Examination of Long Term Effectiveness of a Reductive Dechlorination Barrier in Groundwater

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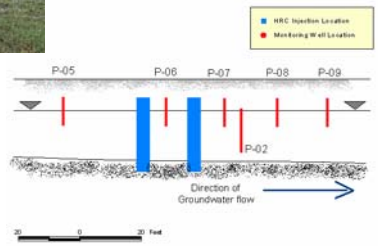
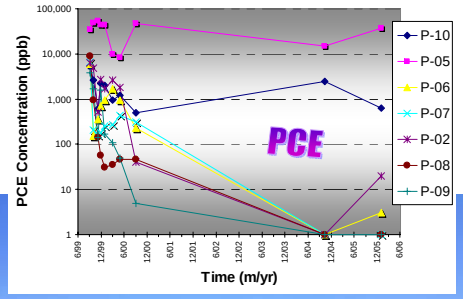
Chevron

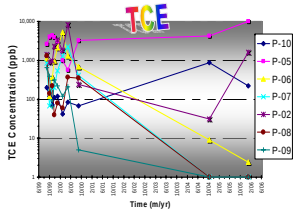


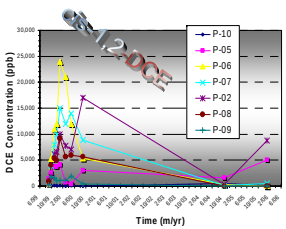
Concentrations (in microgram/liter) of PCE and its dechlorinated daughter products from the 7 monitoring wells over time. HRC was injected in September 1999.

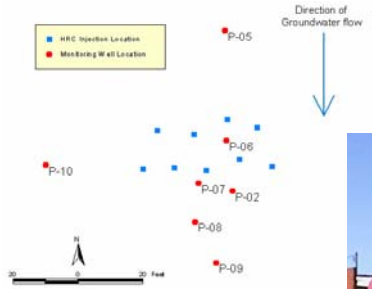
Sampling Date		9/99	10/99	11/99	12/99	1/00	3/00	5/00	9/00	11/04	1/06
P-10	PCE	5300	2600	610	2200	2000	940	1200	500	2500	630
cross-	TCE	200	120	72	110	120	42	84	67	880	220
gradient	cis-1,2-DCE	140	98	95	100	97	24	62	47	460	150
w ell	VC	<100	<10	3.5	<1.0	1.2	<1.0	<1.0	<1	5	3.2
P-05	PCE	35000	49000	55000	45000	45000	10000	8300	47000	15000	37000
up-	TCE	2600	4000	4400	3900	3100	990	560	3200	4200	9900
gradient	cis-1,2-DCE	1400	2500	3800	3700	4100	710	370	3000	1600	5000
w ell	VC	250	240	120	110	290	170	160	130	42	170
	Ethene	<10	<20	<20	<20	<20	<10	<20	<30		
P-06	PCE	6000	150	360	700	960	1700	940	230	<1	3.1
betw een	TCE	1100	120	370	960	2100	5200	1300	680	9	2.4
injection	cis-1,2-DCE	550	5200	11000	12000	24000	21000	12000	5300	280	9.6
points	VC	290	380	1500	1200	2800	2100	4100	1500	50	4.4
	Ethene	<10	<30	<20	<20	21	44	203	880		
P-07	PCE	6500	210	160	180	250	270	430	310	<1	<1
dow n-	TCE	840	68	210	200	540	1300	2200	410	<1	<1
gradient	cis-1,2-DCE	560	3900	8000	10000	15000	12000	14000	8900	140	510
w ell	VC	160	140	390	360	1100	540	2200	770	37	<1
	Ethene	<10	<20	<20	<20	<10	89	180	240		
P-02	PCE	6400	4800	510	2700	1700	2600	1800	41	<1	20
deep	TCE	1400	890	960	2300	3300	1800	8200	240	31	1600
dow n-	cis-1,2-DCE	490	1800	6100	6500	10000	7800	7000	17000	310	8800
gradient	VC	180	510	280	390	880	3600	1300	2400	80	710
w ell	Ethene	<10	<10	<30	<20	25	373	243	140		
P-08	PCE	9000	950	140	56	31	35	46	47	<1	<1
dow n-	TCE	1300	140	220	40	80	60	370	350	<1	<1
gradient	cis-1,2-DCE	860	4000	5300	4900	9200	5600	5900	5600	4	11
w ell	VC	170	250	930	920	2000	2400	2300	1000	2	20
	Ethene	<10	<20	<30	<20	130	876	1150	580		
P-09	PCE	3900	1700	140	1600	170	110	49	<5.0	<1	<1
dow n-	TCE	640	390	64	310	220	120	210	<5.0	<1	<1
gradient	cis-1,2-DCE	160	1700	1600	1000	1100	1100	1900	430	8	1.4
w ell	VC	<100	120	440	290	530	570	1200	190	5	<1
	Ethene	<10	<20	<30	87	447	580	1200	1310		

