ORNL/TM-13711/V2

**OAK RIDGE
NATIONAL
LABORATORY**

LOCKHEED MARTIN

Environmental Sciences Division

**Laboratory Evaluation of
In Situ Chemical Oxidation
for Groundwater
Remediation, Test Area
North, Operable Unit 1-07B,
Idaho National Engineering
and Environmental
Laboratory**

Volume Two - Appendices C, D, and E

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ENVIRONMENTAL SCIENCES DIVISION

**LABORATORY EVALUATION OF IN SITU CHEMICAL OXIDATION
FOR GROUNDWATER REMEDIATION, TEST AREA NORTH,
OPERABLE UNIT 1-07B, IDAHO NATIONAL ENGINEERING AND
ENVIRONMENTAL LABORATORY**

Volume Two - Appendices C, D, and E

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Environmental Sciences Division
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PREFACE

These appendices support the results and discussion of the laboratory work performed to evaluate the feasibility of in situ chemical oxidation for Idaho National Environmental and Engineering Laboratory's (INEEL) Test Area North (TAN) which is contained in ORNL/TM-13711/V1. This volume contains Appendices C-E.

Appendix C is a compilation of all recorded data and mathematical calculations made to interpret the data. For the Task 3 and Task 4 work, the spreadsheet column definitions are included immediately before the actual spreadsheet pages and are listed as "Sample Calculations/Column Definitions" in the table of contents.

Appendix D includes the chronological order in which the experiments were conducted and the final project costs through October 1998.

Appendix E is a compilation of the monthly progress reports submitted to INEEL during the course of the project.

APPENDIX C: CALCULATIONS

Experiment: 2a-3-B Reactor Performance
Calibration Curve Date: 4/22/98
Experiment Start Date: 5/12/98

For additional comments, see Laboratory Notebook B000025

Pages: 55-56

Experiment Description:

Tested a 500 mL flask(29/42 S.T.) with ORBO tube adapter/teflon sleeve assembly at 100 ppb TCE in DI water and obtained a mass balance.
This Adapter utilized a Teflon Stopcock to close off the ORBO tube and sampling port while not in use. A 10" long needle was used for sampling
All sample extractions placed on horizontal shaker for 2 hours.

Appears to be no significant difference between plastic and glass syringe sampling

TCE SPIKE SOLUTION INFORMATION

Solution: DI Water

Volume of Solution in Flask

0.5003 liters

Mass of TCE Added:

0.0607 mg

(added 60.7 uL of a SAT. TCE soln-assuming it was 1000ppm)

Spike Concentration:

121 ppb

Equilibrated at 12C

Start: 5/12/98 13:10 End:

5/13/98 11:10 Equilibration Time (hrs)

22.00

TEST START TIME:

5/13/98 11:10

ORNL No.	Sampling Time	Sample Name	Time (hrs)	Hexane (mL)	Sample (mL)	GC Conc. TCE (ppb)	Flag	Sample TCE (ppb)	TCE (mg) In Aliquot	Remaining Vol (mL)
338	5/13/98 11:10	2a-3b-t0-p	0.00	4.923	4.924	107		107.0	0.001	495.38
339	5/13/98 11:12	2a-3b-t0-g	0.03	5.006	4.961	106		107.3	0.001	490.42
340	5/13/98 12:07	2a-3b-t1hr-p	0.95	5.006	5.232	106		102	0.001	485.18
341	5/13/98 12:10	2a-3b-t1hr-g	1.00	5.045	4.829	102		106	0.001	480.35
342	5/13/98 13:16	2a-3b-t2hr-p	2.10	5.005	4.974	107		108	0.001	475.38
343	5/13/98 13:18	2a-3b-t2hr-g	2.13	5.015	5.227	110		105	0.001	470.15
344	5/13/98 15:10	2a-3b-t4hr-p	4.00	5.000	5.166	113		109	0.001	464.99
345	5/13/98 15:11	2a-3b-t4hr-g	4.02	4.967	5.211	110		105	0.001	459.78
346	5/14/98 8:15	2a-3b-t21hr-p	21.08	4.973	4.933	100		100	0.000	454.84
347	5/14/98 8:15	2a-3b-t21hr-g	21.08	4.918	4.904	106		106	0.001	449.94
348	5/14/98 11:10	2a-3b-t24hr-p	24.00	4.880	4.835	108		109	0.001	445.10
349	5/14/98 11:11	2a-3b-t24hr-g	24.02	4.914	4.731	102		106	0.000	440.37

Beginning TCE mass (mg)

0.054

Final TCE mass in Reactor (mg)

0.046

Total Mass of TCE in Aliquots (mg)

0.006

Total mass of TCE on ORBO tubes (mg)

0.000

0.053 Total Mass Recovered (mg)

98.7 % Recovered

p-for plastic syringe
g-for glass syringe

average

stdev

106

3

Count

12

					(g Charcoal)			
350	5/14/98 11:12	2a-3b-charcoal	24.03	4.945	0.092 ND	U	0	0 mg TCE
351	5/14/98 11:14	2a-3b-charcoal	24.07	4.962	0.049 ND	U	0	0 mg TCE

Charcoal Desorption
(ORBO) tube extraction
Data

%Diff glass/Plastic Syringe

339	5/13/98 11:12	2a-3b-t0-g	0.03	5.006	4.961	106	107	0.3
338	5/13/98 11:10	2a-3b-t0-p	0.00	4.923	4.924	107	107	.
341	5/13/98 12:10	2a-3b-t1hr-g	1.00	5.045	4.829	102	106	4.0
340	5/13/98 12:07	2a-3b-t1hr-p	0.95	5.006	5.232	106	102	
347	5/14/98 8:15	2a-3b-t21hr-g	21.08	4.918	4.904	106	106	5.3
346	5/14/98 8:15	2a-3b-t21hr-p	21.08	4.973	4.933	100	100	
349	5/14/98 11:11	2a-3b-t24hr-g	24.02	4.914	4.731	102	106	-2.9
348	5/14/98 11:10	2a-3b-t24hr-p	24.00	4.880	4.835	108	109	
343	5/13/98 13:18	2a-3b-t2hr-g	2.13	5.015	5.227	110	105	-2.0
342	5/13/98 13:16	2a-3b-t2hr-p	2.10	5.005	4.974	107	108	
345	5/13/98 15:11	2a-3b-t4hr-g	4.02	4.967	5.211	110	105	-4.0
344	5/13/98 15:10	2a-3b-t4hr-p	4.00	5.000	5.166	113	109	

0.1 Avg. % Difference

Experiment: 2b-1, Hexane Extraction Time
 Calibration Curve Date: 1/30/98
 Experiment Start Date: 2/17/98

For additional comments, see Laboratory Notebook B000025

Pages: 16-20

Experiment Description:

In this test, an equilibrated mixture of TCE spiked TAN 40 GW was equilibrated with reactive zone media and then extracted with hexane for various time periods before sample collection. During sample collection, aliquots of both the hexane layer and aqueous layer was taken. Furthermore, a portion of the aqueous layer was also filtered (0.45 micron) prior to analysis. All aqueous/filtered aqueous samples were extracted w/hexane and placed on a horizontal shaker for an additional 30 minutes prior to analysis. The extractions were performed at room temperature.

NOTE: the filtered samples are not used in computations. The filters have been found to absorb TCE, making the data obtained invalid.

TCE SPIKE SOLUTION INFORMATION

Prepared a saturated TCE solution using DI water and allowed to equilibrate overnight. Added approximately 260 uL of the saturated TCE solution to 259.43 mL of TAN 40 groundwater. The TAN 40 gw was already sparged and cooled to 15C and was allowed to mix for a few minutes prior to initial sampling. The TAN 40 Gw was then dispensed into vials containing crushed basalt or sediment and allowed to equilibrate overnight at 12-15C.

Initial TCE Concentration

Sample	Volume	Vol Aqueous	GC TCE	Sample			
ORNL#	Name	Collection Time	Hexane (mL)	Sample (mL)	(ug/L)	TCE (ug/L)	
59	2b-1-59-T0	2/18/98 11:15	4.908	5.007	734.19	719.609266	avg-1sd 718.81
60	2b-1-60-T0	2/18/98 11:15	4.914	4.990	734.72	723.472195	
						AVG	STDEV
						721.54	2.731503076
						avg+1sd	724.27

Container	Soil	TAN 40 GW	Initial TCE	Total Mass	Extraction	Hexane	Total Mass	EXT Start	
	Mass (g)	Contents	Volume (mL)	Mass (ug)	(grams)	Container	Vol (mL)	Transferred (g)	Time=0
Vial1	10.567	sediment & spiked GW	37.351	26.9503	47.918	Bottle1	39.652	46.964	2/19/98 13:20
Vial2	10.094	sediment & spiked GW	38.025	27.4366	48.119	Bottle2	40.53	47.11	2/19/98 13:23
Vial3	10.889	Crushed basalt & spiked GW	38.214	27.5730	49.103	Bottle3	40.364	48.614	2/19/98 13:25
Vial4	10.354	Crushed basalt & spiked GW	39.265	28.3313	49.619	Bottle4	39.864	48.9	2/19/98 13:36
Vial5		0 Spiked GW Only	42.038	30.3321	42.038	Bottle5	40.061	41.464	2/19/98 13:38
Vial6		0 Spiked GW Only	41.747	30.1222	41.747	Bottle6	40.53	41.208	2/19/98 13:39
(assuming GW spg=1.0)									
									Wt% Transferred
									98.01
									97.90
									99.00
									98.55
									98.63
									98.71

Exp. 2b-1, Hexane Extraction Time

For additional comments, see Laboratory Notebook B000025

Pages: 16-20

ORNL	Sample		Collect	Elapsed	Hexane	Vol Aqueous	GC Value		TCE Conc.	TCE Mass in
GC #	Name	Sample Type	Bottle #	Time	Time (min)	Vol (mL)	Sample (mL)	(ug/L)	FLAG	Aliquot (ug)
61	2B-1-B1-T5-A	Aqueous	1	2/19/98 13:28	8	2.878	2.918	346		0.9964
67	2B-1-B1-T30-A	Aqueous	1	2/19/98 13:49	29	2.912	2.862	91		0.2638
73	2B-1-B1-T2HR-A	Aqueous	1	2/19/98 15:18	118	2.921	3.095	5 U		0.0144
79	2B-1-B1-T24HR-A	Aqueous	1	2/20/98 14:00	1480	2.942	3.188	0 ND		0.0000
85	2B-1-B1-T5-H	Hexane Layer	1	2/19/98 13:27	7 NA	NA		253		0.2531
91	2B-1-B1-T30-H	Hexane Layer	1	2/19/98 13:48	28 NA	NA		440		0.4400
97	2B-1-B1-T2HR-H	Hexane Layer	1	2/19/98 15:17	117 NA	NA		517		0.5168
103	2B-1-B1-T24HR-H	Hexane Layer	1	2/20/98 14:00	1480 NA	NA		548		0.5478
109	2B-1-B1-T5-F	Filtered Aqueous	1	2/19/98 13:28	8	2.997	3.015	264		1.0297
115	2B-1-B1-T30-F	Filtered Aqueous	1	2/19/98 13:49	29	2.947	2.988	64		0.2755
121	2B-1-B1-T2HR-F	Filtered Aqueous	1	2/19/98 15:18	118	2.964	2.245	0 ND		0.0104
127	2B-1-B1-T24HR-F	Filtered Aqueous	1	2/20/98 14:00	1480	2.967	2.354	0 ND		0.0000

	Actual Hex vol (mL)	Act TCE mass in Hex (ug)	Act. Aque. vol (mL)	Act. TCE mass in Aque. (ug)	Summed masses in aliquots (ug)	
					Cum Mass (ug)	
5min	39.65	10.04	37.351	12.76	0	22.79
30min	38.65	17.01	31.418	2.90	2.2791	22.18
2hrs	37.65	19.46	25.569	0.12	3.2584	22.83
24hrs	36.65	20.08	20.229	0.00	3.7999	23.88

MASS BALANCE

26.9503 ug Initial TCE

2.5901 ug TCE in Aq. aliquots

1.758 ug TCE in Hexane aliquots

22.6026 ug TCE left in Bottle

Must assume mass of solids filtered is negligible

Assume complete transfer of vial contents to extraction bottle

14.687 mL aqueous volume left in bottle

0 ug TCE left in aqueous phase

35.65 mL hexane volume left in bottle

19.53 ug TCE left in hexane phase

Total Recovered (ug)

88.60 Total wt% Recovered

Exp. 2b-1, Hexane Extraction Time

For additional comments, see Laboratory Notebook B000025

Pages:

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ORNL	Sample		Collect	Elapsed	Hexane	Vol Aqueous	GC Value		TCE Conc.	TCE Mass in	
GC #	Name	Sample Type	Bottle #	Time	Time (min)	Vol (mL)	Sample (mL)	(ug/L)	FLAG	Aliquot (ug)	
62	2B-1-B2-T5-A	Aqueous	2	2/19/98 13:31	8	2.954	2.986	245.10		242	0.7241
68	2B-1-B2-T30-A	Aqueous	2	2/19/98 13:51	28	2.940	3.184	30.55		28	0.0898
74	2B-1-B2-T2HR-A	Aqueous	2	2/19/98 15:20	117	2.955	2.967	5.42 U		5	0.0160
80	2B-1-B2-T24HR-A	Aqueous	2	2/20/98 14:00	1477	2.962	3.035	0.00 ND		0	0.0000
86	2B-1-B2-T5-H	Hexane Layer	2	2/19/98 13:31	8 NA	NA		347.14		347	0.3471
92	2B-1-B2-T30-H	Hexane Layer	2	2/19/98 13:50	27 NA	NA		518.95		519	0.5189
98	2B-1-B2-T2HR-H	Hexane Layer	2	2/19/98 15:19	116 NA	NA		575.76		576	0.5758
104	2B-1-B2-T24HR-H	Hexane Layer	2	2/20/98 14:00	1477 NA	NA		603.88		604	0.6039
110	2B-1-B2-T5-F	Filtered Aqueous	2	2/19/98 13:31	8	2.988	2.949	174.65		242	0.7151
116	2B-1-B2-T30-F	Filtered Aqueous	2	2/19/98 13:51	28	2.961	3.187	23.26		28	0.0899
122	2B-1-B2-T2HR-F	Filtered Aqueous	2	2/19/98 15:20	117	2.961	2.952	0.00 ND		5	0.0159
128	2B-1-B2-T24HR-F	Filtered Aqueous	2	2/20/98 14:00	1477	2.964	2.913	18.60		0	0.0000

	Actual Hex vol (mL)	Act TCE mass in Hex (ug)	Act. Aque vol (mL)	Act. TCE mass in Aque. (ug)	Summed masses in aliquots (ug)	
					Cum Mass (ug)	
5min	40.53	14.06972052	38.025	9.22	0	23.29
30min	39.53	20.51398003	32.090	0.91	1.7863	23.21
2hrs	38.53	22.18402073	25.719	0.14	2.4849	24.81
24hrs	37.53	22.66348649	19.800	0.00	3.0927	25.76

MASS BALANCE

27.4366 ug Initial TCE

1.6508 ug TCE in Aq. aliquots

2.046 ug TCE in Hexane aliquots

23.7400 ug TCE left in Bottle

Must assume mass of solids filtered is negligible

Assume complete transfer of vial contents to extraction bottle

3.264 mL aqueous volume left in bottle

0 ug TCE left in aqueous phase

36.53 mL hexane volume left in bottle

22.06 ug TCE left in hexane phase

93.88 Total wt% Recovered

Exp. 2b-1, Hexane Extraction Time

For additional comments, see Laboratory Notebook B000025

Pages: 16-20

ORNL	Sample		Collect	Elapsed	Hexane	Vol Aqueous	GC Value	TCE Conc.	TCE Mass in		
GC #	Name	Sample Type	Bottle #	Time	Time (min)	Vol (mL)	Sample (mL)	(ug/L)	FLAG	(ug/L)	Aliquot (ug)
63	2B-1-B3-T5-A	Aqueous	3	2/19/98 13:34	9	2.978	3.436	371.58		322	1.1064
69	2B-1-B3-T30-A	Aqueous	3	2/19/98 13:54	29	2.953	3.542	151.63		126	0.4478
75	2B-1-B3-T2HR-A	Aqueous	3	2/19/98 15:22	117	2.935	3.237	5.71 U		5	0.0168
81	2B-1-B3-T24HR-A	Aqueous	3	2/20/98 14:01	1476	2.944	3.253	0.00 ND		0	0.0000
87	2B-1-B3-T5-H	Hexane Layer	3	2/19/98 13:34	9 NA	NA		326.45		326	0.3265
93	2B-1-B3-T30-H	Hexane Layer	3	2/19/98 13:52	27 NA	NA		487.10		487	0.4871
99	2B-1-B3-T2HR-H	Hexane Layer	3	2/19/98 15:21	116 NA	NA		574.16		574	0.5742
105	2B-1-B3-T24HR-H	Hexane Layer	3	2/20/98 14:01	1476 NA	NA		573.92		574	0.5739
111	2B-1-B3-T5-F	Filtered Aqueous	3	2/19/98 13:34	9	2.982	2.428	207.70		322	0.7819
117	2B-1-B3-T30-F	Filtered Aqueous	3	2/19/98 13:53	28	2.944	2.217	51.50		126	0.2803
123	2B-1-B3-T2HR-F	Filtered Aqueous	3	2/19/98 15:22	117	2.956	2.433	0.00 ND		5	0.0126
129	2B-1-B3-T24HR-F	Filtered Aqueous	3	2/20/98 14:01	1476	2.967	2.841	0.00 ND		0	0.0000

	Actual Hex vol (mL)	Act TCE mass in Hex (ug)	Act. Aque vol (mL)	Act. TCE mass in Aque. (ug)	Summed masses in aliquots (ug)	
					Cum Mass (ug)	
5min	40.36	13.17684031	38.214	12.31	0	25.48
30min	39.36	19.17403541	32.350	4.09	2.2147	25.48
2hrs	38.36	22.02704188	26.591	0.14	3.4298	25.59
24hrs	37.36	21.44376279	20.921	0.00	4.0334	25.48

