

MITIGATION OF VAPOR INTRUSION BY CHLORINATED SOLVENTS USING BIOREMEDIATION PRODUCTS AT A SITE IN YORK, PA: A CASE STUDY

SATYA GANTI, STEVE VEDDER & DINKAR GANTI

Mitigation of the chemicals of concern at the sub-slab source VP 3 through bioremediation was examined using VaporRemed. In the following table, values of PCE, TCE, and DCE were monitored after the addition of VaporRemed before, 2 hours after the addition of VaporRemed, and 24 hours after the addition of VaporRemed. Table 3 below shows the values recorded on three different occasions.

Location Id	Collection Date Time	Analyte	Result	Units
VP-3 (Before)	07/25/2018 09:00	Tetrachloroethene	55600	ug/m3
VP-3 (After)	07/25/2018 11:00	Tetrachloroethene	28400	ug/m3
VP-3 (Before)	07/25/2018 09:00	Trichloroethene	21900	ug/m3
VP-3 (After)	07/25/2018 11:00	Trichloroethene	11400	ug/m3
VP-3	3/4/2016 09:00	Tetrachloroethene	118000	ug/m3
VP-3	2/21/2018 09:00	Tetrachloroethene	107000	ug/m3
VP-3	5/17/2018 09:00	Tetrachloroethene	110000	ug/m3
VP-3	6/21/2018 09:00	Tetrachloroethene	32000	ug/m3
VP-3	7/25/2018 09:00	Tetrachloroethene	55000	ug/m3
VP-3	8/28/2018 09:00	Tetrachloroethene	15500	ug/m3
VP-3	3/4/2016 09:00	Trichloroethene	7300	ug/m3
VP-3	2/21/2018 09:00	Trichloroethene	7710	ug/m3
VP-3	5/17/2018 09:00	Trichloroethene	6750	ug/m3
VP-3	6/21/2018 09:00	Trichloroethene	15500	ug/m3
VP-3	7/25/2018 09:00	Trichloroethene	21500	ug/m3
VP-3	8/28/2018 09:00	Trichloroethene	11500	ug/m3
VP-3	3/4/2016 09:00	"cis-1,2-Dichloroethene"	32000	ug/m3
VP-3	2/21/2018 09:00	"cis-1,2-Dichloroethene"	23300	ug/m3
VP-3	5/17/2018 09:00	"cis-1,2-Dichloroethene"	92700	ug/m3
VP-3	6/21/2018 09:00	"cis-1,2-Dichloroethene"	434000	ug/m3
VP-3	7/25/2018 09:00	"cis-1,2-Dichloroethene"	86500	ug/m3
VP-3	8/28/2018 09:00	"cis-1,2-Dichloroethene"	147000	ug/m3

Table 1: Values of PCE, TCE, and DCE before and after addition of VaporRemed

Keywords: VaporRemed, Chlorinated Solvents, Remediation

It is seen from the Table 1 that there is a consistent reduction of both PCE and TCE after the addition of VaporRemed. The value of DCE, on the other hand, showed a significant increase in the values. This suggests the degradation of both PCE and TCE into DCE as has been proposed in the literature. The rate of decay was extrapolated based on the values recorded. A first order decay rate for PCE and an approximate second-order decay rate for TCE was calculated for data on 7/25/2018. PCE showed a decay rate of -800 % while the rate of decay for TCE was -762 %. These results clearly showed that VaporRemed is effective in mitigating the contamination in the sub-slab application. It was decided to determine if either PCE or TCE is toxic to the aerobic bacteria in VaporRemed.

The sustained population count indicates that the conditions at VP-003 and that PCE and TCE are not toxic to the bacteria in VaporRemed and indicates that the conditions in the sub-slab soil-gas location are not anaerobic and therefore support aerobic bioremediation.

Bacterial counts in VP-3 were determined between Mar 23rd and Mar 25th, 2020, as bacterial count is an important parameter for measuring the effectiveness of bioremediation. A sustained population indicates that the bacteria are able to utilize TCE and PCE. It also confirms that the conditions are not anoxic.

