Quadrel Services**	**0GMG04UA**	**0GMG03DA**	**DPT Groundwater**	**NET 8240**	**Ceimic 8021A**
2-Butanone	48 ppt	u	u	u	u	u
Toluene	u	5J ppb	u	u	6J ppb	5.2 ppb
Benzene	u	2J ppb	u	u	u	u
Ethylbenzene	u	41 ppb	u	u	u	u
Xylene	u	180 ppb	u	u	u	u
TCE	u	u	u	18.2 ppb	u	u

Notes:
u = non detect
J = estimated value
ppb = parts per billion
ppt = parts per trillion
* = Two separate laboratories were used for the second event.

3.2 Comparison of Results for Study Locations #4 and #5

Background well cluster BG5, located at Study Location #4, was available for comparison at that location. However, no groundwater or DPT samples were collected at Study Location #5; therefore, it was compared to the BG5 well cluster results. Table 3-3 presents a compares results from Quadrel soil-gas samples at Study Locations #4 and #5 to background well cluster BG5 groundwater data. Results of the USGS sample placed at Study Location #4 are not presented because the sample had no detectable contaminant concentration. No TEG samples were placed at Study Locations #4 and #5.

Table 3-2
Location #3 — Comparison Between Conventional Data and Quadrel Soil Gas Results

		Soil Results	1st Event Groundwater		2nd Event Groundwater	
Detected Compound	**Quadrel Services**	**002SMW0302 002SMW0310 002SMW0316**	**002G03UA 002G03DA**	**DPT Groundwater**	**NET 8240**	**Ceimic 8021A**
Tetra-chloroethene	52 ppt	u	u	u	u	u
Toluene	38 ppt	u	u	u	u	u
TCE	u	u	u	11.1 ppb	260D ppb	u
Vinyl Chloride	u	u	u	u	46 ppb	24 ppb
1,2- Di-chloroethene	u	u	u	u	770D ppb	1,220D ppb
1,1,2-Tri chloroethane	u	u	u	u	7J	u
2-Butanone	u	8J ppb at 2'	u	u	u	u

Notes:
u = non detect
J = estimated value
D = value after dilution
ppb = parts per billion
ppt = parts per trillion
* = Two separate laboratories were used for the second event.

Table 3-3
Locations #4 and #5 — Comparison between Quadrel and Conventional Groundwater Data

Detected Compounds	**Quadrel #4**	**Quadrel #5***	**0BGG05LF01**	**0BGG05LS01**	**0BGG05UF01**
Tetrachloroethene	34 ppt	85 ppt	28 ppb	u	19 ppb
Trichloroethane	u	38 ppt	u	u	u
Chlorobenzene	u	72 ppt	u	u	u

Notes:
u = non-detect
ppb = parts per billion
ppt = parts per trillion
* = Location #5 is approximately 500 feet east of BG5 well cluster.

4.0 CONCLUSIONS

4.1 Study Location #1

All methods suggest that the area surrounding Study Location #1 is non contaminated. The results indicate an absence of false positives for all methods.

4.2 Study Location #2

None of the three soil-gas methods detected concentrations of known contaminants at Study Location #2. Apparently, these methods lack the proper sensitivity necessary to detect the conventionally identified contaminants under the conditions present at this location.

4.3 Study Location #3

Although Study Location #3 had the highest concentrations of known contaminants, none was detected by the three soil-gas methods. The Quadrel sample did show concentrations of tetrachloroethene and toluene, even though these compounds were not detected by conventional sampling methods. Results from this location are consistent with those of Study Location #2, which indicate that passive soil-gas methods are not a viable screening technology for the SWMU 2 area.

4.4 Study Locations #4 and #5

Although the USGS method detected no contaminants at Study Location #4, the Quadrel method did have some level of success identifying tetrachloroethene (PCE) at this location. Both the Quadrel results and the groundwater sample results indicate the presence of this compound at Study Location #4, suggesting that passive soil gas might be a viable screening technology for fluvial deposits contamination. The higher PCE soil gas concentration at Study Location #5, as well as comparable concentrations of TCE and chlorobenzene, may warrant further investigation in this area.

4.5 Further Testing

Unsatisfied with their results from the first test, Quadrel offered to analyze 10 more soil-gas samples at no charge. For this second test, samplers were placed to repeat testing at Study Locations 1 through 3 at SWMU 2. Seven additional samplers were placed at SWMU 2 and on the airfield apron near wells 007G10LF and 007G11LF to expand the second test. Results from the second test samples did not correlate with any of the know contaminants at any of the selected locations. Several conventionally detected contaminants were not detected by the Quadrel method.

4.6 Method Evaluation

Based on the results of these tests, passive soil gas does not appear to be an effective screening tool for contaminant detection at SWMU 2 or the airfield apron. However, the method may have applicability for detecting PCE and related compounds in the fluvial deposits aquifer near the BG5 well cluster. Of the three methods evaluated, Quadrel's was the easiest to use, had the quickest turnaround time, and showed the most sensitivity. Although known contaminant concentrations were low at most test locations, the USGS and TEG methods were unsuccessful at detecting any contaminants.

5.0 REFERENCES

USGS, 1996, *Locating VOC contamination in a fractured-rock aquifer at the groundwater/surface water interface using passive vapor collectors*. Ground Water, Vol. 34, No. 2.