MASS BALANCE

27.5730 ug Initial TCE

2.6457 ug TCE in Aq. aliquots

1.962 ug TCE in Hexane aliquots

22.9657 ug TCE left in Bottle

Must assume mass of solids filtered is negligible

Assume complete transfer of vial contents to extraction bottle

4.186 mL aqueous volume left in bottle

0 ug TCE left in aqueous phase

36.36 mL hexane volume left in bottle

20.87 ug TCE left in hexane phase

92.40 Total wt% Recovered

Exp. 2b-1, Hexane Extraction Time

For additional comments, see Laboratory Notebook B000025

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ORNL GC #	Sample Name	Sample Type	Bottle #	Collect Time	Elapsed Time (min)	Hexane Vol (mL)	Vol Aqueous Sample (mL)	GC Value (ug/L)	FLAG	TCE Conc. (ug/L)	TCE Mass in Aliquot (ug)
64	2B-1-B4-T5-A	Aqueous	4	2/19/98 13:41	5	2.956	2.768	412.13		440	1.2182
70	2B-1-B4-T30-A	Aqueous	4	2/19/98 13:56	20	2.945	3.383	286.85		250	0.8449
76	2B-1-B4-T2HR-A	Aqueous	4	2/19/98 15:24	108	2.947	2.988	5.41 U		5	0.0159
82	2B-1-B4-T24HR-A	Aqueous	4	2/20/98 14:02	1466	2.952	3.038	0.00 ND		0	0.0000
88	2B-1-B4-T5-H	Hexane Layer	4	2/19/98 13:41	5 NA	NA		218.82		219	0.2188
94	2B-1-B4-T30-H	Hexane Layer	4	2/19/98 13:55	19 NA	NA		397.26		397	0.3973
100	2B-1-B4-T2HR-H	Hexane Layer	4	2/19/98 15:23	107 NA	NA		592.60		593	0.5926
106	2B-1-B4-T24HR-H	Hexane Layer	4	2/20/98 14:02	1466 NA	NA		593.87		594	0.5939
112	2B-1-B4-T5-F	Filtered Aqueous	4	2/19/98 13:41	5	2.974	3.416	308.97		440	1.5034
118	2B-1-B4-T30-F	Filtered Aqueous	4	2/19/98 13:56	20	2.970	2.982	143.27		250	0.7447
124	2B-1-B4-T2HR-F	Filtered Aqueous	4	2/19/98 15:24	108	2.962	2.981	0.00 ND		5	0.0159
130	2B-1-B4-T24HR-F	Filtered Aqueous	4	2/20/98 14:02	1466	2.968	2.710	34.66		0	0.0000

	Actual Hex vol (mL)	Act TCE mass in Hex (ug)	Act. Aque vol (mL)	Act. TCE mass in Aque. (ug)	Summed masses in aliquots (ug)	
					Cum Mass (ug)	
5min	39.86	8.723163427	39.265	17.28	0	26.00
30min	38.86	15.43894512	33.081	8.26	2.9404	26.64
2hrs	37.86	22.43811458	26.716	0.14	4.9273	27.51
24hrs	36.86	21.89256919	20.747	0.00	5.5517	27.44

MASS BALANCE

28.3313 ug Initial TCE
 4.3431 ug TCE in Aq. aliquots
 1.803 ug TCE in Hexane aliquots
 22.1857 ug TCE left in Bottle

Must assume mass of solids filtered is negligible

Assume complete transfer of vial contents to extraction bottle

4.065 mL aqueous volume left in bottle
 0 ug TCE left in aqueous phase

35.86 mL hexane volume left in bottle
 21.30 ug TCE left in hexane phase

96.87 Total wt% Recovered

Exp. 2b-1, Hexane Extraction Time

For additional comments, see Laboratory Notebook B000025

Pages:

ORNL	Sample		Collect	Elapsed	Hexane	Vol Aqueous	GC Value	TCE Conc.	TCE Mass in		
GC #	Name	Sample Type	Bottle #	Time	Time (min)	Vol (mL)	Sample (mL)	(ug/L)	FLAG	(ug/L)	Aliquot (ug)
65	2B-1-B5-T5-A	Aqueous	5	2/19/98 13:44	6	2.943	2.874	318.93		327	0.9385
71	2B-1-B5-T30-A	Aqueous	5	2/19/98 13:58	20	2.961	2.957	94.25		94	0.2790
77	2B-1-B5-T2HR-A	Aqueous	5	2/19/98 15:26	108	2.948	3.302	0.00 ND		0	0.0000
83	2B-1-B5-T24HR-A	Aqueous	5	2/20/98 14:02	1464	2.983	2.614	0.00 ND		0	0.0000
89	2B-1-B5-T5-H	Hexane Layer	5	2/19/98 13:43	5	NA	NA	352.21		352	0.3522
95	2B-1-B5-T30-H	Hexane Layer	5	2/19/98 13:57	19	NA	NA	583.70		584	0.5837
101	2B-1-B5-T2HR-H	Hexane Layer	5	2/19/98 15:25	107	NA	NA	648.96		649	0.6490
107	2B-1-B5-T24HR-H	Hexane Layer	5	2/20/98 14:02	1464	NA	NA	645.51		646	0.6455
113	2B-1-B5-T5-F	Filtered Aqueous	5	2/19/98 13:44	6	2.935	2.857	210.03		327	0.9330
119	2B-1-B5-T30-F	Filtered Aqueous	5	2/19/98 13:58	20	2.945	2.379	51.19		94	0.2245
125	2B-1-B5-T2HR-F	Filtered Aqueous	5	2/19/98 15:26	108	2.938	2.278	0.00 ND		0	0.0000
131	2B-1-B5-T24HR-F	Filtered Aqueous	5	2/20/98 14:02	1464	2.968	3.254	0.00 ND		0	0.0000

	Actual Hex vol (mL)	Act TCE mass in Hex (ug)	Act. Aque vol (mL)	Act. TCE mass in Aque. (ug)	Summed masses in aliquots (ug)	
						Cum Mass (ug)
5min	40.06	14.10977938	42.038	13.73	0	27.84
30min	39.06	22.79981586	36.307	3.43	2.2238	28.45
2hrs	38.06	24.69997755	30.971	0.00	3.3110	28.01
24hrs	37.06	23.92312488	25.391	0.00	3.9599	27.88

MASS BALANCE

30.3321 ug Initial TCE

2.3751 ug TCE in Aq. aliquots

2.230 ug TCE in Hexane aliquots

25.7267 ug TCE left in Bottle

Must assume mass of solids filtered is negligible

Assume complete transfer of vial contents to extraction bottle

7.817 mL aqueous volume left in bottle

0 ug TCE left in aqueous phase

36.06 mL hexane volume left in bottle

23.28 ug TCE left in hexane phase

91.93 Total wt% Recovered

ORNL GC #	Sample Name	Sample Type	Bottle #	Collect Time	Elapsed Time (min)	Hexane Vol (mL)	Vol Aqueous Sample (mL)	GC Value (ug/L)	FLAG	TCE Conc. (ug/L)	TCE Mass in Aliquot (ug)
66	2B-1-B6-T5-A	Aqueous	6	2/19/98 13:46	7	2.929	2.974	230.92		227	0.6764
72	2B-1-B6-T30-A	Aqueous	6	2/19/98 14:00	21	2.974	2.919	60.62		62	0.1803
78	2B-1-B6-T2HR-A	Aqueous	6	2/19/98 15:28	109	2.945	3.071	0.00	ND	0	0.0000
84	2B-1-B6-T24HR-A	Aqueous	6	2/20/98 14:03	1464	2.962	2.658	0.00	ND	0	0.0000
90	2B-1-B6-T5-H	Hexane Layer	6	2/19/98 13:46	7	NA	NA	464.47		464	0.4645
96	2B-1-B6-T30-H	Hexane Layer	6	2/19/98 13:59	20	NA	NA	634.28		634	0.6343
102	2B-1-B6-T2HR-H	Hexane Layer	6	2/19/98 15:27	108	NA	NA	673.87		674	0.6739
108	2B-1-B6-T24HR-H	Hexane Layer	6	2/20/98 14:03	1464	NA	NA	670.46		670	0.6705
114	2B-1-B6-T5-F	Filtered Aqueous	6	2/19/98 13:46	7	2.948	2.993	202.09		227	0.6807
120	2B-1-B6-T30-F	Filtered Aqueous	6	2/19/98 14:00	21	2.979	3.084	42.22		62	0.1905
126	2B-1-B6-T2HR-F	Filtered Aqueous	6	2/19/98 15:28	109	2.955	2.941	0.00	ND	0	0.0000
132	2B-1-B6-T24HR-F	Filtered Aqueous	6	2/20/98 14:03	1464	2.959090909	3.010	58.51		0	0.0000

	Actual Hex vol (mL)	Act TCE mass in Hex (ug)	Act. Aque. vol (mL)	Act. TCE mass in Aque. (ug)	Summed masses in aliquots (ug)	
5min	40.53	18.8248227	41.747	9.50	0	28.32
30min	39.53	25.07296854	35.780	2.21	1.8216	29.10
2hrs	38.53	25.96408392	29.777	0.00	2.8267	28.79
24hrs	37.53	25.16251409	23.765	0.00	3.5005	28.66

MASS BALANCE

30.1222 ug Initial TCE
 1.7279 ug TCE in Aq. aliquots
 2.443 ug TCE in Hexane aliquots
 25.9512 ug TCE left in Bottle

Must assume mass of solids filtered is negligible

Assume complete transfer of vial contents to extraction bottle

6.472 mL aqueous volume left in bottle
 0 ug TCE left in aqueous phase

36.53 mL hexane volume left in bottle
 24.49 ug TCE left in hexane phase

95.16 Total wt% Recovered

Experiment: 2b-3, Sludge Hexane Ext Test

For additional comments, see the RMAL Laboratory Research Notebook

Calibration Curve Date: 1/30/98 and 4/22/98

Experiment Start Date: 4/8/98

Experiment Description:

In this test, an equilibrated mixture of TCE spiked TSF05 GW was equilibrated with TSF05 sludge and then extracted with hexane for various time periods before sample collection. During sample collection, aliquots of both the hexane layer and aqueous layer was taken. Furthermore, a portion of the aqueous layer was also filtered (0.45 micron) prior to analysis. All aqueous/filtered aqueous samples were extracted w/hexane and placed on a horizontal shaker for an additional 30 minutes prior to analysis. The extractions were performed at room temperature.

NOTE: the filtered samples are not used in computations.

The filters have been found to absorb TCE, making the data obtained invalid.

TCE SPIKE SOLUTION INFORMATION

4/8/98 09:30: Started equilibration of solutions at 4 C. Due to problems with the incubator shaker did not start shaking the samples continuously. Samples were hand shaken at various times throughout the work day.

Initial TCE Concentration

ORNL#	Sample Name	Collection Ti	Volume Hexane (mL)	Vol Aqueous Sample (mL)	GC TCE (ug/L)	Sample TCE (ug/L)	FLAG
243R	2b-3-spikeA		5.000	5.000	79,058	79,058	
244R	2b-3-spikeB		5.000	5.000	75,757	75,757	

Steven Robert Cline:
Analyzed several days later
also.

77,407 ppb
2334.209181

(ASSUMED VALUES-RMAL did not Determine Gravimetrically)

Container	Soil Mass (g)	Contents	TSF05 GW Volume (mL)	Initial TCE Mass (ug)	Total Mass (grams)	Extraction Container	Hexane Vol (mL)	Total Mass Transferred (g)	EXT Start Time=0	Wt% Transferred
Vial1	9.948	Dried Sludge	34.50	2670	44.443	TSF-05-1	41.49242	43.404	4/9/98 8:45	97.66
Vial2	10.130	Dried Sludge	35.56	2753	45.692	TSF-05-2	41.22121	44.932	4/9/98 8:45	98.34
Vial3	0.000	Spiked GW	43.08	3335	43.083	TSF-05-3	41.02879	42.763	4/9/98 8:45	99.26
Vial4	0.000	Spiked GW	42.54	3293	42.540	TSF-05-4	40.9697	42.979	4/9/98 8:45	101.03

(assuming GW spg=1.0)

4/9/98 08:45: Transferred the entire contents of each 40 mL vial into 125 mL extraction vials containing 40 mL of hexane.

Placed 125 vials onto shaker and started extraction at 08:45 at 250 rpm.

Experi 2b-3, Sludge Hexane Ext Test For additional comments, see the RMAL Laboratory Research Notebook

CONTAINER #1

ORNL GC #	Sample Name	Sample Typ	Collect Bottl Time	Elapsed Time (min)	Hexane Vol (mL)	Vol of sam Sample (m)	Hexane Layer DF	GC Value (ug/L)	FLAG	Sample TCE Con		TCE Mass in Aliquot (		Mass in both Aq. Aliq % of Initi		Vol of Phase at sampling (mL)		ug TCE in Phase at Sa		% of Initial
249R	TSF-05-1-30-A	Aqueous	1 4/9/98 9:24	39	3.135	2.402	NA	1763		2,301	5.52624	13.0012	0.5%	34.496	79.364	3%				
259R	SF-05-1-2hr-A	Aqueous	1 4/9/98 10:52	127	3.150	2.773	NA	1140		1,294	3.58955	7.12992	0.3%	32.023	41.452	2%				
269R	SF-05-1-4hr-A	Aqueous	1 4/9/98 12:48	243	3.111	2.983	NA	1519		1,584	4.726	8.12751	0.3%	26.001	41.193	2%				
279R	SF-05-1-24hr-A	Aqueous	1 4/10/98 8:22	1417	3.088	3.105	NA	3470		3,451	10.7148	16.0601	0.6%	20.283	69.992	3%				
245	TSF-05-1-30-H	Hexane	1 4/9/98 9:18	33	10.358	0.080	129.981	437		56,831	4.56369			41.492	2358.048	88%				
255	SF-05-1-2hr-HE	Hexane	1 4/9/98 10:47	122	9.842	0.082	121.296	615		74,569	6.10112			41.412	3088.072	116%				
265	SF-05-1-4hr-HE	Hexane	1 4/9/98 12:45	240	10.333	0.077	134.725	640		86,201	6.66096			41.330	3562.699	133%				
275	F-05-1-24hr-H	Hexane	1 4/10/98 8:15	1410	10.283	0.071	145.404	688		100,052	7.12488			41.253	4127.428	155%				
253	TSF-05-1-30-A	Aq-filtered	1 4/9/98 9:24	39	3.123	3.249	NA	399		383	1.24486									
263	F-05-1-2hr-AQ	Aq-filtered	1 4/9/98-10:52	127	3.121	2.735	NA	140		159	0.43612						aliqu	aqueous	hex	total
273	F-05-1-4hr-AQ	Aq-filtered	1 4/9/98-12:48	243	3.091	2.147	NA	100		144	0.30834						0%	3%	88%	92%
283	-05-1-24hr-AQ	Aq-filtered	1 4/10/98 8:22	1417	3.085	1.549	NA	49		98	0.15179						0%	2%	116%	117%
																	0%	2%	133%	135%
																	1%	3%	155%	158%

Steven Robert Cline:
Did not use filtered values.

hexane conc increased 48 ppb bet. 4 & 24 hrs
but DF changed it to approx 20,000 ppb increase

Steven Robert Cline:
assumes conc of second aqueous sample equals that of the first (ie, didn't use the filtered sample data)

CONTAINER #2

250R	TSF-05-2-30-A	Aqueous	2 4/9/98 9:26	41	3.14	3.11	NA	1303		1,318	4.09513	7.96626	0.3%	35.562	46.857	1.7%				
260R	TSF-05-2-2hr-A	Aqueous	2 4/9/98 10:55	130	3.12	2.88	NA	1203		1,301	3.7466	6.68246	0.2%	32.387	42.148	1.5%				
270R	TSF-05-2-4hr-A	Aqueous	2 4/9/98 12:49	244	3.08	3.16	NA	1472		1,435	4.5394	7.85643	0.3%	26.570	38.121	1.4%				
280R	TSF-05-2-24hr-A	Aqueous	2 4/10/98 8:24	1419	3.08	3.56	NA	4184		3,622	12.908	16.9934	0.6%	21.150	76.602	2.8%				
246	TSF-05-2-30-H	Hexane	2 4/9/98 9:18	33	10.45	0.08	128.778	543		69,987	5.72621			41.221	2884.950	104.8%				
256	TSF-05-2-2hr-H	Hexane	2 4/9/98 10:47	122	10.38	0.07	153.200	674		103,325	7.0449			41.139	4250.736	154.4%				
266	TSF-05-2-4hr-H	Hexane	2 4/9/98 12:45	240	10.32	0.08	129.509	713		92,343	7.41542			41.071	3792.638	137.8%				
276	TSF-05-2-24hr-H	Hexane	2 4/10/98 8:15	1410	10.33	0.07	155.886	759		118,310	7.88737			40.991	4849.654	176.2%				
254	TSF-05-2-30-A	Aq-filtered	2 4/9/98 9:26	41	3.12	2.94	NA	287		287	0.84249									
264	TSF-05-2-2hr-A	Aq-filtered	2 4/9/98-10:55	130	3.12	2.26	NA	118		118	0.26688						aliqu	aqueous	hex	total
274	TSF-05-2-4hr-A	Aq-filtered	2 4/9/98-12:49	244	3.10	2.31	NA	120		120	0.27817						0%	2%	105%	107%
284	TSF-05-2-24hr-A	Aq-filtered	2 4/10/98 8:24	1419	3.08	1.13	NA	43		43	0.04828						0%	2%	154%	156%
																	0%	1%	138%	139%
																	1%	3%	176%	180%

Steven Robert Cline:
Did not use filtered values.

hex conc. incr 46 ppb bet 4 & 24 hrs
but DF caused a 26,000 ppb increase

Steven Robert Cline:
assumes conc of second aqueous sample equals that of the first (ie, didn't use the filtered sample data)

Experi 2b-3, Sludge Hexane Ext Test For additional comments, see the RMAL Laboratory Research Notebook

CONTAINER #3

CONTAINER #3										Sample					
ORNL	Sample		Collect	Elapsed	Hexane	Vol of sam	Hexane	GC Value	TCE Con	TCE Mass in	Vol of Phase at				
GC #	Name	Sample Typ	Bottl Time	Time (min)	Vol (mL)	Sample (m	Layer DF	(ug/L)	FLAG	(ug/L)	Aliquot (ug)	sampling ug TCE in			
												%of Initial	Phase at Sa	%of Initial	
251	TSF-05-3-30-A	Aqueous	3 4/9/98 9:19	34	3.138	2.967	NA	194		206	0.60984	0.02%	43.083	8.855	0.3%
261	TSF-05-3-2hr-A	Aqueous	3 4/9/98 10:49	124	3.121	2.728	NA	169		193	0.52638	0.02%	40.039	7.726	0.2%
271	TSF-05-3-4hr-A	Aqueous	3 4/9/98 12:47	242	3.109	3.018	NA	183		188	0.56856	0.02%	37.311	7.029	0.2%
281	TSF-05-3-24hr-	Aqueous	3 4/10/98 8:20	1415	3.089	2.993	NA	193		199	0.59608	0.02%	34.293	6.830	0.2%
247R	TSF-05-3-30-H	Hexane	3 4/9/98 9:18	33	10.336	0.085	122.821	898		110,333	9.36157		41.029	4526.823	136%
257R	TSF-05-3-2hr-H	Hexane	3 4/9/98 10:47	122	10.394	0.080	130.434	895		116,740	9.37461		40.944	4779.814	143%
267R	TSF-05-3-4hr-H	Hexane	3 4/9/98 12:45	240	10.302	0.076	136.980	896		122,784	9.30184		40.864	5017.412	150%
277R	TSF-05-3-24hr-	Hexane	3 4/10/98 8:15	1410	10.302	0.077	134.314	917		123,196	9.5197		40.788	5024.908	151%

hex conc. increased 21 ppb bet 4 & 24 hrs
but DF caused a 412 ppb increase

aliquot	aqueous	hex	total
0%	0.3%	136%	136%
0%	0.2%	143%	144%
0%	0.2%	150%	151%
0%	0.2%	151%	151%