Number of Hours	Bacterial Count in CFU/ml*
After 2 hours	14,800,000
After 24 hours	15,300,000

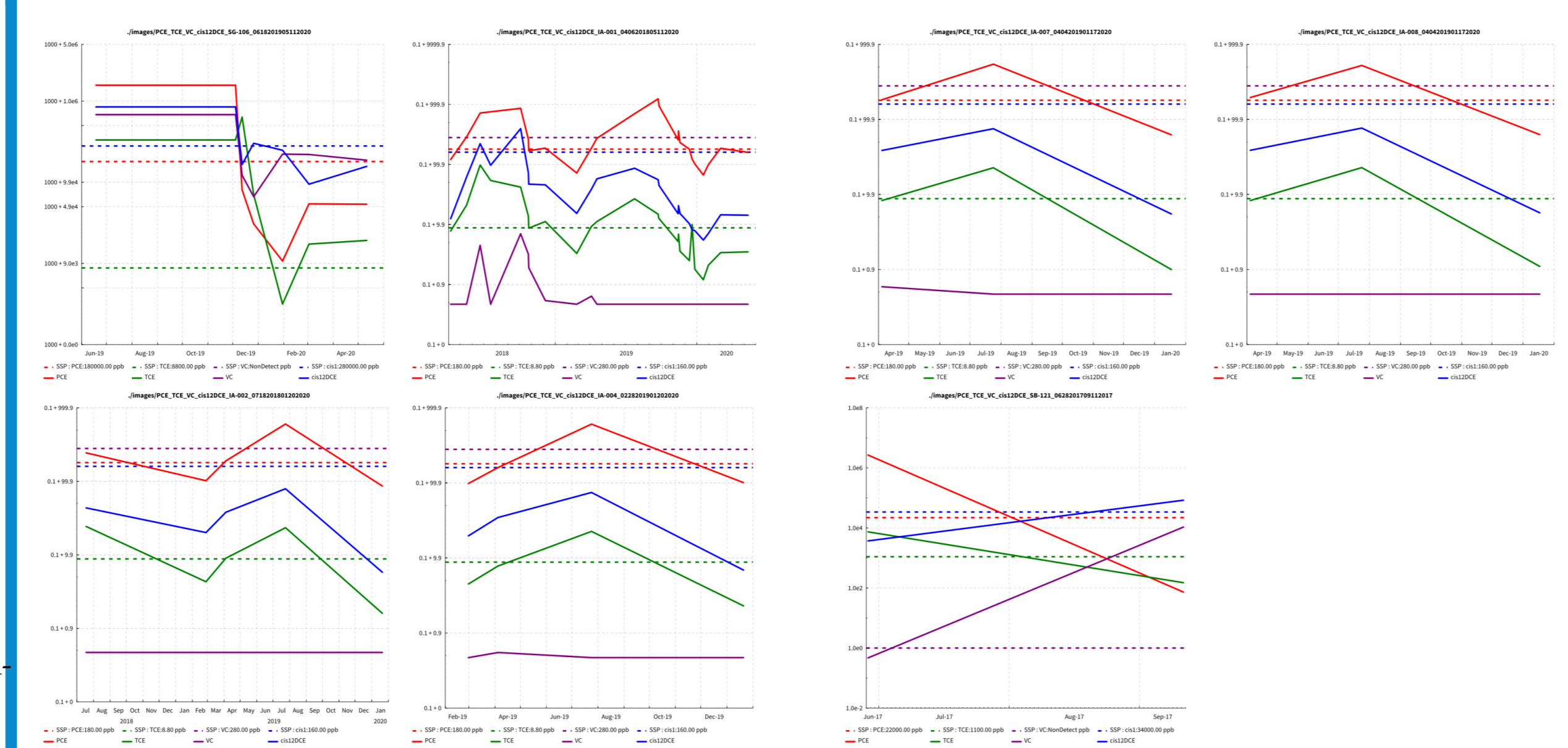
CFU/ml : Colony Forming Units/ml

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Conclusions

- VaporRemed has demonstrated enhanced aerobic bioremediation of chlorinated hydrocarbons in soil and sub-slab areas.
- VaporRemed has reduced the concentration of PCE and TCE in soil gas at location SG 106.
- The results show that SG 106 appears to be the active source of the contamination in the sub-slab sampling point VP 3.
- It is recommended that VaporRemed be considered to enhance the bioremediation of these contaminants and to reduce the cost of cleanup.