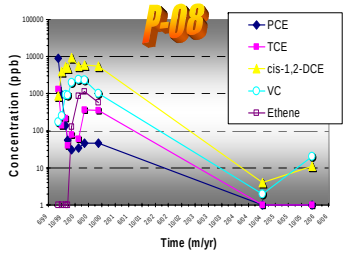


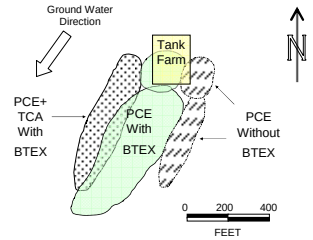
To accelerate the natural reductive dechlorination process of chlorinated hydrocarbons such as tetrachloroethene (PCE) and trichloroethene (TCE) in groundwater, an organic compound (hydrogen releasing compound or HRC) was injected into an aquifer six years ago in a pilot test. Using a direct-push technique, the organic compound was injected in an array to form a reactive barrier across the groundwater flow gradient. The concentrations of PCE and TCE in groundwater from the downgradient wells decreased rapidly following the injection of the organic compound. The PCE concentrations down-gradient from the reactive barrier dropped by approximately 95 percent within 2 months of the injection and continued to decrease over time. A temporary rise in the concentrations of dechlorination daughter compounds such as cis-1,2-dichloroethene (cis-1,2-DCE), vinyl chloride, and ethene was observed in association with the decrease in concentration of PCE and TCE in these downgradient wells. The down-gradient PCE concentrations eventually dropped below the analytical detection limit, even as the PCE concentration up-gradient of the reactive barrier remained relatively stable after five years. The concentrations of PCE and all its dechlorination daughter compounds remain low after six years in all the down-gradient wells. This approach has a much lower cost to implement and maintain compared to a pump and treat system. It is a preferred remedial alternative for the site.











Concentrations (in microgram/liter) of organic acids from the 5 down-gradient monitoring wells over time following the HRC injection in September 1999.

Collection Date		9/99	10/99	11/99	12/99	1/00	3/00	5/00	9/00	5/01	1/06
P-06	Acetic	<1	125	238	275	258	177	129	384	447	<1
	Butyric	<1	<1	77	86	86	64	72	107	391	<1
	Lactic	<1	48	47	104	162	221	174	112	791	<1
	Propionic	<1	337	623	872	1100	520	569	1190	1060	<1
	Pyruvic	<0.1	0.4	0.3	0.7	<0.1	0.4	<0.1	0.6	2.5	<1
P-07	Acetic	<1	838	379	413	397	354	<1	724	386	<1
	Butyric	<1	557	651	452	381	212	411	1050	517	<1
	Lactic	<1	1620	1120	970	1070	1220	2557	4590	300	<1
	Propionic	<1	375	824	1140	1050	708	1220	1810	785	<1
	Pyruvic	<0.1	3.5	0.6	1.1	<0.1	1.3	<0.1	8.7	2	<1
P-08	Acetic	<1	76	119	297	339	352	189	403	528	0.18
	Butyric	<1	<1	24	99	125	85	103	225	426	<1
	Lactic	<1	<1	<1	<1	<1	54	43	<1	<1	<1
	Propionic	<1	129	263	837	1060	1080	1060	1370	1380	<1
	Pyruvic	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.5	0.4	0.34
P-09	Acetic	<1	29	50	28	114	70	59	430	606	<1
	Butyric	<1	<1	<1	<1	<1	<1	<1	21	94.2	<1
	Lactic	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Propionic	<1	14	96	31	160	82	156	648	644	<1
	Pyruvic	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.3	0.3	<1
P-02	Acetic	<1	81	53	83	102	330	43	94		4.3
	Butyric	<1	<1	<1	7	18	130	32	11		<1
	Lactic	<1	20	<1	<1	<1	58	4	<1		<1
	Propionic	<1	199	36	125	249	1200	345	358		<1
	Pyruvic	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.4		<1