CONTAINER #4

252	TSF-05-4-30-A	Aqueous	4 4/9/98 9:19	34	3.118	2.982	NA	195	204	0.6092	0.02%	42.540	8.691	0.3%
262	TSF-05-4-2hr-A	Aqueous	4 4/9/98 10:49	124	3.113636	2.963	NA	177	186	0.55101	0.02%	39.486	7.343	0.2%
272	TSF-05-4-4hr-A	Aqueous	4 4/9/98 12:47	242	3.1	2.985	NA	184	191	0.57122	0.02%	36.523	6.989	0.2%
282	TSF-05-4-24hr-	Aqueous	4 4/10/98 8:20	1415	3.066667	2.986	NA	195	200	0.59816	0.02%	33.538	6.718	0.2%
248R	TSF-05-4-30-H	Hexane	4 4/9/98 9:18	33	10.417	0.081818	128.315	903	115,830	9.47697		40.970	4745.507	144.1%
258R	TSF-05-4-2hr-H	Hexane	4 4/9/98 10:47	122	10.36818	0.083333	125.418	900	112,927	9.41056		40.888	4617.332	140.2%
268R	TSF-05-4-4hr-H	Hexane	4 4/9/98 12:45	240	10.28485	0.072727	142.417	906	129,074	9.38717		40.805	5266.787	159.9%
278R	TSF-05-4-24hr-	Hexane	4 4/10/98 8:15	1410	10.26818	0.071212	145.191	849	123,239	8.7761		40.732	5019.742	152.4%

hex conc dropped 57ppb between 4 and 24hrs
but DF caused a 5835 ppb decrease

aliquot	aqueous	hex	total
0.02%	0.26%	144.11%	144.40%
0.02%	0.22%	140.22%	140.46%
0.02%	0.21%	159.94%	160.17%
0.02%	0.20%	152.44%	152.66%

Experiment: 2b-3b, Sludge Hexane Ext Test

For additional comments, see the RMAL Laboratory Research Notebook

Calibration Curve Date: 8/26/98

Experiment Start Date: 9/14/98

Experiment Description:

TSF05 Media was spiked with TCE (approx 1000 ppb) and then equilibrated overnight (12degrees C)
Then extraction with hexane (1:1) began. Aliquots of the hexane phase were collected with time to determine the extent of recovery
and to determine if recovery is significantly affected by extraction time

The extractions were performed at room temperature

1	2	3	4	5	6	7	8	9	10	11	12	13
Container	Soil Mass (g)	Contents	TSF05 GW Volume (mL)	Initial TCE mass (mg)	GW Volume (mL)	Total Weight (g)	Init. Aq. TCE (ppb)	Equil Start Time=0	Hexane Vol (mL)	Total Mass Transferred (g)	Not Transferred (g)	Wt%
Vial1	LOST SAMPLE-VIAL BROKE											
Vial2	10.275	Dried Sludge/GW		0.044	36.971	47.246	1190.12199	9/14/98 13:01	39.508182	46.579	0.667	0.9858824
Vial3	10.231	Dried Sludge/GW		0.044	37.347	47.578	1178.14015	9/14/98 13:02	39.52803	46.769	0.809	0.9829963
Vial4	0	Spiked GW Only		0.044	42.699	42.699	1030.4691	9/14/98 13:03	39.526364	42.416	0.283	0.9933722

9/15/98 8:05

Placed 125 vials onto shaker and started extraction at 250 rpm.

Most Columns on the following page are self explanatory except for the following:

Col 21 is the GC value of the GC sample listed in Cols 14 and 15 (It is linked to this file from the G.C. spreadsheets)

Col 23= Col 21 x Col 19 x conversion factors to yield TCE mass of the aliquot (ug)

Col 24 is the Volume of Sample remaining in the reactor at the time of the current sampling

Col 25= Col 21 x Col 24 x conversion factors to yield TCE mass in the Reactor at the current sampling (ug)

Col 26= running total of Col 23

Col 27= Col 25 + Col 26

Cols 28,29&30: Cols 24,25&26 expressed in %Recovered Thus, these values assume 44ug TCE Initially in each Reactor

Experiment 2b-3b, Sludge Hexane For additional comments, see the RMAL Laboratory Research Notebook

14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
CONTAINER #2																
ORNL	Sample	Bottle	Collect	Elapsed	Hex Aliquot	Hexane	GC Value	TCE in	Vol	TCE	TCE in Prev	Total TCE	Sample	Aliquot	Total TCE	
GC #	Name	No	Time	Time (hrs)	Vol (mL)	Sample DF	(ppb)	FLAG	Aliquot(ug)	Hex (mL)	sample (ug)	Aliquots (ug)	(ug)	%Rec	%Rec	%Rec
1999	2b-3b-2-2hrs	2	9/15/98 10:10	2.1	1.0	1.000	1,142		1.142080179	39.51	45.1	0	45.1	103%	0%	103%
2000	2b-3b-2-4hrs	2	9/15/98 12:10	4.1	1.0	1.000	1,168		1.167837153	38.51	45.0	1.142080179	46.1	102%	3%	105%
2001	2b-3b-2-6hrs	2	9/15/98 14:10	6.1	1.0	1.000	1,175 E		1.17491047	37.51	44.1	2.309917331	46.4	100%	5%	105%
2002	2b-3b-2-20hrs	2	9/16/98 7:00	22.9	1.0	1.000	1,195 E		1.195232877	36.51	43.6	3.484827801	47.1	99%	8%	107%
2003	2b-3b-2-24hrs	2	9/16/98 8:10	24.1	1.0	1.000	1,189 E		1.188969427	35.51	42.2	4.680060678	46.9	96%	11%	107%
2014	2b-3b-2-48hrs	2	9/17/98 8:10	48.1	1.0	1.000	1,201 E		1.200605823	34.51	41.4	5.869030106	47.3	94%	13%	107%
Average:																106%

CONTAINER #3																
ORNL	Sample	Bottle	Collect	Elapsed	Hex Aliquot	Hexane	GC Value	TCE in	Vol	TCE	TCE in Prev	Total TCE	Sample	Aliquot	Total TCE	
GC #	Name	No	Time	Time (hrs)	Vol (mL)	Sample DF	(ppb)	FLAG	Aliquot(ug)	Hex (mL)	sample (ug)	Aliquots (ug)	(ug)	%Rec	%Rec	%Rec
2004	2b-3b-2-2hrs	3	9/15/98 10:10	2.1	1.0	1.000	1,152		1.151764088	39.53	45.5	0	45.5	103%	0%	103%
2005	2b-3b-2-4hrs	3	9/15/98 12:10	4.1	1.0	1.000	1,153		1.152968679	38.53	44.4	1.151764088	45.6	101%	3%	104%
2006	2b-3b-2-6hrs	3	9/15/98 14:10	6.1	1.0	1.000	1,175 E		1.175198149	37.53	44.1	2.304732767	46.4	100%	5%	105%
2007	2b-3b-2-20hrs	3	9/16/98 7:00	22.9	1.0	1.000	1,192 E		1.191745162	36.53	43.5	3.479930916	47.0	99%	8%	107%
2008	2b-3b-2-24hrs	3	9/16/98 8:10	24.1	1.0	1.000	1,190 E		1.190126835	35.53	42.3	4.671676079	47.0	96%	11%	107%
2015	2b-3b-2-48hrs	3	9/17/98 8:10	48.1	1.0	1.000	1,199 E		1.198602632	34.53	41.4	5.861802913	47.2	94%	13%	107%
Average:																106%

CONTAINER #4																
ORNL	Sample	Bottle	Collect	Elapsed	Hex Aliquot	Hexane	GC Value	TCE in	Vol	TCE	TCE in Prev	Total TCE	Sample	Aliquot	Total TCE	
GC #	Name	No	Time	Time (hrs)	Vol (mL)	Sample DF	(ppb)	FLAG	Aliquot(ug)	Hex (mL)	sample (ug)	Aliquots (ug)	(ug)	%Rec	%Rec	%Rec
2009	2b-3b-2-2hrs	4	9/15/98 10:10	2.1	1.0	1.000	1,167		1.166700168	39.53	46.1	0	46.1	105%	0%	105%
2010	2b-3b-2-4hrs	4	9/15/98 12:10	4.1	1.0	1.000	1,173 E		1.173180169	38.53	45.2	1.166700168	46.4	103%	3%	105%
2011	2b-3b-2-6hrs	4	9/15/98 14:10	6.1	1.0	1.000	1,172 E		1.172301638	37.53	44.0	2.339880337	46.3	100%	5%	105%
2012	2b-3b-2-20hrs	4	9/16/98 7:00	22.9	1.0	1.000	1,172 E		1.17176783	36.53	42.8	3.512181976	46.3	97%	8%	105%
2013	2b-3b-2-24hrs	4	9/16/98 8:10	24.1	1.0	1.000	1,173 E		1.172642839	35.53	41.7	4.683949805	46.3	95%	11%	105%
2016	2b-3b-2-48hrs	4	9/17/98 8:10	48.1	1.0	1.000	1,179 E		1.179453478	34.53	40.7	5.856592645	46.6	93%	13%	106%
Average:																105%

1169 THE LARGEST CALB. STANDARD CONCENTRATION

Minimum 27.00 ug
Maximum 47.30 ug
Difference 20.30 ug

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

1 2 3 4 5 6 7 8 9 10

General Data					Sample Data				
Flask No.	RXN Time (hrs)	Sample Name	Volume GW Used (mL)	Media Type	Solid Mass (grams)	vol (mL) aqueous aliquot	Cum Aliquot Vol (mL)	Actual Vol at Sampling	Actual L/S Ratio

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Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

11	12	13	14	15	16	17	18	19	20
MnO ₄ ⁻ Calb. Slope:	slope	STOCK SOLUTION ABS or CONC: DF:				DF of Stock	CONC:	Stock Conc.	
Calibration Date:		Diluted Sample, ABS for ESD, Conc for RMAL							
MnO₄⁻ Data									pH Data
Volume KMnO ₄ Added (mL)	Initial MnO ₄ ⁻ (mg/L)	Aliquot MnO ₄ ⁻ ABS or Conc.	Final Spec DF	Final MnO ₄ ⁻ (mg/L)	mg MnO ₄ ⁻ Consumed in Interval	Cum. mg MnO ₄ ⁻ Consumed	Cum mg MnO ₄ ⁻ per gram	mg MnO ₄ ⁻ in Aliquot	pH

stock solution for 0.01% and 0.1% MnO₄⁻ Loading (calb. Pipette)

This is the conc. at the beginning of each sampling interval.
 @ T=0: 0
 @ T=0.5hr: (Col 11 x Stock Conc.) / [(Col 4 - (Col 8 @ T=0) + Col 11)]
 (Stock Conc at top of page)
 @ All Other Sampling Periods: Col 15 of previous sampling Period

(Col 15 - Col 12) x Col 9

Running total of oxidant mass consumed from each reactor

Col 17 / Col 6 (Assumed that mass of solid withdrawn in aliquot was negligible)

Col 15 x Col 7

Laboratory Determined value for each sample aliquot

Dilution Factor used on Spec. Sample.

ESD:
Measured Absorbance
RMAL:
Measured Conc.

Actual Conc. of Aliquot
 ESD:
(Col 13 / slope) x Col 14
 RMAL:
Col 13 x Col 14
 (Slope at top of page)

Calculations for 0.01% and 0.1% MnO₄⁻ Loadings Only

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp. Repeated 3a-R1 For additional comments, see Laboratory Notebook B000025 75-77
MnO4- Calb. Slope: 0.022 STOCK SOLUTION ABS: 0.514 DF: 1666.667 CONC: 38384.029 mg/L MnO4-
Calibration Date: 06/10/98

Calibration Date: 06/10/98

Sample Data																	MnO ₄ - Data				pH Data	
Flask No.	RXN Time (hrs)	Sample Name	Volume GW Used (mL)	Media Type	Solid Mass (grams)	vol (mL) aqueous aliquot	Cum Vol (mL) Sampling	Actual Vol at L/S Ratio	Volume Initial Added (n (mg/L)	MnO ₄ - Aliquot ABS	Final Spec DF	Final MnO ₄ - (mg/L)	mg MnO ₄ - Consumed in Interval	Cum. mg MnO ₄ - Consumed	Cum mg MnO ₄ - in Aliquot per g or mL	mg MnO ₄ - in Aliquot	pH Reading					
1	0.00	Initial	199.905	DI WATER	0	6.5	6.5	199.9 NA	0	0.0 NA	NA	99.0	0.0	0.0	0.00	0.0 NT						
1	0.58	30min	199.905	DI WATER	0	6.5	13	193.9 NA	0.5	99.0 0.423	5	94.8	0.8	0.8	0.00	0.6 NT						
1	1.00	1 hour	199.905	DI WATER	0	6.5	19.5	187.4 NA	0.5	94.8 0.415	5	93.0	0.3	1.2	0.01	0.6 NT						
1	2.03	2 hours	199.905	DI WATER	0	6.5	26	180.9 NA	0.5	93.0 0.394	5	88.3	0.9	2.0	0.01	0.6 NT						
1	4.02	4hours	199.905	DI WATER	0	6.5	32.5	174.4 NA	0.5	88.3 0.413	5	92.5	-0.7	1.3	0.01	0.6 NT						
1	20.42	20 hours	199.905	DI WATER	0	6.5	39	167.9 NA	0.5	92.5 0.408	5	91.4	0.2	1.4	0.01	0.6 NT						
1	23.50	24 hours	199.905	DI WATER	0	6.5	45.5	161.4 NA	0.5	91.4 0.415	5	93.0	-0.3	1.2	0.01	0.6 NT						
2	0.00	Initial	199.946	GW	0	6.5	6.5	199.9 NA	0	0.0 NA	NA	99.0	0.0	0.0	0.00	0.0 NT						
2	0.58	30min	199.946	GW	0	6.5	13	193.9 NA	0.5	99.0 0.423	5	94.8	0.8	0.8	0.00	0.6 NT						
2	1.00	1 hour	199.946	GW	0	6.5	19.5	187.4 NA	0.5	94.8 0.417	5	93.4	0.3	1.1	0.01	0.6 NT						
2	2.03	2 hours	199.946	GW	0	6.5	26	180.9 NA	0.5	93.4 0.419	5	93.9	-0.1	1.0	0.00	0.6 NT						
2	4.02	4hours	199.946	GW	0	6.5	32.5	174.4 NA	0.5	93.9 0.429	5	96.1	-0.4	0.6	0.00	0.6 NT						
2	20.42	20 hours	199.946	GW	0	6.5	39	167.9 NA	0.5	96.1 0.426	5	95.4	0.1	0.7	0.00	0.6 NT						
2	23.50	24 hours	199.946	GW	0	6.5	45.5	161.4 NA	0.5	95.4 0.411	5	92.1	0.5	1.2	0.01	0.6 NT						
3	0.00	Initial	198.257	CB/GW	50.034	6.5	6.5	198.3 4.0	0	0.0 NA	NA	99.8	0.0	0.0	0.00	0.0 NT						
3	0.58	30min	198.257	CB/GW	50.034	6.5	13	192.3 3.8	0.5	99.8 0.405	5	90.7	1.7	1.7	0.03	0.6 NT						
3	1.00	1 hour	198.257	CB/GW	50.034	6.5	19.5	185.8 3.7	0.5	90.7 0.392	5	87.8	0.5	2.3	0.05	0.6 NT						
3	2.03	2 hours	198.257	CB/GW	50.034	6.5	26	179.3 3.6	0.5	87.8 0.382	5	85.6	0.4	2.7	0.05	0.6 NT						
3	4.02	4hours	198.257	CB/GW	50.034	6.5	32.5	172.8 3.5	0.5	85.6 0.375	5	84.0	0.3	3.0	0.06	0.5 NT						
3	20.42	20 hours	198.257	CB/GW	50.034	6.5	39	166.3 3.3	0.5	84.0 0.309	5	69.2	2.5	5.4	0.11	0.4 NT						
3	23.50	24 hours	198.257	CB/GW	50.034	6.5	45.5	159.8 3.2	0.5	69.2 0.293	5	65.6	0.6	6.0	0.12	0.4 NT						
4	0.00	Initial	198.9	CB/GW	50.001	6.5	6.5	198.9 4.0	0	0.0 NA	NA	99.5	0.0	0.0	0.00	0.0 NT						
4	0.58	30min	198.9	CB/GW	50.001	6.5	13	192.9 3.9	0.5	99.5 0.405	5	90.7	1.7	1.7	0.03	0.6 NT						
4	1.00	1 hour	198.9	CB/GW	50.001	6.5	19.5	186.4 3.7	0.5	90.7 0.395	5	88.5	0.4	2.1	0.04	0.6 NT						
4	2.03	2 hours	198.9	CB/GW	50.001	6.5	26	179.9 3.6	0.5	88.5 0.382	5	85.6	0.5	2.6	0.05	0.6 NT						
4	4.02	4hours	198.9	CB/GW	50.001	6.5	32.5	173.4 3.5	0.5	85.6 0.379	5	84.9	0.1	2.7	0.05	0.6 NT						
4	20.42	20 hours	198.9	CB/GW	50.001	6.5	39	166.9 3.3	0.5	84.9 0.315	5	70.6	2.4	5.1	0.10	0.5 NT						
4	23.50	24 hours	198.9	CB/GW	50.001	6.5	45.5	160.4 3.2	0.5	70.6 0.295	5	66.1	0.7	5.9	0.12	0.4 NT						

Prepared by: S.R. Cline

Last Updated: 11/3/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Experiment: Repeated 3a-R1

For additional comments, see Laboratory Notebook B000025

Pages: 75-77

Experiment Start Date: 6/10/98

Comments:

This procedure was re performed using a new MnO₄ calb curve and the oxidant was added via a 4% stock solution
Collected a 6-7 mL aliquot at each sampling period.