Earlier studies by other environmental companies generally restricted with delineation of soil and groundwater contaminations. Their studies did not include indoor air monitoring. Since TCE is known to be a carcinogenic, we believed that it was important to monitor TCE, PCE levels in indoor air. Prior to the present study, only once in 2016 was the indoor air levels measured in VP 3 and the data showed that the values of PCE and TCE showed exceedances in VP 3. However, there was no follow up action. During the one of our meetings with the DEP, it was suggested that we focus on the evaluation of sub-slab gas monitoring and also record the values in different rooms in the facility. These rooms are listed below.

- IA 001: Basement: Just outside VP 3 sub-slab sampling point.
- IA 002: Basement: the Middle room in the basement away from VP 3
- IA 003: Basement: Just below the warehouse and the loading dock
- IA 004: H Block closer to the rear parking lot away from VP 3
- IA 005: Restroom away from VP 3
- IA 006: A room identified as a Vault away from VP 3
- IA 007: Yoga room In the line of VP 3
- IA 008: WIS office in the line of VP 3
- IA 009: Ambient air on top of the warehouse away from VP 3
- IA 010: Store in the front D Block: Jewelry store away from VP 3
- IA 011: Store in the front C block away from VP 3
- IA 012: Store in Front C block away from VP 3

Indoor air in the basement was selected as the primary indicator of indoor air contamination. Thus, the sampling point IA 001 was selected to detect the changes after adding VaporRemed to VP 3. IA 001 was also closest to VP 3 which was already identified as a location of concern. The results are presented below.

Date	Location	PCE	TCE	DCE	VC
04/06/2018 08:35	IA-001	121.000000	7.800000	12.500000	0.470000
05/17/2018 09:00	IA-001	288.000000	21.000000	61.800000	0.470000
06/21/2018 09:00	IA-001	719.000000	97.800000	222.000000	4.500000
07/18/2018 09:00	IA-001	754.000000	54.100000	97.000000	0.470000
10/03/2018 16:15	IA-001	861.000000	41.900000	395.000000	7.000000
10/23/2018 16:10	IA-001	262.000000	13.800000	72.300000	3.200000
10/24/2018 16:00	IA-001	169.000000	8.700000	47.000000	1.900000
12/06/2018 09:00	IA-001	187.000000	11.200000	45.80000	0.540000
02/25/2019 09:00	IA-001	72.000000	3.300000	15.300000	0.470000
04/04/2019 09:00	IA-001	188.000000	9.300000	38.900000	0.640000
04/18/2019 09:00	IA-001	273.000000	11.200000	57.600000	0.470000
07/24/2019 09:00	IA-001	700.000000	26.800000	86.50000	0.470000
09/23/2019 09:00	IA-001	1240.000000	14.800000	55.600000	0.470000
09/24/2019 09:00	IA-001	1050.000000	12.900000	49.100000	0.470000
09/24/2019 17:00	IA-001	1050.000000	12.900000	49.100000	0.470000
09/25/2019 09:00	IA-001	939.000000	12.500000	44.400000	0.470000
09/25/2019 17:00	IA-001	939.000000	12.500000	44.400000	0.470000
11/13/2019 16:30	IA-001	257.000000	5.200000	15.100000	0.470000
11/14/2019 16:30	IA-001	360.000000	6.900000	20.600000	0.470000
11/18/2019 08:30	IA-001	232.000000	3.600000	15.300000	0.470000
12/12/2019 17:00	IA-001	180.000000	2.500000	10.300000	0.470000
12/19/2019 17:00	IA-001	123.000000	10.000000	8.200000	0.470000
12/26/2019 17:00	IA-001	102.000000	1.800000	7.900000	0.470000
01/17/2020 16:15	IA-001	66.700000	1.200000	5.500000	0.470000
01/30/2020 16:30	IA-001	99.500000	2.100000	7.100000	0.470000
03/02/2020 05:15	IA-001	186.000000	3.400000	14.500000	0.470000

Table 2: Values of PCE, TCE, and DCE before and after addition of VaporRemed