Controlled Methanogenesis during Remediation of a Recently Active Dry Cleaning Facility in an Urban Setting

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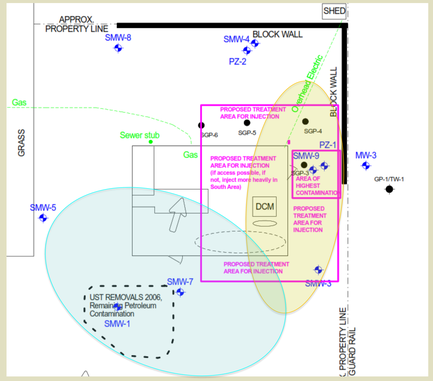
INTRODUCTION

Operations at a recently active dry cleaning facility resulted in releases of PCE. Near the suspected point(s) of release groundwater contained PCE (max. 82 ppm) plus relatively low levels of TCE (1.2 ppm), *cis* 1,2-DCE (1.5 ppm) and VC (<0.2 ppm). Groundwater was located ca. 10 ft bgs and the shallow aquifer was confined by dolomite bedrock at about 16 ft bgs. Contaminated groundwater migrated through interbedded silt and clay within a residential area. Mitigation was required to reduce the concentration of PCE, but given the urban setting (*i.e.,* homes with basements immediately adjacent to the targeted treatment area), the State of Wisconsin had special interest in assuring that the remedial action did not stimulate excessive methanogenesis which could create indoor air/vapor intrusion issues (methane production can induce contaminant migration) or cause other potential safety issues associated with high levels of methane.

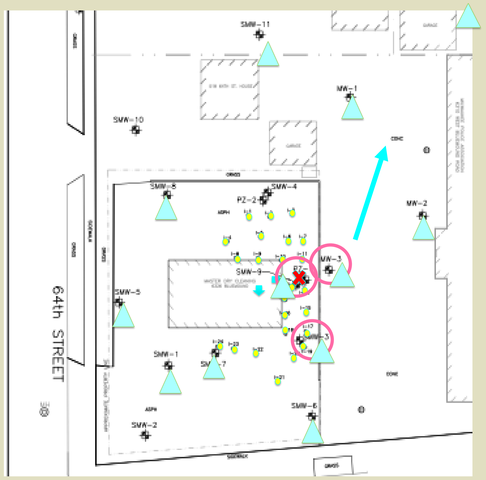
A thorough analysis of conventional (i.e., no active control of methanogens) remedial amendments (EHC®, EHC-L®, EZVI, Ferox-Plus™) and antimethanogenic Provect-IR® ISCR Regent considered cost, injection capabilities, and predicted performance. In addition to multiple technical advantages, only Provect-IR offered the ability to actively control methane production and it was identified as the best alternative for this site.

SITE CONDITIONS

- Former gas station 1950s to 1970s (USTs removed)
- Recently active dry cleaning operations (1970s to 2015)
- Shallow groundwater *ca*. 16 ft bgs (1 to 2 ft seasonal variation)
- Flows north at *ca*. 40 ft/year
- Interbedded silty sand and clay confined by bedrock *ca*. 20 ft bgs.
- PCE (max. 162 ppm),TCE (5 ppm) DCE (7.9) and VC (<0.2 ppm)
- BTEX impacts (max. 20 ppm) - Not Treated



PHASE ONE REMEDIAL ACTION



December 1-4, 2015
Provect-IR15
(15% weight basis of GMA-Fine ZVI)

- Targeted PCE source area SMW-9 ✖
  - 81,900 ppb PCE
  - 1,190 ppb TCE
  - 1,480 ppb *cis*-DCE
  - < 250 ppb *trans*-DCE
  - <176 ppb VC
- 24 direct push points
- 3,200 lbs Provect-IR @ 15-20 ft bgs
- 100 to 150 lbs per point (25% slurry)
- 5 to 10 gpm @ est. 50 to 100 psi
- No impacts in surrounding wells
- Sources (floor drain; back door)

Injection and post-remedial monitoring routinely (weekly / monthly) measured multiple parameters (DO/ORP, pH, temperature, water level) at 16 monitoring well locations (△). In addition, well-head gasses, indoor air vapor monitoring, vadose zone gas monitoring was conducted using an MSA Altair 4x four-gas meter (LEL Methane, oxygen, carbon dioxide, sulfur dioxide) and measurements of COI concentrations in groundwater were conducted.

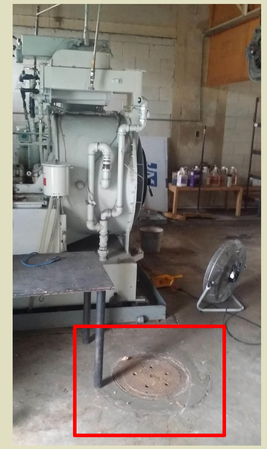
RESULTS

After 140 days of treatment, the concentration of PCE in the source area was reduced from 81,800 ppb to 14,100 ppb, with some transient production of DCE (47,000 ppb). Proximal to the source area, total contaminant concentrations in MW-3 and SMW-3 were reduced by 59% (TCE reduced from 677 ppb to < 5 ppb) and 89% (TCE reduced from 92 ppb to 56 ppb) without the accumulation of any catabolic intermediates.

COI (ppb)	SMW-3 (up gradient)			SMW-9 (source)			MW-3 (side gradient)		
	10/15	04/16	10/16	10/15	04/16	10/16	10/15	04/16	10/16
BTEX	450	120	398	<3,000	170	176	<20	<20	<20
PCE	21	29	1	81,800	14,100	369	240	<5	<1
TCE	92	56	8	1,190	1,710	<83	677	<5	<1
cis-DCE	1,350	105	102	1,480	47,000	43,300	1,200	436	18
trans-DCE	15	2	<1	<250	180	149	29	10	<1
VC	229	41	5	<176	2,110	9,770	91	489	43
% Decrease PCE	>95			>99			>99		
% Decrease All CHCs	95			37			>97		

After 12 months, the treated area remained reducing (OPR<-50 mV) compared to the surrounding aquifer (ORP>+150 mV). The concentration of PCE in the source area (SMW-9) was reduced by >99% (from 81,800 ppb to 369 ppb); TCE was reduced by >99% (from 677 ppb to <1 ppb).

After 14 months there was still evidence of DCE stall at SMW-9, but this correlated increases in PCE and other indicators of new releases. This is likely associated with an identified PCE source located about 15 ft from this well location. Namely, about 55 USG of sludge containing 10% PCE was recovered from a floor drain and sump area within the building (red outline). The sump area was recently excavated and treated with EZVI-CH4.



During the first 12 months of treatment no excessive methane production was observed, there were no vapor intrusion issues noted, and there was no noted induced migration of solvents. However, after 12 months, the concentrations of CH4 at SMW-9 began to increase to 5 ppm water and nearly 5% in soil gasses. This indicates that the longevity and overall affect of the antimethanogenic reagents (AMR) originally employed (*i.e.,* Red Yeast Rice Extract) can be enhanced by using essential plant oils (garlic based) which are now integrated into our antimethanogenic ERD (ERD-CH4 Ole EGO™) and ISCR (Provect-IR EGO™) amendments.

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