C-21

Prepared by: S.R. Cline

Last Updated: 11/3/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp. Repeated 3a-R1 For additional comments, see Laboratory Notebook B000025 75-77
MnO₄- Calb. Slope: 0.022 STOCK SOLUTION ABS: 0.514 DF: 1666.667 CONC: 38384.029 mg/L MnO₄-
Calibration Date: 06/10/98

Calculation Date: 06/10/2026																		
Sample Data										MnO ₄ - Data				pH Data				
Flask No.	RXN Time (hrs)	Sample Name	Volume GW Used (mL)	Media Type	Solid Mass (grams)	vol (mL) aqueous aliquot	Cum Vol (mL) Sampling	Actual Vol at L/S	Actual L/S Ratio	Volume KMnO ₄ Added (n (mg/L)	Initial MnO ₄ - Aliquot MnO ₄ - ABS	Final Spec DF	Final MnO ₄ - (mg/L)	mg MnO ₄ - Consume in Interval	Cum mg MnO ₄ - Consumed	mg MnO ₄ - in Aliquot per g or mL	pH Reading	
5	0.00	Initial	199.124	AB/GW	49.859	6.5	6.5	199.1	4.0	0	0.0 NA	NA	99.4	0.0	0.0	0.00	0.0 NT	
5	0.58	30min	199.1	AB/GW	49.9	6.5	13	193.1	3.9	0.5	99.4	0.428	5	95.9	0.7	0.7	0.01	0.6 NT
5	1.00	1 hour	199.1	AB/GW	49.9	6.5	19.5	186.6	3.7	0.5	95.9	0.421	5	94.3	0.3	1.0	0.02	0.6 NT
5	2.03	2 hours	199.1	AB/GW	49.9	6.5	26	180.1	3.6	0.5	94.3	0.411	5	92.1	0.4	1.4	0.03	0.6 NT
5	4.02	4hours	199.1	AB/GW	49.9	6.5	32.5	173.6	3.5	0.5	92.1	0.42	5	94.1	-0.4	1.0	0.02	0.6 NT
5	20.42	20 hours	199.1	AB/GW	49.9	6.5	39	167.1	3.4	0.5	94.1	0.375	5	84.0	1.7	2.7	0.05	0.5 NT
5	23.50	24 hours	199.1	AB/GW	49.9	6.5	45.5	160.6	3.2	0.5	84.0	0.352	5	78.9	0.8	3.5	0.07	0.5 NT
6	0.00	Initial	200.168	AB/GW	49.9	6.5	6.5	200.2	4.0	0	0.0 NA	NA	98.8	0.0	0.0	0.00	0.0 NT	
6	0.58	30min	200.2	AB/GW	49.9	6.5	13	194.2	3.9	0.5	98.8	0.431	5	96.6	0.4	0.4	0.01	0.6 NT
6	1.00	1 hour	200.2	AB/GW	49.9	6.5	19.5	187.7	3.8	0.5	96.6	0.424	5	95.0	0.3	0.7	0.01	0.6 NT
6	2.03	2 hours	200.2	AB/GW	49.9	6.5	26	181.2	3.6	0.5	95.0	0.414	5	92.7	0.4	1.1	0.02	0.6 NT
6	4.02	4hours	200.2	AB/GW	49.9	6.5	32.5	174.7	3.5	0.5	92.7	0.426	5	95.4	-0.5	0.7	0.01	0.6 NT
6	20.42	20 hours	200.2	AB/GW	49.9	6.5	39	168.2	3.4	0.5	95.4	0.391	5	87.6	1.3	2.0	0.04	0.6 NT
6	23.50	24 hours	200.2	AB/GW	49.9	6.5	45.5	161.7	3.2	0.5	87.6	0.366	5	82.0	0.9	2.9	0.06	0.5 NT
7	0.00	Initial	199.859	SED1/GW	50	6.5	6.5	199.9	4.0	0	0.0 NA	NA	99.0	0.0	0.0	0.00	0.0 NT	
7	0.58	30min	199.9	SED1/GW	50.0	6.5	13	193.9	3.9	0.5	99.0	0.364	5	81.5	3.4	3.4	0.07	0.5 NT
7	1.00	1 hour	199.9	SED1/GW	50.0	6.5	19.5	187.4	3.7	0.5	81.5	0.343	5	76.8	0.9	4.3	0.09	0.5 NT
7	2.03	2 hours	199.9	SED1/GW	50.0	6.5	26	180.9	3.6	0.5	76.8	0.322	5	72.1	0.9	5.1	0.10	0.5 NT
7	4.02	4hours	199.9	SED1/GW	50.0	6.5	32.5	174.4	3.5	0.5	72.1	0.309	5	69.2	0.5	5.6	0.11	0.4 NT
7	20.42	20 hours	199.9	SED1/GW	50.0	6.5	39	167.9	3.4	0.5	69.2	0.233	5	52.2	2.9	8.5	0.17	0.3 NT
7	23.50	24 hours	199.9	SED1/GW	50.0	6.5	45.5	161.4	3.2	0.5	52.2	0.229	5	51.3	0.1	8.6	0.17	0.3 NT
8	0.00	Initial	199.613	SED1/GW	50.087	6.5	6.5	199.6	4.0	0	0.0 NA	NA	99.1	0.0	0.0	0.00	0.0 NT	
8	0.58	30min	199.6	SED1/GW	50.1	6.5	13	193.6	3.9	0.5	99.1	0.378	5	84.7	2.8	2.8	0.06	0.6 NT
8	1.00	1 hour	199.6	SED1/GW	50.1	6.5	19.5	187.1	3.7	0.5	84.7	0.365	5	81.8	0.5	3.3	0.07	0.5 NT
8	2.03	2 hours	199.6	SED1/GW	50.1	6.5	26	180.6	3.6	0.5	81.8	0.348	5	78.0	0.7	4.0	0.08	0.5 NT
8	4.02	4hours	199.6	SED1/GW	50.1	6.5	32.5	174.1	3.5	0.5	78.0	0.341	5	76.4	0.3	4.3	0.09	0.5 NT
8	20.42	20 hours	199.6	SED1/GW	50.1	6.5	39	167.6	3.3	0.5	76.4	0.293	5	65.6	1.8	6.1	0.12	0.4 NT
8	23.50	24 hours	199.6	SED1/GW	50.1	6.5	45.5	161.1	3.2	0.5	65.6	0.271	5	60.7	0.8	6.9	0.14	0.4 NT

Prepared by: S.R. Cline

Last Updated: 11/3/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Experiment: Repeated 3a-R2

For additional comments, see Laboratory Notebook B000025

Pages: 82-84

Experiment Start Date: 6/22/98

Comments:

This procedure was re performed using a new MnO_4 calb curve and the oxidant was added via a 4% stock solution

Collected a 6-7 mL aliquot at each sampling period.

C-23

Prepared by: S.R. Cline

LastUpdated: 11/3/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.		Repeated 3a-R2		For additional comments, see Laboratory Notebook B000025										82-84						
MnO4- Calb. Slope:		0.022 STOCK SOLUTION ABS:										0.263 DF:			3333.333 CONC:			39280.16 mg/L MnO4-		
Calibration Date: 06/10/98																				
		Sample Data										MnO4- Data						pH Data		
Flask No.	RXN	Sample Name	Volume GW Used (mL)	Media Type	Solid Mass (grams)	vol (mL) aqueous aliquot	Cum Vol (mL)	Actual Aliquot	Actual Vol at Sampling	Actual L/S Ratio	Volume Initial KMnO4 Added (n (mg/L))	Aliquot MnO4- ABS	Final Spec DF	Final MnO4- (mg/L)	mg MnO4- Consumed in Interval	Cum mg MnO4 Consumed per g or mL	mg MnO4 in Aliquot	pH Reading		
1	0.00	Initial	200.0	DI WATER	0	6.5	6.5	200.0	NA	NA	0	0.0 NA	NA	989.4	0.0	0.0	0.00	0.0 NT		
1	0.57	30min	200.0	DI WATER	0	6.5	13	198.5	NA	NA	5	989.4	0.435	50	974.5	3.0	3.0	0.01	6.3 NT	
1	1.10	1 hour	200.0	DI WATER	0	6.5	19.5	192.0	NA	NA	5	974.5	0.419	50	938.7	6.9	9.8	0.05	6.1 NT	
1	2.32	2 hours	200.0	DI WATER	0	6.5	26	185.5	NA	NA	5	938.7	0.428	50	958.9	-3.7	6.1	0.03	6.2 NT	
1	4.23	4 hours	200.0	DI WATER	0	6.5	32.5	179.0	NA	NA	5	958.9	0.421	50	943.2	2.8	8.9	0.04	6.1 NT	
1	21.15	20 hours	200.0	DI WATER	0	6.5	39	172.5	NA	NA	5	943.2	0.424	50	949.9	-1.2	7.7	0.04	6.2 NT	
1	24.10	24 hours	200.0	DI WATER	0	6.5	45.5	166.0	NA	NA	5	949.9	0.391	50	876.0	12.3	20.0	0.10	5.7 NT	
2	0.00	Initial	200.0	GW	0	6.5	6.5	200.0	NA	NA	0	0.0 NA	NA	989.4	0.0	0.0	0.00	0.0 NT		
2	0.57	30min	200.0	GW	0	6.5	13	198.5	NA	NA	5	989.4	0.435	50	974.5	3.0	3.0	0.01	6.3 NT	
2	1.10	1 hour	200.0	GW	0	6.5	19.5	192.0	NA	NA	5	974.5	0.419	50	938.7	6.9	9.8	0.05	6.1 NT	
2	2.32	2 hours	200.0	GW	0	6.5	26	185.5	NA	NA	5	938.7	0.407	50	911.8	5.0	14.8	0.07	5.9 NT	
2	4.23	4 hours	200.0	GW	0	6.5	32.5	179.0	NA	NA	5	911.8	0.414	50	927.5	-2.8	12.0	0.06	6.0 NT	
2	21.15	20 hours	200.0	GW	0	6.5	39	172.5	NA	NA	5	927.5	0.422	50	945.4	-3.1	8.9	0.04	6.1 NT	
2	24.10	24 hours	200.0	GW	0	6.5	45.5	166.0	NA	NA	5	945.4	0.402	50	900.6	7.4	16.4	0.08	5.9 NT	
3	0.00	Initial	200.0	CB/GW	50.5	6.5	6.5	200.0	4.0	4.0	0	0.0 NA	NA	989.4	0.0	0.0	0.00	0.0 NT		
3	0.57	30min	200.0	CB/GW	50.5	6.5	13	198.5	3.9	3.9	5	989.4	0.435	50	974.5	3.0	3.0	0.06	6.3 NT	
3	1.10	1 hour	200.0	CB/GW	50.5	6.5	19.5	192.0	3.8	3.8	5	974.5	0.434	50	972.3	0.4	3.4	0.07	6.3 NT	
3	2.32	2 hours	200.0	CB/GW	50.5	6.5	26	185.5	3.7	3.7	5	972.3	0.415	50	929.7	7.9	11.3	0.22	6.0 NT	
3	4.23	4 hours	200.0	CB/GW	50.5	6.5	32.5	179.0	3.5	3.5	5	929.7	0.432	50	967.8	-6.8	4.5	0.09	6.3 NT	
3	21.15	20 hours	200.0	CB/GW	50.5	6.5	39	172.5	3.4	3.4	5	967.8	0.413	50	925.2	7.3	11.8	0.23	6.0 NT	
3	24.10	24 hours	200.0	CB/GW	50.5	6.5	45.5	166.0	3.3	3.3	5	925.2	0.401	50	898.4	4.5	16.3	0.32	5.8 NT	
4	0.00	Initial	200.0	CB/GW	50.31	6.5	6.5	200.0	4.0	4.0	0	0.0 NA	NA	989.4	0.0	0.0	0.00	0.0 NT		
4	0.57	30min	200.0	CB/GW	50.31	6.5	13	198.5	3.9	3.9	5	989.4	0.432	50	967.8	4.3	4.3	0.09	6.3 NT	
4	1.10	1 hour	200.0	CB/GW	50.31	6.5	19.5	192.0	3.8	3.8	5	967.8	0.406	50	909.6	11.2	15.5	0.31	5.9 NT	
4	2.32	2 hours	200.0	CB/GW	50.31	6.5	26	185.5	3.7	3.7	5	909.6	0.413	50	925.2	-2.9	12.6	0.25	6.0 NT	
4	4.23	4 hours	200.0	CB/GW	50.31	6.5	32.5	179.0	3.6	3.6	5	925.2	0.417	50	934.2	-1.6	11.0	0.22	6.1 NT	
4	21.15	20 hours	200.0	CB/GW	50.31	6.5	39	172.5	3.4	3.4	5	934.2	0.406	50	909.6	4.3	15.2	0.30	5.9 NT	
4	24.10	24 hours	200.0	CB/GW	50.31	6.5	45.5	166.0	3.3	3.3	5	909.6	0.398	50	891.6	3.0	18.2	0.36	5.8 NT	

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.		Repeated 3a-R2		For additional comments, see Laboratory Notebook B000025										82-84					
MnO4- Calb. Slope:		0.022 STOCK SOLUTION ABS:		0.263 DF:										3333.333 CONC: 39280.16 mg/L MnO4-					
Calibration Date: 06/10/98																			
				Sample Data						MnO4- Data				pH Data					
Flask No.	RXN	Sample Time (hrs)	Sample Name	Volume GW Used (mL)	Media Type	Solid Mass (grams)	vol (mL) aliquot	Cum Vol (mL) aliquot	Actual Vol at L/S	Actual Sampling Ratio	Volume KMnO4 Added (n (mg/L)	Initial MnO4- (mg/L)	Aliquot MnO4- ABS	Final Spec DF	Final MnO4- (mg/L)	mg MnO4- Consumed in Interval	Cum mg MnO4 Consumed per g or mL	mg MnO4- in Aliquot	pH Reading
5	0.00	Initial		200.0	AB/GW	49.98	6.5	6.5	200.0	4.0	0	0.0	NA	NA	989.4	0.0	0.0	0.00	0.0 NT
5	0.57	30min		200.0	AB/GW	50.0	6.5	13	198.5	4.0	5	989.4	0.435	50	974.5	3.0	3.0	0.06	6.3 NT
5	1.10	1 hour		200.0	AB/GW	50.0	6.5	19.5	192.0	3.8	5	974.5	0.427	50	956.6	3.4	6.4	0.13	6.2 NT
5	2.32	2 hours		200.0	AB/GW	50.0	6.5	26	185.5	3.7	5	956.6	0.406	50	909.6	8.7	15.1	0.30	5.9 NT
5	4.23	4 hours		200.0	AB/GW	50.0	6.5	32.5	179.0	3.6	5	909.6	0.413	50	925.2	-2.8	12.3	0.25	6.0 NT
5	21.15	20 hours		200.0	AB/GW	50.0	6.5	39	172.5	3.5	5	925.2	0.416	50	932.0	-1.2	11.2	0.22	6.1 NT
5	24.10	24 hours		200.0	AB/GW	50.0	6.5	45.5	166.0	3.3	5	932.0	0.4	50	896.1	6.0	17.1	0.34	5.8 NT
6	0.00	Initial		200.0	AB/GW	49.96	6.5	6.5	200.0	4.0	0	0.0	NA	NA	989.4	0.0	0.0	0.00	0.0 NT
6	0.57	30min		200.0	AB/GW	50.0	6.5	13	198.5	4.0	5	989.4	0.43	50	963.3	5.2	5.2	0.10	6.3 NT
6	1.10	1 hour		200.0	AB/GW	50.0	6.5	19.5	192.0	3.8	5	963.3	0.411	50	920.8	8.2	13.4	0.27	6.0 NT
6	2.32	2 hours		200.0	AB/GW	50.0	6.5	26	185.5	3.7	5	920.8	0.406	50	909.6	2.1	15.4	0.31	5.9 NT
6	4.23	4 hours		200.0	AB/GW	50.0	6.5	32.5	179.0	3.6	5	909.6	0.426	50	954.4	-8.0	7.4	0.15	6.2 NT
6	21.15	20 hours		200.0	AB/GW	50.0	6.5	39	172.5	3.5	5	954.4	0.415	50	929.7	4.3	11.7	0.23	6.0 NT
6	24.10	24 hours		200.0	AB/GW	50.0	6.5	45.5	166.0	3.3	5	929.7	0.41	50	918.5	1.9	13.5	0.27	6.0 NT
7	0.00	Initial		200.0	SED1/GW	50.07	6.5	6.5	200.0	4.0	0	0.0	NA	NA	989.4	0.0	0.0	0.00	0.0 NT
7	0.57	30min		200.0	SED1/GW	50.1	6.5	13	198.5	4.0	5	989.4	0.42	50	940.9	9.6	9.6	0.19	6.1 NT
7	1.10	1 hour		200.0	SED1/GW	50.1	6.5	19.5	192.0	3.8	5	940.9	0.412	50	923.0	3.4	13.1	0.26	6.0 NT
7	2.32	2 hours		200.0	SED1/GW	50.1	6.5	26	185.5	3.7	5	923.0	0.422	50	945.4	-4.2	8.9	0.18	6.1 NT
7	4.23	4 hours		200.0	SED1/GW	50.1	6.5	32.5	179.0	3.6	5	945.4	0.41	50	918.5	4.8	13.7	0.27	6.0 NT
7	21.15	20 hours		200.0	SED1/GW	50.1	6.5	39	172.5	3.4	5	918.5	0.398	50	891.6	4.6	18.4	0.37	5.8 NT
7	24.10	24 hours		200.0	SED1/GW	50.1	6.5	45.5	166.0	3.3	5	891.6	0.395	50	884.9	1.1	19.5	0.39	5.8 NT
8	0.00	Initial		200.0	SED1/GW	45	6.5	6.5	200.0	4.4	0	0.0	NA	NA	989.4	0.0	0.0	0.00	0.0 NT
8	0.57	30min		200.0	SED1/GW	45.0	6.5	13	198.5	4.4	5	989.4	0.428	50	958.9	6.1	6.1	0.13	6.2 NT
8	1.10	1 hour		200.0	SED1/GW	45.0	6.5	19.5	192.0	4.3	5	958.9	0.419	50	938.7	3.9	9.9	0.22	6.1 NT
8	2.32	2 hours		200.0	SED1/GW	45.0	6.5	26	185.5	4.1	5	938.7	0.424	50	949.9	-2.1	7.9	0.17	6.2 NT
8	4.23	4 hours		200.0	SED1/GW	45.0	6.5	32.5	179.0	4.0	5	949.9	0.414	50	927.5	4.0	11.9	0.26	6.0 NT
8	21.15	20 hours		200.0	SED1/GW	45.0	6.5	39	172.5	3.8	5	927.5	0.412	50	923.0	0.8	12.6	0.28	6.0 NT
8	24.10	24 hours		200.0	SED1/GW	45.0	6.5	45.5	166.0	3.7	5	923.0	0.388	50	869.2	8.9	21.6	0.48	5.7 NT

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Experiment: Repeated 3a-R3

For additional comments, see Laboratory Notebook B000025

Pages: 85-86

Experiment Start Date: 6/25/98

Comments:

Re-performed after a new calibration curve was prepared.

Collected a 6-7 mL aliquot at each sampling period.

(still performed by adding solid KMnO_4)

Laboratory notebook does indicate that the dilutions for the 1 and 2 time points was made using an adjustable pipette. Dilutions for the other time points were made using a 10uL Hamilton syringe for better accuracy.

Prepared by: S.R. Cline

Last Updated: 11/3/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp. Repeated 3a-R3 For additional comments, see Laboratory Notebook B000025

MnO4- Calb. Slope: 0.022

Calibration Date: 06/10/98

Calibration Date: 06/10/98																			pH Data	
Sample Data																			pH Data	
Flask No.	RXN Time (hrs)	Sample Name	Volume GW Used (mL)	Media Type	Solid Mass (grams)	vol (mL) aliquot	Cum Vol (mL)	Actual Aliquot Vol (mL)	Actual L/S Sampling Ratio	Mass KMnO4 Added (n (mg/L))	Initial MnO4- NA	Aliquot MnO4- ABS	Final Spec DF	Final MnO4- (mg/L)	mg MnO4- Consumed in Interval	Cum. mg MnO4- Consumed	Cum. mg MnO4- in Aliquot per g or mL	mg MnO4- in Aliquot	pH Reading	
1	0	Initial	200.006	DI Water	0	6.5	6.5	200.0	NA	0	0	NA	NA	10355.2	0.0	0.0	0.0	0.0	NT	
1	0.92	1 hour	200.006	DI Water	0	6.5	13	193.5	NA	2660.5	10355	0.429	500	9611	144.0	144.0	0.72	62.5	NT	
1	2.08	2 hours	200.006	DI Water	0	6.5	19.5	187.0	NA	2660.5	9611	0.425	500	9521	16.8	160.8	0.80	61.9	NT	
1	3.33	3 hours	200.006	DI Water	0	6.5	26	180.5	NA	2660.5	9521	0.454	500	10171	-117.3	43.5	0.22	66.1	NT	
1	4.17	4 hours	200.006	DI Water	0	6.5	32.5	174.0	NA	2660.5	10171	0.452	500	10126	7.8	51.3	0.26	65.8	NT	
1	19.67	20 hours	200.006	DI Water	0	6.5	39	167.5	NA	2660.5	10126	0.391	500	8760	228.9	280.2	1.40	56.9	NT	
1	23.92	24 hours	200.006	DI Water	0	6.5	45.5	161.0	NA	2660.5	8760	0.408	500	9140	-61.3	218.9	1.09	59.4	NT	
2	0	Initial	199.67	GW	0	6.5	6.5	199.7	NA	0	0	NA	NA	10368.1	0.0	0.0	0.00	0.0	NT	
2	0.92	1 hour	199.67	GW	0	6.5	13	193.2	NA	2659.2	10368	0.438	500	9813	107.3	107.3	0.54	63.8	NT	
2	2.08	2 hours	199.67	GW	0	6.5	19.5	186.7	NA	2659.2	9813	0.272	500	6094	694.2	801.5	4.01	39.6	NT	
2	3.33	3 hours	199.67	GW	0	6.5	26	180.2	NA	2659.2	6094	0.439	500	9835	-674.1	127.5	0.64	63.9	NT	
2	4.17	4 hours	199.67	GW	0	6.5	32.5	173.7	NA	2659.2	9835	0.446	500	9992	-27.2	100.2	0.50	64.9	NT	
2	19.67	20 hours	199.67	GW	0	6.5	39	167.2	NA	2659.2	9992	0.441	500	9880	18.7	118.9	0.60	64.2	NT	
2	23.92	24 hours	199.67	GW	0	6.5	45.5	160.7	NA	2659.2	9880	0.44	500	9857	3.6	122.5	0.61	64.1	NT	
3	0	Initial	200.06	CB/GW	50.055	6.5	6.5	200.1		4.0	0	0	NA	10350.8	0.0	0.0	0.00	0.0	NT	
3	0.92	1 hour	200.06	CB/GW	50.055	6.5	13	193.6		3.9	2660.1	10351	0.443	500	9925	82.5	82.5	1.65	64.5	NT
3	2.08	2 hours	200.06	CB/GW	50.055	6.5	19.5	187.1		3.7	2660.1	9925	0.453	500	10149	-41.9	40.6	0.81	66.0	NT
3	3.33	3 hours	200.06	CB/GW	50.055	6.5	26	180.6		3.6	2660.1	10149	0.46	500	10305	-28.3	12.3	0.25	67.0	NT
3	4.17	4 hours	200.06	CB/GW	50.055	6.5	32.5	174.1		3.5	2660.1	10305	0.447	500	10014	50.7	63.0	1.26	65.1	NT
3	19.67	20 hours	200.06	CB/GW	50.055	6.5	39	167.6		3.3	2660.1	10014	0.442	500	9902	18.8	81.7	1.63	64.4	NT
3	23.92	24 hours	200.06	CB/GW	50.055	6.5	45.5	161.1		3.2	2660.1	9902	0.449	500	10059	-25.3	56.5	1.13	65.4	NT
4	0	Initial	199.972	CB/GW	50	6.5	6.5	200.0		4.0	0	0	NA	10357.0	0.0	0.0	0.00	0.0	NT	
4	0.92	1 hour	199.972	CB/GW	50	6.5	13	193.5		3.9	2660.5	10357	0.44	500	9857	96.7	96.7	1.93	64.1	NT
4	2.08	2 hours	199.972	CB/GW	50	6.5	19.5	187.0		3.7	2660.5	9857	0.451	500	10104	-46.1	50.6	1.01	65.7	NT
4	3.33	3 hours	199.972	CB/GW	50	6.5	26	180.5		3.6	2660.5	10104	0.446	500	9992	20.2	70.8	1.42	64.9	NT
4	4.17	4 hours	199.972	CB/GW	50	6.5	32.5	174.0		3.5	2660.5	9992	0.452	500	10126	-23.4	47.4	0.95	65.8	NT
4	19.67	20 hours	199.972	CB/GW	50	6.5	39	167.5		3.3	2660.5	10126	0.443	500	9925	33.8	81.2	1.62	64.5	NT
4	23.92	24 hours	199.972	CB/GW	50	6.5	45.5	161.0		3.2	2660.5	9925	0.438	500	9813	18.0	99.2	1.98	63.8	NT

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.		Repeated 3a-R3		For additional comments, see Laboratory Notebook B000025															
MnO4- Calb. Slope:		0.022																	
Calibration Date: 06/10/98																			
				Sample Data										pH Data					
Flask No.	RXN	Sample Name	Volume GW Used (mL)	Media Type	Solid Mass (grams)	vol (mL) aqueous aliquot	Cum Vol (mL)	Actual Vol at L/S	Actual L/S	Mass Added (n (mg/L))	Initial MnO4-	Aliquot MnO4- ABS	Final Spec DF	Final MnO4- (mg/L)	mg MnO4- Consumed in Interval	Cum. mg MnO4- Consumed	Cum. mg MnO4- in Aliquot per g or mL	mg MnO4- in Aliquot	pH Reading
5	0	Initial	199.729	AB/GW	50.181	6.5	6.5	199.7	4.0	0	0 NA	NA	NA	10371.2	0.0	0.0	0.00	0.0	NT
5	0.92	1 hour	199.7	AB/GW	50.2	6.5	13	193.2	3.9	2660.8	10371	0.315	500	7057	640.4	640.4	12.76	45.9	NT
5	2.08	2 hours	199.7	AB/GW	50.2	6.5	19.5	186.7	3.7	2660.8	7057	0.449	500	10059	-560.6	79.8	1.59	65.4	NT
5	3.33	3 hours	199.7	AB/GW	50.2	6.5	26	180.2	3.6	2660.8	10059	0.458	500	10261	-36.3	43.5	0.87	66.7	NT
5	4.17	4 hours	199.7	AB/GW	50.2	6.5	32.5	173.7	3.5	2660.8	10261	0.455	500	10193	11.7	55.2	1.10	66.3	NT
5	19.67	20 hours	199.7	AB/GW	50.2	6.5	39	167.2	3.3	2660.8	10193	0.449	500	10059	22.5	77.7	1.55	65.4	NT
5	23.92	24 hours	199.7	AB/GW	50.2	6.5	45.5	160.7	3.2	2660.8	10059	0.45	500	10081	-3.6	74.1	1.48	65.5	NT
6	0	Initial	199.689	AB/GW	50.05	6.5	6.5	199.7	4.0	0	0 NA	NA	NA	10370.2	0.0	0.0	0.00	0.0	NT
6	0.92	1 hour	199.7	AB/GW	50.1	6.5	13	193.2	3.9	2660	10370	0.315	500	7057	640.1	640.1	12.79	45.9	NT
6	2.08	2 hours	199.7	AB/GW	50.1	6.5	19.5	186.7	3.7	2660	7057	0.45	500	10081	-564.6	75.5	1.51	65.5	NT
6	3.33	3 hours	199.7	AB/GW	50.1	6.5	26	180.2	3.6	2660	10081	0.458	500	10261	-32.3	43.2	0.86	66.7	NT
6	4.17	4 hours	199.7	AB/GW	50.1	6.5	32.5	173.7	3.5	2660	10261	0.452	500	10126	23.3	66.5	1.33	65.8	NT
6	19.67	20 hours	199.7	AB/GW	50.1	6.5	39	167.2	3.3	2660	10126	0.45	500	10081	7.5	74.0	1.48	65.5	NT
6	23.92	24 hours	199.7	AB/GW	50.1	6.5	45.5	160.7	3.2	2660	10081	0.445	500	9969	18.0	92.0	1.84	64.8	NT
7	0	Initial	199.742	SED1/GW	50.002	6.5	6.5	199.7	4.0	0	0 NA	NA	NA	10365.8	0.0	0.0	0.00	0.0	NT
7	0.92	1 hour	199.7	SED1/GW	50.0	6.5	13	193.2	3.9	2659.6	10366	0.454	500	10171	37.6	37.6	0.75	66.1	NT
7	2.08	2 hours	199.7	SED1/GW	50.0	6.5	19.5	186.7	3.7	2659.6	10171	0.467	500	10462	-54.4	-16.7	-0.33	68.0	NT
7	3.33	3 hours	199.7	SED1/GW	50.0	6.5	26	180.2	3.6	2659.6	10462	0.455	500	10193	48.5	31.7	0.63	66.3	NT
7	4.17	4 hours	199.7	SED1/GW	50.0	6.5	32.5	173.7	3.5	2659.6	10193	0.457	500	10238	-7.8	23.9	0.48	66.5	NT
7	19.67	20 hours	199.7	SED1/GW	50.0	6.5	39	167.2	3.3	2659.6	10238	0.442	500	9902	56.2	80.1	1.60	64.4	NT
7	23.92	24 hours	199.7	SED1/GW	50.0	6.5	45.5	160.7	3.2	2659.6	9902	0.456	500	10216	-50.4	29.7	0.59	66.4	NT
8	0	Initial	199.642	SED1/GW	50.02	6.5	6.5	199.6	4.0	0	0 NA	NA	NA	10377.8	0.0	0.0	0.00	0.0	NT
8	0.92	1 hour	199.6	SED1/GW	50.0	6.5	13	193.1	3.9	2661.3	10378	0.468	500	10485	-20.6	-20.6	-0.41	68.2	NT
8	2.08	2 hours	199.6	SED1/GW	50.0	6.5	19.5	186.6	3.7	2661.3	10485	0.468	500	10485	0.0	-20.6	-0.41	68.2	NT
8	3.33	3 hours	199.6	SED1/GW	50.0	6.5	26	180.1	3.6	2661.3	10485	0.461	500	10328	28.3	7.6	0.15	67.1	NT
8	4.17	4 hours	199.6	SED1/GW	50.0	6.5	32.5	173.6	3.5	2661.3	10328	0.461	500	10328	0.0	7.6	0.15	67.1	NT
8	19.67	20 hours	199.6	SED1/GW	50.0	6.5	39	167.1	3.3	2661.3	10328	0.445	500	9969	59.9	67.5	1.35	64.8	NT
8	23.92	24 hours	199.6	SED1/GW	50.0	6.5	45.5	160.6	3.2	2661.3	9969	0.453	500	10149	-28.8	38.7	0.77	66.0	NT

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Experiment: 3b-R1

For additional comments, see RMAL Laboratory Notebook

Comments:

Sample	Total Carbon %		Inorganic Carbon %		TOC %	
	Result	Error	Result	Error	Result	Error
3b-R1-3	4.89	0.489	1.47	0.147	3.42	0.342
3b-R1-4	3.83	0.383	1.19	0.119	2.64	0.264
INEEL Dry	8.11	0.811	1.44	0.144	6.67	0.667

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp. 3b-R1

For additional comments, see RMAL Laboratory Notebook

MnO4- Calb. Slope:		0.046																
Calibration Date: 5/5/98		5/5/98																
Sample Data																		pH Data
Flask No.	RXN Time (hrs)	Sample Name	Volume GW Used (mL)	Media Type	Solid Mass (grams)	vol (mL) aqueous aliquot	Cum Vol (mL) aliquot	Actual Vol at Sampling	Actual L/S Ratio	Mass KMnO4 Added (n (mg/L))	Initial MnO4- (mg/L)	Aliquot MnO4- (mg/L)	Final Spec DF	Final MnO4- (mg/L)	mg MnO4- Consumed in Interval	Cum mg MnO4- Consumed per g or mL	mg MnO4- in Aliquot	pH Reading
1	0.01	Initial	398	GW	0	6.5	6.5	398.0	NA	0.0	0.0	NA	NA	102.2	0.0	0.0	0.00	7.89
1	0.17	10 min		398 GW		0	6.5	13	391.5	NA	53.1	102.2 in RMAL	5	97.5	1.8	1.8	0.00	7.93
1	0.80	48 min		398 GW		0	6.5	19.5	385.0	NA	53.1	97.5 in RMAL	5	100.0	-1.0	0.9	0.00	7.95
1	1.30	1.5 hours		398 GW		0	6.5	26	378.5	NA	53.1	100.0 in RMAL	5	100.0	0.0	0.9	0.00	8.00
1	2.30	2.5 hours		398 GW		0	6.5	32.5	372.0	NA	53.1	100.0 in RMAL	5	101.0	-0.4	0.5	0.00	8.03
1	5.00	5 hours		398 GW		0	6.5	39	365.5	NA	53.1	101.0 in RMAL	5	100.5	0.2	0.7	0.00	8.02
1	24.00	24 hours		398 GW		0	6.5	45.5	359.0	NA	53.1	100.5 in RMAL	5	101.0	-0.2	0.5	0.00	8.17
2	0	Initial	401	GW	0	6.5	6.5	401.0	NA	0.0	0.0	NA	NA	101.2	0.0	0.0	0.00	7.89
2	0.17	10 min		401 GW		0	6.5	13	394.5	NA	53.0	101.2 in RMAL	5	86.0	6.0	6.0	0.01	7.98
2	0.80	48 min		401 GW		0	6.5	19.5	388.0	NA	53.0	86.0 in RMAL	5	100.0	-5.4	0.6	0.00	7.98
2	1.30	1.5 hours		401 GW		0	6.5	26	381.5	NA	53.0	100.0 in RMAL	5	100.0	0.0	0.6	0.00	8.00
2	2.30	2.5 hours		401 GW		0	6.5	32.5	375.0	NA	53.0	100.0 in RMAL	5	100.0	0.0	0.6	0.00	8.03
2	5.00	5 hours		401 GW		0	6.5	39	368.5	NA	53.0	100.0 in RMAL	5	99.5	0.2	0.7	0.00	8.05
2	24.00	24 hours		401 GW		0	6.5	45.5	362.0	NA	53.0	99.5 in RMAL	5	99.0	0.2	0.9	0.00	8.25
3	0.01	Initial	403	TSF Sludge	107	6.5	6.5	403.0	3.8	0.0	0.0	NA	NA	101.4	0.0	0.0	0.00	7.10
3	0.17	10 min		403 TSF Sludge	107	6.5	13	396.5	3.7	53.4	101.4 in RMAL	5	0.0	40.2	40.2	0.38	0.0	6.94
3	0.80	48 min		403 TSF Sludge	107	6.5	19.5	390.0	3.6	53.4	0.0 in RMAL	5	0.0	0.0	40.2	0.38	0.0	6.75
3	1.30	1.5 hours		403 TSF Sludge	107	6.5	26	383.5	3.6	53.4	0.0 in RMAL	5	0.0	0.0	40.2	0.38	0.0	6.73
3	2.30	2.5 hours		403 TSF Sludge	107	6.5	32.5	377.0	3.5	53.4	0.0 in RMAL	5	0.0	0.0	40.2	0.38	0.0	6.64
3	5.00	5 hours		403 TSF Sludge	107	6.5	39	370.5	3.5	53.4	0.0 in RMAL	5	0.0	0.0	40.2	0.38	0.0	6.62
3	24.00	24 hours		403 TSF Sludge	107	6.5	45.5	364.0	3.4	53.4	0.0 in RMAL	5	0.0	0.0	40.2	0.38	0.0	6.59
4	0	Initial	396	TSF Sludge	112	6.5	6.5	396.0	3.5	0.0	0.0	NA	NA	101.9	0.0	0.0	0.00	7.66
4	0.17	10 min		396 TSF Sludge	112	6.5	13	389.5	3.5	52.7	101.9 in RMAL	5	0.0	39.7	39.7	0.35	0.0	7.22
4	0.80	48 min		396 TSF Sludge	112	6.5	19.5	383.0	3.4	52.7	0.0 in RMAL	5	0.0	0.0	39.7	0.35	0.0	7.18
4	1.30	1.5 hours		396 TSF Sludge	112	6.5	26	376.5	3.4	52.7	0.0 in RMAL	5	0.0	0.0	39.7	0.35	0.0	7.19
4	2.30	2.5 hours		396 TSF Sludge	112	6.5	32.5	370.0	3.3	52.7	0.0 in RMAL	5	0.0	0.0	39.7	0.35	0.0	7.11
4	5.00	5 hours		396 TSF Sludge	112	6.5	39	363.5	3.2	52.7	0.0 in RMAL	5	0.0	0.0	39.7	0.35	0.0	7.13
4	24.00	24 hours		396 TSF Sludge	112	6.5	45.5	357.0	3.2	52.7	0.0 in RMAL	5	0.0	0.0	39.7	0.35	0.0	7.18

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Experiment: 3b-R2

For additional comments, see RMAL Laboratory Notebook

Experiment Start Date: 5/7/98

Comments:

Sample	Total Carbon %		Inorganic Carbon %		TOC %	
	Result	Error	Result	Error	Result	Error
3b-R2-3	3.04	0.304	0.673	0.0673	2.367	0.2367
3b-R2-4	2.42	0.242	1.12	0.112	1.3	0.13
INEEL Dry	8.11	0.811	1.44	0.144	6.67	0.667

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Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp. 3b-R2

For additional comments, see RMAL Laboratory Notebook

MnO4- Calb. Slope:		0.046		5/5/98		Sample Data															pH Data				
Calibration Date: 5/5/98						Flask No.	RXN	Sample Name	Volume GW Used (mL)	Media Type	Solid Mass (grams)	vol (mL) aqueous aliquot	Cum Vol (mL)	Actual Aliquot	Actual L/S	Mass Added (in (mg/L))	Initial MnO4- (mg/L)	Aliquot MnO4- (mg/L)	Final Spec DF	Final MnO4- (mg/L)	mg MnO4- Consumed in Interval	Cum. mg MnO4- Consumed	Cum mg MnO4- in Aliquot per g or mL	mg MnO4- in Aliquot	pH Reading
1	0.01	Initial	399	GW	0							6.5	6.5	399.0	NA	0.0	0.0	NA	NA	1016.4	0.0	0.0	0.00	0.0	7.89
1	0.17	10 min		399 GW							0	6.5	13	392.5	NA	529.7	1016.4 in RMAL	50	825.0	75.1	75.1	0.19	5.4	8.05	
1	0.80	48 min		399 GW							0	6.5	19.5	386.0	NA	529.7	825.0 in RMAL	50	985.0	-61.8	13.4	0.03	6.4	8.07	
1	1.30	1.5 hours		399 GW							0	6.5	26	379.5	NA	529.7	985.0 in RMAL	50	1000.0	-5.7	7.7	0.02	6.5	8.08	
1	2.30	2.5 hours		399 GW							0	6.5	32.5	373.0	NA	529.7	1000.0 in RMAL	50	1000.0	0.0	7.7	0.02	6.5	8.09	
1	5.00	5 hours		399 GW							0	6.5	39	366.5	NA	529.7	1000.0 in RMAL	50	995.0	1.8	9.5	0.02	6.5	8.09	
1	24.00	24 hours		399 GW							0	6.5	45.5	360.0	NA	529.7	995.0 in RMAL	50	975.0	7.2	16.7	0.04	6.3	8.27	
2	0	Initial	396	GW	0							6.5	6.5	396.0	NA	0.0	0.0	NA	NA	1016.5	0.0	0.0	0.00	0.0	7.89
2	0.17	10 min		396 GW							0	6.5	13	389.5	NA	525.7	1016.5 in RMAL	50	785.0	90.2	90.2	0.23	5.1	8.05	
2	0.80	48 min		396 GW							0	6.5	19.5	383.0	NA	525.7	785.0 in RMAL	50	980.0	-74.7	15.5	0.04	6.4	8.05	
2	1.30	1.5 hours		396 GW							0	6.5	26	376.5	NA	525.7	980.0 in RMAL	50	1000.0	-7.5	8.0	0.02	6.5	8.08	
2	2.30	2.5 hours		396 GW							0	6.5	32.5	370.0	NA	525.7	1000.0 in RMAL	50	1005.0	-1.9	6.1	0.02	6.5	8.10	
2	5.00	5 hours		396 GW							0	6.5	39	363.5	NA	525.7	1005.0 in RMAL	50	995.0	3.6	9.8	0.02	6.5	8.12	
2	24.00	24 hours		396 GW							0	6.5	45.5	357.0	NA	525.7	995.0 in RMAL	50	1010.0	-5.4	4.4	0.01	6.6	8.16	
3	0.01	Initial	397	TSF Sludge	107							6.5	6.5	397.0	3.7	0.0	0.0	NA	NA	1016.6	0.0	0.0	0.00	0.0	7.38
3	0.17	10 min		397 TSF Sludge	107						107	6.5	13	390.5	3.6	527.1	1016.6 in RMAL	50	0.0	397.0	397.0	3.71	0.0	7.00	
3	0.80	48 min		397 TSF Sludge	107						107	6.5	19.5	384.0	3.6	527.1	0.0 in RMAL	50	0.0	0.0	397.0	3.71	0.0	7.01	
3	1.30	1.5 hours		397 TSF Sludge	107						107	6.5	26	377.5	3.5	527.1	0.0 in RMAL	50	0.0	0.0	397.0	3.71	0.0	7.01	
3	2.30	2.5 hours		397 TSF Sludge	107						107	6.5	32.5	371.0	3.5	527.1	0.0 in RMAL	50	0.0	0.0	397.0	3.71	0.0	7.00	
3	5.00	5 hours		397 TSF Sludge	107						107	6.5	39	364.5	3.4	527.1	0.0 in RMAL	50	0.0	0.0	397.0	3.71	0.0	7.04	
3	24.00	24 hours		397 CB/GW	107						107	6.5	45.5	358.0	3.3	527.1	0.0 in RMAL	50	0.0	0.0	397.0	3.71	0.0	7.06	
4	0	Initial	393	TSF Sludge	117							6.5	6.5	393.0	3.4	0.0	0.0	NA	NA	1017.4	0.0	0.0	0.00	0.0	7.33
4	0.17	10 min		393 TSF Sludge	117						117	6.5	13	386.5	3.3	522.1	1017.4 in RMAL	50	0.0	393.2	393.2	3.36	0.0	7.00	
4	0.80	48 min		393 TSF Sludge	117						117	6.5	19.5	380.0	3.2	522.1	0.0 in RMAL	50	0.0	0.0	393.2	3.36	0.0	6.94	
4	1.30	1.5 hours		393 TSF Sludge	117						117	6.5	26	373.5	3.2	522.1	0.0 in RMAL	50	0.0	0.0	393.2	3.36	0.0	6.96	
4	2.30	2.5 hours		393 TSF Sludge	117						117	6.5	32.5	367.0	3.1	522.1	0.0 in RMAL	50	0.0	0.0	393.2	3.36	0.0	6.93	
4	5.00	5 hours		393 TSF Sludge	117						117	6.5	39	360.5	3.1	522.1	0.0 in RMAL	50	0.0	0.0	393.2	3.36	0.0	6.96	
4	24.00	24 hours		393 CB/GW	117						117	6.5	45.5	354.0	3.0	522.1	0.0 in RMAL	50	0.0	0.0	393.2	3.36	0.0	7.03	

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Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Experiment: 3b-R3

For additional comments, see RMAL Laboratory Notebook

Experiment Start Date: 5/7/98

Comments:

Sample	Total Carbon %		Inorganic Carbon %		TOC %	
	Result	Error	Result	Error	Result	Error
3b-R3-3	1.75	0.175	0.835	0.0835	0.915	0.0915
3b-R3-4	2.29	0.229	2.26	0.226	0.03	0.003
INEEL Dry	8.11	0.811	1.44	0.144	6.67	0.667

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp. 3b-R3		For additional comments, see RMAL Laboratory Notebook																	
MnO4- Calb. Slope:		0.046																	
Calibration Date: 5/5/98		5/5/98																	
Sample Data																	pH Data		
Flask No.	RXN Time (hrs)	Sample Name	Volume GW Used (mL)	Media Type	Solid Mass (grams)	vol (mL) aliquot	Cum Allocated Vol (mL)	Actual Vol at L/S Sampling	Actual L/S Ratio	Mass KMnO4 Added (mg)	Initial MnO4- (mg/L)	Aliquot MnO4- (mg/L)	Final Spec DF	Final MnO4- (mg/L)	mg MnO4- Consumed in Interval	Cum. mg MnO4- Consumed	Cum mg MnO4- in Aliquot per g or mL	pH Reading	
1	0.01	Initial	399	GW	0	6.5	6.5	399.0	NA	0.0	0.0	NA	NA	10167.4	0.0	0.0	0.00	0.0	7.89
1	0.17	10 min	399	GW	0	6.5	13	392.5	NA	5298.6	10167.4	in RMAL	500	10200.0	-12.8	-12.8	-0.03	66.3	8.60
1	0.50	30 min	399	GW	0	6.5	19.5	386.0	NA	5298.6	10200.0	in RMAL	500	10200.0	0.0	-12.8	-0.03	66.3	8.64
1	1.00	1 hour	399	GW	0	6.5	26	379.5	NA	5298.6	10200.0	in RMAL	500	10300.0	-38.0	-50.7	-0.13	67.0	8.64
1	2.00	2.5 hours	399	GW	0	6.5	32.5	373.0	NA	5298.6	10300.0	in RMAL	500	10200.0	37.3	-13.4	-0.03	66.3	8.66
1	4.00	4 hours	399	GW	0	6.5	39	366.5	NA	5298.6	10200.0	in RMAL	500	10150.0	18.3	4.9	0.01	66.0	8.64
1	24.00	24 hours	399	GW	0	6.5	45.5	360.0	NA	5298.6	10150.0	in RMAL	500	10250.0	-36.0	-31.1	-0.08	66.6	8.65
2	0.01	Initial	399	GW	0	6.5	6.5	399.0	NA	0.0	0.0	NA	NA	10167.6	0.0	0.0	0.00	0.0	7.97
2	0.17	10 min	399	GW	0	6.5	13	392.5	NA	5298.7	10167.6	in RMAL	500	10150.0	6.9	6.9	0.02	66.0	8.66
2	0.50	30 min	399	GW	0	6.5	19.5	386.0	NA	5298.7	10150.0	in RMAL	500	10250.0	-38.6	-31.7	-0.08	66.6	8.64
2	1.00	1 hour	399	GW	0	6.5	26	379.5	NA	5298.7	10250.0	in RMAL	500	10350.0	-38.0	-69.6	-0.17	67.3	8.69
2	2.00	2.5 hours	399	GW	0	6.5	32.5	373.0	NA	5298.7	10350.0	in RMAL	500	10250.0	37.3	-32.3	-0.08	66.6	8.69
2	4.00	4 hours	399	GW	0	6.5	39	366.5	NA	5298.7	10250.0	in RMAL	500	10300.0	-18.3	-50.7	-0.13	67.0	8.69
2	24.00	24 hours	399	GW	0	6.5	45.5	360.0	NA	5298.7	10300.0	in RMAL	500	10250.0	18.0	-32.7	-0.08	66.6	8.65
3	0.01	Initial	401	TSF Sludge	103	6.5	6.5	401.0	3.9	0.0	0.0	NA	NA	10166.9	0.0	0.0	0.00	0.0	7.82
3	0.17	10 min	401	TSF Sludge	103	6.5	13	394.5	3.8	5325.3	10166.9	in RMAL	500	5900.0	1683.3	1683.3	16.34	38.4 Consumption Rate	7.27
3	0.50	30 min	401	TSF Sludge	103	6.5	19.5	388.0	3.8	5325.3	5900.0	in RMAL	500	6550.0	-252.2	1431.1	13.89	42.6 mg/hr	7.48
3	1.00	1 hour	401	TSF Sludge	103	6.5	26	381.5	3.7	5325.3	6550.0	in RMAL	500	5550.0	381.5	1812.6	17.60	36.1 763	7.64
3	2.00	2.5 hours	401	TSF Sludge	103	6.5	32.5	375.0	3.6	5325.3	5550.0	in RMAL	500	4450.0	412.5	2225.1	21.60	28.9 412.5	7.75
3	4.00	4 hours	401	TSF Sludge	103	6.5	39	368.5	3.6	5325.3	4450.0	in RMAL	500	3165.0	473.5	2698.6	26.20	20.6 236.76	7.95
3	24.00	24 hours	401	CB/GW	103	6.5	45.5	362.0	3.5	5325.3	3165.0	in RMAL	20	302.0	1036.4	3735.0	36.26	2.0 51.82	8.00
4	0	Initial	402	TSF Sludge	106	6.5	6.5	402.0	3.8	0.0	0.0	NA	NA	10166.3	0.0	0.0	0.00	0.0	7.71
4	0.17	10 min	402	TSF Sludge	106	6.5	13	395.5	3.7	5338.5	10166.3	in RMAL	500	5450.0	1865.3	1865.3	17.60	35.4 Consumption Rate	8.34
4	0.50	30 min	402	TSF Sludge	106	6.5	19.5	389.0	3.7	5338.5	5450.0	in RMAL	500	5900.0	-175.1	1690.2	15.95	38.4 mg/hr	7.49
4	1.00	1 hour	402	TSF Sludge	106	6.5	26	382.5	3.6	5338.5	5900.0	in RMAL	500	4565.0	510.6	2200.9	20.76	29.7 1021.3	7.66
4	2.00	2.5 hours	402	TSF Sludge	106	6.5	32.5	376.0	3.5	5338.5	4565.0	in RMAL	500	3230.0	502.0	2702.8	25.50	21.0 501.96	7.81
4	4.00	4 hours	402	TSF Sludge	106	6.5	39	369.5	3.5	5338.5	3230.0	in RMAL	500	1905.0	489.6	3192.4	30.12	12.4 244.79	7.94
4	24.00	24 hours	402	CB/GW	106	6.5	45.5	363.0	3.4	5338.5	1905.0	in RMAL	5	0.0	691.5	3883.9	36.64	0.0 34.576	7.94

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Experiment: 3b-R4

For additional comments, see RMAL Laboratory Notebook

Experiment Start Date: 5/7/98

Comments:

Sample	Total Carbon %		Inorganic Carbon %		TOC %	
	Result	Error	Result	Error	Result	Error
3b-R4-3	1.35	0.135	0.474	0.0474	0.876	0.0876
3b-R4-4	1.51	0.151	0.406	0.0406	1.104	0.1104
INEEL Dry	8.11	0.811	1.44	0.144	6.67	0.667

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp. 3b-R4																		
For additional comments, see RMAL Laboratory Notebook																		
MnO4- Calb. Slope:		0.046																
Calibration Date: 5/5/98		5/5/98																
Sample Data																		
Flask No.	RXN Time (hrs)	Sample Name	Volume GW Used (mL)	Media Type	Solid Mass (grams)	vol (mL) aqueous aliquot	Cum Vol (mL)	Actual Vol at L/S	Actual L/S	Mass Added (mg/L)	Initial MnO4- (mg/L)	Aliquot MnO4- ABS	Final Spec DF	Final MnO4- (mg/L)	mg MnO4- Consumed in Interval	Cum. mg MnO4- Consumed	Cum mg MnO4- in Aliquot per g or mL	pH Reading
1	0.01	Initial	400	GW	0	6.5	6.5	400.0	NA	0.0	0 NA	NA	NA	30502	0.0	0.0	0.0	8.07
1	0.17	10 min		400 GW		0	6.5	13	393.5	15936.4	30502 in RMAL	2000	30000.0	197.7	197.7	0.49	195.0	9.00
1	0.50	30 min		400 GW		0	6.5	19.5	387.0	15936.4	30000 in RMAL	2000	30200.0	-77.4	120.3	0.30	196.3	9.00
1	1.00	1 hour		400 GW		0	6.5	26	380.5	15936.4	30200 in RMAL	2000	30200.0	0.0	120.3	0.30	196.3	9.01
1	2.00	2 hours		400 GW		0	6.5	32.5	374.0	15936.4	30200 in RMAL	2000	30400.0	-74.8	45.5	0.11	197.6	8.99
1	4.00	4 hours		400 GW		0	6.5	39	367.5	15936.4	30400 in RMAL	2000	30400.0	0.0	45.5	0.11	197.6	9.00
1	24.00	24 hours		400 GW		0	6.5	45.5	361.0	15936.4	30400 in RMAL	2000	30200.0	72.2	117.7	0.29	196.3	8.97
2	0.01	Initial	399	GW	0	6.5	6.5	399.0	NA	0.0	0 NA	NA	NA	30504	0.0	0.0	0.0	8.10
2	0.17	10 min		399 GW		0	6.5	13	392.5	15896.5	30504 in RMAL	2000	30400.0	40.7	40.7	0.10	197.6	9.00
2	0.50	30 min		399 GW		0	6.5	19.5	386.0	15896.5	30400 in RMAL	2000	30600.0	-77.2	-36.5	-0.09	198.9	8.99
2	1.00	1 hour		399 GW		0	6.5	26	379.5	15896.5	30600 in RMAL	2000	30600.0	0.0	-36.5	-0.09	198.9	9.01
2	2.00	2 hours		399 GW		0	6.5	32.5	373.0	15896.5	30600 in RMAL	2000	30800.0	-74.6	-111.1	-0.28	200.2	9.01
2	4.00	4 hours		399 GW		0	6.5	39	366.5	15896.5	30800 in RMAL	2000	30800.0	0.0	-111.1	-0.28	200.2	9.00
2	24.00	24 hours		399 GW		0	6.5	45.5	360.0	15896.5	30800 in RMAL	2000	30600.0	72.0	-39.1	-0.10	198.9	8.96
3	0.01	Initial	398	TSF Sludge	105	6.5	6.5	398.0	3.8	0.0	0 NA	NA	NA	30505	0.0	0.0	0.0	7.90
3	0.17	10 min		398 TSF Sludge	105	6.5	13	391.5	3.7	15856.7	30505 in RMAL	2000	17440.0	5114.9	5114.9	48.71	113.4 Consumption Rate	7.60
3	0.50	30 min		398 TSF Sludge	105	6.5	19.5	385.0	3.7	15856.7	17440 in RMAL	2000	19020.0	-608.3	4506.6	42.92	123.6 mg/hr	7.49
3	1.00	1 hour		398 TSF Sludge	105	6.5	26	378.5	3.6	15856.7	19020 in RMAL	2000	23800.0	-1809.2	2697.4	25.69	154.7	7.51
3	2.00	2 hours		398 TSF Sludge	105	6.5	32.5	372.0	3.5	15856.7	23800 in RMAL	2000	22000.0	669.6	3367.0	32.07	143.0 669.6	7.79
3	4.00	4 hours		398 TSF Sludge	105	6.5	39	365.5	3.5	15856.7	22000 in RMAL	2000	18060.0	1440.1	4807.1	45.78	117.4 720.04	7.91
3	24.00	24 hours		398 CB/GW	105	6.5	45.5	359.0	3.4	15856.7	18060 in RMAL	2000	9700.0	3001.2	7808.3	74.36	63.1 150.06	8.27
3	95.17	96 hours		398 CB/GW	105	6.5	52	352.5	3.4	15856.7	9700 in RMAL	200	2480.0	2545.1	10353.4	98.60	16.1 35.762	
4	0	Initial	399	TSF Sludge	104	6.5	6.5	399.0	3.8	0.0	0 NA	NA	NA	30504	0.0	0.0	0.0	7.85
4	0.17	10 min		399 TSF Sludge	104	6.5	13	392.5	3.8	15896.5	30504 in RMAL	2000	21200.0	3651.7	3651.7	35.11	137.8 Consumption Rate	7.45
4	0.50	30 min		399 TSF Sludge	104	6.5	19.5	386.0	3.7	15896.5	21200 in RMAL	2000	23600.0	-926.4	2725.3	26.20	153.4 mg/hr	7.44
4	1.00	1 hour		399 TSF Sludge	104	6.5	26	379.5	3.6	15896.5	23600 in RMAL	2000	25200.0	-607.2	2118.1	20.37	163.8	7.56
4	2.00	2 hours		399 TSF Sludge	104	6.5	32.5	373.0	3.6	15896.5	25200 in RMAL	2000	23200.0	746.0	2864.1	27.54	150.8 746	7.73
4	4.00	4 hours		399 TSF Sludge	104	6.5	39	366.5	3.5	15896.5	23200 in RMAL	2000	20400.0	1026.2	3890.3	37.41	132.6 513.1	7.91
4	24.00	24 hours		399 CB/GW	104	6.5	45.5	360.0	3.5	15896.5	20400 in RMAL	2000	14040.0	2289.6	6179.9	59.42	91.3 114.48	8.09
4	94.67	96 hours		399 CB/GW	104	6.5	52	353.5	3.4	15896.5	14040 in RMAL	200	7560.0	2290.7	8470.6	81.45	49.1 32.415	8.21

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

1 2 3 4 5 6 7 8 9 10 11

General Data							Sample Data			
Reactor No.	Sample Time	RXN Time (hrs)	Sample Name	Volume GW Used (mL)	Media Type	Solid Mass (grams)	vol (mL) aqueous aliquot	Cum Aliquot Vol (mL)	Actual Vol at Sampling	Actual L/S Ratio

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Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

12	13	14	15	16	17	18	19	20	21
MnO ₄ - Calb. Slope:	slope	STOCK SOLUTION	ABS or CONC:	DF:	DF of Stock	CONC:	Stock Conc.		
Calibration Date: 4/8/98		Diluted Sample, ABS for ESD, Conc for RMAL							
MnO ₄ - Data									pH Data
Volume Stock MnO ₄ - Added (mL)	Initial MnO ₄ - (mg/L)	Final MnO ₄ - ABS or Conc.	Final Spec DF	Final MnO ₄ - (mg/L)	mg MnO ₄ - Consumed in Interval	Cum. mg MnO ₄ - Consumed	Cum mg MnO ₄ - per gram	mg MnO ₄ - in Aliquot	pH

1.25 mL or 12.5 mL for 0.01% or 0.1% MnO₄ loadings (calb. Pipette)

This is the conc. at the beginning of each sampling interval.
@ T=0: 0
@ T=0.5hr:
(Col 12xStock Conc./[Col 5-(Col 9 @ T=0)+Col 12]
(Stock Conc at top of page)

@ All Other Sampling Periods:
Col 16 of previous sampling Period

Dilution Factor used on Spec. Sample.

ESD:
Measured Absorbance
RMAL:
Measured Conc.

(Col 16 -Col 13) x Col 10

Running total of oxidant mass consumed from each reactor

Actual Conc. of Aliquot
ESD:
(Col 14/slope)xCol 15
RMAL:
Col 14 x Col 15
(Slope at top of page)

Col 18/Col 7
(Assumed that mass of solid withdrawn in aliquot was negligible)

Col 16 x Col 8

Laboratory Determined value for each sample aliquot

Calculations for 0.01% and 0.1% MnO₄ Loadings Only

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
ORNL GC #	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)	Flag Aq. C/Co	mg TCE Oxidized in Interval	Cum. mg TCE Oxidized	% of Init Aq TCE Oxidized In Interval	% of Total TCE Oxidized In Interval	Cum % Total TCE Oxidized	mg TCE in Aliquot	%Diff (ppb)	AVG (ppb)	STDEV (ppb)	
Unique number for each GC sample	Actual Conc. of the Aliquot This value is linked from the GC data files and represents: (GC Area Count/AVG CF)/x DF	Same as Col 24	Col 23/Ratio where Ratio= (Col 25/Col 26)	Portion of Aliquot extracted (determined gravimetrically)	Volume used to extract a portion of the aliquot sample (Col 26) (determined gravimetrically and corrected for spec. gravity of hexane=0.66)	For Each Reactor: @ T=0; 0 @ all other T=x sample collection times: (Col 27 _{T=x-1} -Col 27 _{T=x})x Col 10	Running Total of Mass Oxidized (Col 30 from each reactor)	100 x (Col 30 _{T=x} /Initial Aqueous TCE) Where Initial Aqueous= Values in Mass Balance Tables in Report (computed differently for each type of experiment as described in report text)	100 x (Col 30 _{T=x} /Total Initial TCE) where Total Initial= Values in Mass Balance Tables in Report (computed differently for each type of experiment as described in report text)	Standard deviation of Col 27 _a & Col 27 _b Average Value of Col 27 _a & Col 27 _b %Diff of Duplicate Samples: (Col 27 _a -Col 27 _b)/Col 27 _a Where a&b represent duplicate aliquot samples from a given reactor	Col 27x Col 8 Note: Assumes that concentration of duplicate samples are identical (Variation of duplicates is computed in next columns)					
Running Total of Col 33																

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Experiment: 4a-R1

For additional comments, see Laboratory Notebook B000025

Pages: 61-65

Solid Media	Initial TCE (ppb)	Co-Contaminant?	MnO4- Concs. (%)
NONE	100	NO	0.01 & 0.1

Experiment Start Date: 5/20/98

Comments:

See general procedure on pages 57-60 in the laboratory Notebook.

Deviations from general procedure:

Step 9 not performed for this run since in only involves groundwater

SPIKE SOLUTION PREPARATION

Volume GW in Tedlar 3.21 liters

Volume Sat. TCE added 0.3 mL

0.3 mg (Assuming 1000 ppm Saturated Conc.)

Predicted Spike Conc: 93 ppb

GC Analysis of Spike Solution

ORNL GC #	Sample Name	Sample Time	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)
352	4AR1TBA	5/26/98 8:45	223		4.71	5.50	191
353	4AR1TBB	5/26/98 8:45	211		4.88	5.47	188

Prepared by: S.R. Cline

LastUpdated: 10/22/98

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Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

4a-R1	For additional comments, see Laboratory Notebook B000025										Conc (ppm):	
	MnO4- Calb. Slope:	0.019	STOCK SO	0.364	DF:	2500	CONC:					
	Calibration Date: 4/8/98											
	pH Data											
Reactor No.	Volume Added (ml)	Initial MnO4- (mg/L)	Final MnO4- ABS	Final Spec DF	Final MnO4- (mg/L)	Mg MnO4- Consumed in Interval	Cum. mg MnO4- Consumed per mL GW	Cum. mg MnO4- in Aliquot	pH			
1	0	0	0.003	1	NA	NA	NA	NA	7.89			
1	0	0	0.003	1	NA	NA	NA	NA	8.12			
1	0	0	0.002	1	NA	NA	NA	NA	8.10			
1	0	0	0.002	1	NA	NA	NA	NA	8.09			
1	0	0	NT	NT	NA	NA	NA	NA	8.09			
1	0	0	NT	NT	NA	NA	NA	NA	8.14			
1	0	0	0.007	1	NA	NA	NA	NA	8.15			
2	0	0	0.004	1	NA	NA	NA	NA	8.13			
2	0	0	0.001	1	NA	NA	NA	NA	8.11			
2	0	0	0.000	1	NA	NA	NA	NA	8.10			
2	0	0	0.001	1	NA	NA	NA	NA	8.09			
2	0	0	NT	NT	NA	NA	NA	NA	8.15			
2	0	0	NT	NT	NA	NA	NA	NA	8.16			
2	0	0	0.001	1	NA	NA	NA	NA	8.18			

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	Exp.	4a-R1	For additional comments, see Laboratory Notebook B000025											
	ORNL	Extract	Flag	Hexane	Aqueous	Aqueous	Flag	Aq.	mg TCE	Cum.	% of Init A	% of Total	Cum %	mg TCE
Reactor	GC #	Conc.		Volume	Volume	Conc.		C/Co	Oxidized	mg TCE	TCE Oxidi	TCE Oxidi	Total TCE	in Aliquot
No.		(ppb)		(mL)	(mL)	(ppb)			in Interval	Oxidized	In Interval	In Interval	Oxidized	
1	354	196		2.88	3.33	169		NA	NA	NA	NA	NA	NA	0.00
1	361	212		2.71	3.44	167		NA	NA	NA	NA	NA	NA	0.00
1	368	214		2.92	3.70	169		NA	NA	NA	NA	NA	NA	0.00
1	375	184		2.73	3.02	167		NA	NA	NA	NA	NA	NA	0.00
1	382	170		2.88	3.10	158		NA	NA	NA	NA	NA	NA	0.00
1	389	142		3.31	2.78	170		NA	NA	NA	NA	NA	NA	0.00
1	396R	180		3.2	3.33	173		NA	NA	NA	NA	NA	NA	0.00
2	356	200		2.85	3.36	170		NA	NA	NA	NA	NA	NA	0.00
2	362	207		2.73	3.20	177		NA	NA	NA	NA	NA	NA	0.00
2	369	188		2.90	3.08	176		NA	NA	NA	NA	NA	NA	0.00
2	376	192		2.95	3.24	176		NA	NA	NA	NA	NA	NA	0.00
2	383	166		3.09	2.90	177		NA	NA	NA	NA	NA	NA	0.00
2	390	173		3.16	3.07	178		NA	NA	NA	NA	NA	NA	0.00
2	398R	171		2.97	3.24	156		NA	NA	NA	NA	NA	NA	0.00

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

4a-R1	For additional comments, see Laboratory Notebook B000025															
MnO4- Calb. Slope:	0.019/STOCK SQ										0.364	DF:	2500	CONC:		Conc (ppm):
Calibration Date: 4/8/98																
pH Data																
Reactor	Volume	Initial	Final	Final	Final	MnO4- Consumed	MnO4- in Interval	Cum.	MnO4- in Aliquot	pH	pH Data					
	Stock Mn	MnO4- (mg/L)	ABS	MnO4- Spec	MnO4- (mg/L)	mg MnO4- Consumed	mg MnO4- Consumed	mg MnO4- Consumed	mg MnO4- Consumed	mg MnO4- Consumed						
No.	Added (ml)															
3	0	0.0	0.003	1	114.7	0	0	0	0.00	0	8.13					
3	1.25	114.7	0.380	5	99.7	8	8	0.01	0.7	8.11						
3	1.25	99.7	0.386	5	101.3	-1	7	0.01	1.4	8.12						
3	1.25	101.3	0.366	5	96.0	3	10	0.02	0.7	8.10						
3	1.25	96.0	0.371	5	97.3	-1	9	0.02	0.7	8.14						
3	1.25	97.3	0.361	5	94.7	1	10	0.02	0.7	8.16						
3	1.25	94.7	0.361	5	94.7	0	10	0.02	0.7	8.15						
4	0	0.0	0.002	1	114.6	0	0	0.00	0	8.13						
4	1.25	114.6	0.402	5	105.5	5	5	0.01	0.7	8.10						
4	1.25	105.5	0.408	5	107.0	-1	4	0.01	0.7	8.10						
4	1.25	107.0	0.394	5	103.4	2	6	0.01	1.4	8.11						
4	1.25	103.4	0.393	5	103.1	0	6	0.01	0.7	8.09						
4	1.25	103.1	0.391	5	102.6	0	6	0.01	0.7	8.14						
4	1.25	102.6	0.388	5	101.8	0	7	0.01	0.7	8.13						

Prepared by: S.R. Cline

Last Updated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4a-R1	For additional comments, see Laboratory Notebook B000025											
	ORNL	Extract	Flag	Hexane	Aqueous	Aqueous	Flag	Aq.	mg TCE	Cum.	% of Init A	% of Total	Cum %	mg TCE
Reactor	GC #	Conc.		Volume	Volume	Conc.		C/Co	Oxidized	mg TCE	TCE Oxidi	TCE Oxidi	Total TCE	in Aliquot
No.		(ppb)		(mL)	(mL)	(ppb)			in Interval	Oxidized	In Interval	In Interval	Oxidized	
3	357	217		2.86	3.56	174		1.00	0.0	0.0	0.0%	0.0%	0.0%	0.00
3	364	35		2.81	3.01	33		0.19	0.1	0.1	80.1%	80.1%	80.1%	0.00
3	370	14		3.10	3.28	13			0	0.1	11.1%	11.1%	91.2%	0.00
3	377	0		1.58	3.28	1			0	0.1	6.7%	6.7%	97.9%	0.00
3	384	0		3.06	3.20	1		0.01	0.0	0.1	0.0%	0.0%	97.9%	0.00
3	391	0		3.20	3.21	1		0.01	0.0	0.1	0.0%	0.0%	97.9%	0.00
3	399	0		3.17	3.12	1		0.01	0.0	0.1	0.0%	0.0%	97.9%	0.00
4	358	216		2.85	3.40	181		1.00	0.0	0.0	0.0%	0.0%	0.0%	0.00
4	365	28		2.81	2.92	27		0.15	0.1	0.1	83.9%	83.9%	83.9%	0.00
4	372	14		2.91	3.31	12		0.07	0.0	0.1	8.2%	8.2%	92.1%	0.00
4	378	0		3.04	3.06	1		0.01	0.0	0.1	5.9%	5.9%	98.1%	0.00
4	385	0		3.02	3.11	1		0.01	0.0	0.1	0.0%	0.0%	98.1%	0.00
4	392	0		3.20	3.08	1		0.01	0.0	0.1	0.0%	0.0%	98.1%	0.00
4	400	0		3.14	2.95	1		0.01	0.0	0.1	0.0%	0.0%	98.1%	0.00

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Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	4a-R1	For additional comments, see Laboratory Notebook B000025								
	MnO4- Calb. Slope:	0.019	STOCK SC	0.364	DF:	2500	CONC:	Conc (ppm):		
	Calibration Date: 4/8/98									
	MnO4- Data								pH Data	
	Volume	Initial	Final	Final	Final	mg MnO4	Cum.	Cum	mg MnO4-	
Reactor	Stock Mn	MnO4-	MnO4-	Spec	MnO4-	Consumed	mg MnO4	mg MnO4	in Aliquot	
No.	Added (m	(mg/L)	ABS	DF	(mg/L)	in Interval	Consumed	per mL GW	pH	
5	0	0.0	0.010	1	1090.2	0	0	0.00	0	8.13
5	12.5	1090.2	0.398	50	1044.1	25	25	0.05	7.3	8.18
5	12.5	1044.1	0.406	50	1065.1	-11	14	0.03	7.5	8.19
5	12.5	1065.1	0.380	50	996.9	36	50	0.09	7.0	8.18
5	12.5	996.9	0.382	50	1002.2	-3	47	0.09	14.0	8.19
5	12.5	1002.2	0.423	50	1109.7	-55	-8	-0.01	7.8	8.23
5	12.5	1109.7	0.415	50	1088.7	11	3	0.01	7.6	8.22
6	0	0.0	0.009	1	1112.8	0	0	0.00	0	8.13
6	12.5	1112.8	0.415	50	1088.7	13	13	0.02	7.6	8.20
6	12.5	1088.7	0.398	50	1044.1	24	37	0.07	7.3	8.20
6	12.5	1044.1	0.420	50	1101.9	-30	6	0.01	7.7	8.20
6	12.5	1101.9	0.417	50	1094.0	4	10	0.02	7.7	
6	12.5	1094.0	0.417	50	1094.0	0	10	0.02	15.3	8.24
6	12.5	1094.0	0.424	50	1112.4	-9	1	0.00	7.8	8.21

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Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4a-R1	For additional comments, see Laboratory Notebook B000025																		
			</																	

Prepared by: S.R. Cline

Last Updated: 10/23/98

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Prepared by: S.R. Cline

Last Updated: 11/1998

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Experiment: 4a-R2

For additional comments, see Laboratory Notebook B000025

Pages: 66-69

Solid Media	Initial TCE (ppb)	Co-Contaminant?	MnO4- Concs. (%)
NONE	1000	NO	0.01 & 0.1

Experiment Start Date: 5/28/98

Comments:

See general procedure on pages 57-60 in the laboratory Notebook.

Deviations from general procedure:

Step 9 not performed for this run since in only involves groundwater

Sparged GW was cooled overnight @ 12C THEN spiked with SAT TCE SOLN and mixed 2 hrs prior to filling reactors

SPIKE SOLUTION PREPARATION

Volume GW in Tedlar 3.16 liters

Volume Sat. TCE added 3 mL

3 mg (Assuming 1000 ppm Saturated Conc.)

Predicted Spike Conc: 950 ppb

GC Analysis of Spike Solution

ORNL GC #	Sample Name	Sample Time	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)
487	4AR2TBA	5/28/98 11:15	1564		4.84	5.15	1469
488	4AR2TBB	5/28/98 11:15	1538		4.87	5.30	1415

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[illegible]

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4a-R2	For additional comments, see Laboratory Notebook B000025								
	MnO4- Calb. Slope:		0.019	STOCK SOLN ABS		0.354	DF:		2500	Conc (ppm):	46435.73
	Calibration Date:	4/8/98									
	MnO4- Data										pH Data
Reactor	Volume	Initial	Final	Final	Final	mg MnO4	Cum.	Cum	mg MnO4-		
Stock Mn	MnO4-	MnO4-	MnO4-	Spec	MnO4-	Consumed	mg MnO4	mg MnO4	in Aliquot	pH	
No.	Added (m	(mg/L)	ABS	DF	(mg/L)	in Interval	Consumed	per mL GW			
1	0	0	NT	NT	NA	NA	NA	NA	NA	8.43	
1	0	0	NT	NT	NA	NA	NA	NA	NA	8.4	
1	0	0	0.008	1	NA	NA	NA	NA	NA	8.39	
1	0	0	0.003	1	NA	NA	NA	NA	NA	8.36	
1	0	0	0.003	1	NA	NA	NA	NA	NA	8.34	
1	0	0	0.003	1	NA	NA	NA	NA	NA	8.23	
1	0	0	0.003	1	NA	NA	NA	NA	NA	8.18	
2	0	0	0.002	1	NA	NA	NA	NA	NA	8.38	
2	0	0	NT	NT	NA	NA	NA	NA	NA	8.4	
2	0	0	0.002	1	NA	NA	NA	NA	NA	8.41	
2	0	0	0.002	1	NA	NA	NA	NA	NA	8.39	
2	0	0	0.003	1	NA	NA	NA	NA	NA	8.36	
2	0	0	0.003	1	NA	NA	NA	NA	NA	8.18	
2	0	0	0.007	1	NA	NA	NA	NA	NA	8.16	

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4a-R2	For additional comments, see Laboratory Notebook B000025													
Reactor No.	ORNL GC #	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)	Flag	Aq. C/Co	mg TCE Oxidized in Interval	Cum. mg TCE Oxidized	% of Init A TCE Oxidized	% of Total TCE Oxidized	Cum % Total TCE Oxidized	mg TCE in Aliquot		
1	489	1,435		2.95	2.96	1,432		NA	NA	NA	NA	NA	NA	0.02		
1	496	1,474		2.97	3.14	1,394		NA	NA	NA	NA	NA	NA	0.01		
1	503	1,536		2.98	3.17	1,440		NA	NA	NA	NA	NA	NA	0.01		
1	510	1,436		2.95	3.15	1,344		NA	NA	NA	NA	NA	NA	0.01		
1	517	1,421		2.64	2.84	1,325		NA	NA	NA	NA	NA	NA	0.01		
1	524	1,339		2.94	3.05	1,292		NA	NA	NA	NA	NA	NA	0.01		
1	531	1,372		2.90	3.07	1,296		NA	NA	NA	NA	NA	NA	0.02		
2	491	1,497		2.96	3.28	1,351		NA	NA	NA	NA	NA	NA	0.01		
2	497	1,516		2.99	3.21	1,412		NA	NA	NA	NA	NA	NA	0.02		
2	504	1,388		3.00	2.93	1,421		NA	NA	NA	NA	NA	NA	0.01		
2	511	1,394		2.98	3.05	1,362		NA	NA	NA	NA	NA	NA	0.01		
2	518	1,379		3.01	3.10	1,341		NA	NA	NA	NA	NA	NA	0.01		
2	525	1,368		3.00	3.13	1,309		NA	NA	NA	NA	NA	NA	0.01		
2	533	1,451		2.94	3.23	1,323		NA	NA	NA	NA	NA	NA	0.01		

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Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4a-R2	For additional comments, see Laboratory Notebook B000025							

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4a-R2	For additional comments, see Laboratory Notebook B000025							
MnO4- Calb. Slope:	0.019	STOCK SOLN ABS	0.354	DF:	2500	Cone (ppm):	46435.73		
Calibration Date:	4/8/98								
MnO4- Data									pH Data
Reactor	Volume	Initial	Final	Final	Final	mg MnO4	Cum.	Cum	mg MnO4-
No.	Added (ml)	MnO4- (mg/L)	MnO4- ABS	Spec DF	MnO4- (mg/L)	Consumed in Interval	mg MnO4 Consumed	mg MnO4 per mL GW	in Aliquot
3	0	0.0	0.001	1	114.8	0	0	0.00	0
3	1.25	114.8	0.353	5	92.6	11	11	0.02	0.6
3	1.25	92.6	0.357	5	93.7	-1	11	0.02	1.3
3	1.25	93.7	0.354	5	92.9	0	11	0.02	0.7
3	1.25	92.9	0.340	5	89.2	2	13	0.03	0.6
3	1.25	89.2	0.204	5	53.5	17	30	0.06	0.4
3	1.25	53.5	0.304	5	79.8	-12	17	0.03	0.6
4	0	0.0	NT	NT	118.4	0	0	0.00	0
4	1.25	118.4	0.414	5	108.6	5	5	0.01	0.8
4	1.25	108.6	0.396	5	103.9	2	7	0.01	0.7
4	1.25	103.9	0.375	5	98.4	3	10	0.02	1.4
4	1.25	98.4	0.389	5	102.1	-2	8	0.02	0.7
4	1.25	102.1	0.369	5	96.8	2	10	0.02	0.7
4	1.25	96.8	0.308	5	80.8	7	18	0.04	0.6

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4a-R2	For additional comments, see Laboratory Notebook B000025											
	ORNL	Extract	Flag	Hexane	Aqueous	Aqueous	Flag	Aq.	mg TCE	Cum.	% of Init A	% of Total	Cum %	mg TCE
Reactor	GC #	Conc.		Volume	Volume	Conc.		C/Co	Oxidized	mg TCE	TCE Oxidi	TCE Oxidi	Total TCE	in Aliquot
No.		(ppb)		(mL)	(mL)	(ppb)			in Interval	Oxidized	In Interval	In Interval	Oxidized	
3	492	1,444		2.95	3.11	1,366		1.00	0.0	0.0	0.0%	0.0%	0.0%	0.01
3	499	312		2.98	3.27	284		0.21	0.5	0.5	78.3%	78.3%	78.3%	0.00
3	505	68		4.23	2.42	120		0.09	0.1	0.6	11.8%	11.8%	90.0%	0.00
3	512	16		2.98	3.07	16		0.01	0.1	0.7	7.2%	7.2%	97.3%	0.00
3	519	13		3.01	3.12	12		0.01	0.0	0.7	0.2%	0.2%	97.5%	0.00
3	526	14		3.01	2.96	14		0.01	0.0	0.7	-0.1%	-0.1%	97.4%	0.00
3	534	15		2.95	3.22	14		0.01	0.0	0.7	0.0%	0.0%	97.4%	0.00
4	493	1,414		2.94	3.04	1,369			0.0	0.0	0.0%	0.0%	0.0%	0.01
4	500	282		3.00	3.34	253			0.5	0.5	80.6%	80.6%	80.6%	0.00
4	507	61		2.95	3.06	59		0.04	0.1	0.6	13.8%	13.8%	94.4%	0.00
4	513	13		2.97	3.03	13		0.01	0.0	0.7	3.3%	3.3%	97.6%	0.00
4	520	0		3.00	3.07	1		0.00	0.0	0.7	0.8%	0.8%	98.4%	0.00
4	527	0		3.00	3.14	1		0.00	0.0	0.7	0.0%	0.0%	98.4%	0.00
4	535	0		2.90	3.05	1		0.00	0.0	0.7	0.0%	0.0%	98.4%	0.00

Steven Robert Cline:
ND, BUT ENTERED AS 1 PPB FOR
PLOTING LOG SCALE

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Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4a-R2	For additional comments, see Laboratory Notebook B000025										2500 Conc (ppm):	46435.73
MnO4- Calb. Slope:		0.019 STOCK SOLN ABS										2500 Conc (ppm):	
Calibration Date: 4/8/98		0.354 DF:										2500 Conc (ppm):	
MnO4- DF:												2500 Conc (ppm):	
Reactor No.	Volume Added (ml)	Initial MnO4- (mg/L)	Final MnO4- ABS	Final MnO4- Spec DF	Final MnO4- (mg/L)	mg MnO4 Consumed in Interval	Cum. mg MnO4 Consumed	Cum mg MnO4 per mL GW	mg MnO4 in Aliquot	pH	pH Data		
5	0	0.0	NT	NT	1114.2	0	0	0.00	0	8.41			
5	12.5	1114.2	0.420	50	1101.9	6	6	0.01	7.7	8.38			
5	12.5	1101.9	0.418	50	1096.6	3	9	0.02	7.7	8.39			
5	12.5	1096.6	0.425	50	1115.0	-9	0	0.00	7.8	8.39			
5	12.5	1115.0	0.411	50	1078.3	18	18	0.04	15.1	8.39			
5	12.5	1078.3	0.428	50	1122.9	-22	-3	-0.01	7.9	8.34			
5	12.5	1122.9	0.419	50	1099.2	11	8	0.02	7.7	8.34			
6	0	0.0	NT	NT	1108.5	0	0	0.00	0	8.4			
6	12.5	1108.5	0.422	50	1107.1	1	1	0.00	7.7	8.38			
6	12.5	1107.1	0.417	50	1094.0	7	8	0.01	7.7	8.39			
6	12.5	1094.0	0.437	50	1146.5	-27	-19	-0.04	8.0	8.39			
6	12.5	1146.5	0.427	50	1120.2	13	-6	-0.01	7.8	8.37			
6	12.5	1120.2	0.436	50	1143.8	-12	-18	-0.03	16.0	8.34			
6	12.5	1143.8	0.416	50	1091.4	25	8	0.01	7.6	8.35			

Prepared by: S.R. Cline

Last Updated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4a-R2	For additional comments, see Laboratory Notebook B000025											
							</							

Steven Robert Cline:
NO, BUT ENTERED AS 1 PPB FOR
PLOTING LOG SCALE

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Experiment: 4a-R3

For additional comments, see Laboratory Notebook B000025

Pages: 70-73

Solid Media	Initial TCE (ppb)	Co-Contaminant?	MnO4- Concs. (%)
C. Basalt	100	NO	0.01 & 0.1

Experiment Start Date: 6/1/98

Comments:

See general procedure on pages 57-60 in the laboratory Notebook.

Deviations from general procedure:

NONE

SPIKE SOLUTION PREPARATION

Volume GW in Tedlar 3.10 liters

Volume Sat. TCE added 0.31 mL

0.31 mg (Assuming 1000 ppm Saturated Conc.)

Predicted Spike Conc: 100 ppb

GC Analysis of Spike Solution

ORNL GC #	Sample Name	Sample Time	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)
629	4a-r3-tb-a	6/2/98 13:15	201		4.90	5.30	186
630	4a-r3-tb-b	6/2/98 13:15	174		5.02	5.00	175

Prepared by: S.R. Cline

LastUpdated: 10/22/98

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	Exp.	4a-R3	For additional comments, see Laboratory Notebook B000025							
	Reaction Date	RXN		Volume		Solid	Sample Data			
Reactor No.	Sample Time	Time (hrs)	Sample Name	GW Used (mL)	Media Type	Mass (grams)	vol (mL) aqueous aliquot	Cum Aliquot Vol (mL)	Actual Vol at Sampling	Actual L/S Ratio
1	6/3/98 11:30	0.0	4a-r3-t0-1a	500.49	GW Only	0.0	14.37	14.37	500.5	NA
1	6/3/98 12:05	0.6	4a-r3-t30m-1	500.49	GW Only	0	7.22	21.59	486.1	NA
1	6/3/98 13:05	1.6	4a-r3-t1.5h-1	500.49	GW Only	0	7.51	29.1	478.9	NA
1	6/3/98 14:30	3.0	4a-r3-t3h-1	500.49	GW Only	0	6.58	35.68	471.4	NA
1	6/3/98 16:30	5.0	4a-r3-t5h-1	500.49	GW Only	0	7.13	42.81	464.8	NA
1	6/4/98 8:30	21.0	4a-r3-t20h-1	500.49	GW Only	0	7.52	50.33	457.7	NA
1	6/4/98 11:40	24.2	4a-r3-t24h-1	500.49	GW Only	0	7.22	57.55	450.2	NA
2	6/3/98 11:33	0.0	4a-r3-t0-2	524.94	GW Only	0.0	7.2	7.2	524.9	NA
2	6/3/98 12:07	0.6	4a-r3-t30m-2a	524.94	GW Only	0	14.54	21.74	517.7	NA
2	6/3/98 13:06	1.5	4a-r3-t1.5h-2	524.94	GW Only	0	7.44	29.18	503.2	NA
2	6/3/98 14:31	3.0	4a-r3-t3h-2	524.94	GW Only	0	7.33	36.51	495.8	NA
2	6/3/98 16:31	5.0	4a-r3-t5h-2	524.94	GW Only	0	7.16	43.67	488.4	NA
2	6/4/98 8:31	21.0	4a-r3-t20h-2	524.94	GW Only	0	7.26	50.93	481.3	NA
2	6/4/98 11:41	24.1	4a-r3-t24h-2	524.94	GW Only	0	7.36	58.29	474.0	NA

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4a-R3	For additional comments, see Laboratory Notebook B000025							
MnO4- Calb. Slope:		0.019	STOCK SOLN ABS	0.369	DF:	2500	Conc (ppm):	48403.35	
Calibration Date: 4/8/98									
MnO4- Data									pH Data
Reactor	Volume	Initial	Final	Final	Final	mg MnO4	Cum.	Cum.	mg MnO4-
No.	Stock Mn	MnO4-	MnO4-	Spec	MnO4-	Consumed	mg MnO4	mg MnO4	in Aliquot
	Added (ml)	(mg/L)	ABS	DF	(mg/L)	in Interval	Consumed	per gram	pH
1	0	0	0.004	1	NA	NA	NA	NA	NA
1	0	0	0.034	1	NA	NA	NA	NA	NA
1	0	0	0.008	1	NA	NA	NA	NA	NA
1	0	0	0.009	1	NA	NA	NA	NA	NA
1	0	0	0.010	1	NA	NA	NA	NA	NA
1	0	0	0.013	1	NA	NA	NA	NA	NA
1	0	0	0.012	1	NA	NA	NA	NA	NA
2	0	0	0.007	1	NA	NA	NA	NA	NA
2	0	0	0.009	1	NA	NA	NA	NA	NA
2	0	0	0.007	1	NA	NA	NA	NA	NA
2	0	0	0.008	1	NA	NA	NA	NA	NA
2	0	0	0.010	1	NA	NA	NA	NA	NA
2	0	0	0.012	1	NA	NA	NA	NA	NA
2	0	0	0.012	1	NA	NA	NA	NA	NA

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Prepared by: S.R. Cline

LastUpdated: 10/23/98

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[illegible]

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4a-R3	For additional comments, see Laboratory Notebook B000025										48403.35
MnO4- Calb. Slope:	0.019	STOCK SOLN ABS	0.169	DF:								2500 Conc (ppm):
Calibration Date: 4/8/98												
MnO4- Data												
Reactor No.	Volume Added (ml)	Initial MnO4- (mg/L)	Final MnO4- ABS	Final MnO4- Spec DF	Final MnO4- (mg/L)	Mg MnO4- Consumed in Interval	Cum. Mg MnO4- Consumed	Cum. Mg MnO4- per gram	Mg MnO4- in Aliquot	pH	pH Data	
3	0	0.0	0.002	1	134.7	0.0	0.0	0.0	0.0	8.2		
3	1.25	134.7	0.463	5	121.5	6.0	6.0	0.1	0.8	8.22		
3	1.25	121.5	0.442	5	116.0	2.4	8.4	0.1	1.6	8.22		
3	1.25	116.0	0.436	5	114.4	0.7	9.1	0.1	0.8	8.22		
3	1.25	114.4	0.422	5	110.7	1.5	10.6	0.1	0.8	8.23		
3	1.25	110.7	0.374	5	98.1	5.2	15.8	0.2	0.7	8.26		
3	1.25	98.1	0.305	5	80.0	7.4	23.2	0.2	1.1	8.3		
4	0	0.0	0.004	1	141.6	0.0	0.0	0.0	0.0	8.21		
4	1.25	141.6	0.465	5	122.0	8.4	8.4	0.1	0.8	8.23		
4	1.25	122.0	0.466	5	122.3	-0.1	8.3	0.1	0.9	8.23		
4	1.25	122.3	0.466	5	122.3	0.0	8.3	0.1	1.7	8.23		
4	1.25	122.3	0.459	5	120.4	0.7	9.0	0.1	0.8	8.24		
4	1.25	120.4	0.380	5	99.7	8.1	17.1	0.2	0.7	8.25		
4	1.25	99.7	0.447	5	117.3	-6.8	10.4	0.1	0.8	8.3		

Prepared by: S.R. Cline

Last Updated: 10/23/98

C-67

Steven Robert Cline:
ND, BUT ENTERED AS 1 PPB FOR
PLOTING LOG SCALE

C-68

Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4a-R3	For additional comments, see Laboratory Notebook B000025								
MnO4- Calb. Slope:		0.019	STOCK SOLN ABS		0.369	DF:		2500	Conc (ppm):	48403.35
Calibration Date:	4/8/98									
MnO4- Data:										pH Data
Reactor	Volume	Initial	Final	Final	Final	mg MnO4	Cum.	Cum	mg MnO4-	
No.	Stock Mn	MnO4-	MnO4-	Spec	MnO4-	Consumed	mg MnO4	mg MnO4	in Aliquot	pH
	Added (ml)	(mg/L)	ABS	DF	(mg/L)	in Interval	Consumed	per gram		
5	0	0.0	0.004	1	1325.6	0.0	0.0	0.0	0.0	8.22
5	12.5	1325.6	0.487	50	1277.6	21.9	21.9	0.2	8.9	8.29
5	12.5	1277.6	0.472	50	1238.3	17.7	39.6	0.4	8.9	8.27
5	12.5	1238.3	0.480	50	1259.3	-9.3	30.3	0.3	9.0	8.24
5	12.5	1259.3	0.466	50	1222.5	16.0	46.3	0.5	16.7	8.23
5	12.5	1222.5	0.464	50	1217.3	2.2	48.5	0.5	8.4	8.23
5	12.5	1217.3	0.454	50	1191.1	10.9	59.4	0.6	8.4	8.24
6	0	0.0	0.004	1	1317.5	0.0	0.0	0.0	0.0	8.2
6	12.5	1317.5	0.494	50	1296.0	9.9	9.9	0.1	9.2	8.27
6	12.5	1296.0	0.462	50	1212.1	38.0	47.8	0.5	8.6	8.25
6	12.5	1212.1	0.486	50	1275.0	-28.0	19.8	0.2	9.0	8.23
6	12.5	1275.0	0.477	50	1251.4	10.3	30.2	0.3	8.7	8.21
6	12.5	1251.4	0.457	50	1198.9	22.6	52.8	0.5	16.7	8.2
6	12.5	1198.9	0.477	50	1251.4	-21.9	30.9	0.3	8.7	8.23

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Prepared by: S.R. Cline

LastUpdated: 10/23/98

[illegible]

Updated: 11/20/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Experiment: 4a-R4

For additional comments, see Laboratory Notebook B000025

Pages: 91-94

Solid Media	Initial TCE (ppb)	Co-Contaminant?	MnO4- Concs. (%)
A. Basalt	100	NO	0.01 & 0.1

Experiment Start Date: 7/14/98

Comments:

See general procedure on pages 57-60 in the laboratory Notebook.

Deviations from general procedure:

NONE

SPIKE SOLUTION PREPARATION

Volume GW in Tedlar 2.97 liters

Volume Sat. TCE added 0.3 mL

0.3 mg (Assuming 1000 ppm Saturated Conc.)

Predicted Spike Conc: 101 ppb

GC Analysis of Spike Solution

ORNL GC #	Sample Name	Sample Time	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)
1246	4a-r4-tba	7/14/98 14:46	192		4.95	5.11	185
1247	4a-r4-tbb	7/14/98 14:46	157		4.82	5.27	143

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Prepared by: S.R. Cline

Last Updated: 10/22/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4a-R4	For additional comments, see Laboratory Notebook B000025								
									Sample Data		
Reactor No.	Sample Time	RXN Time (hrs)	Sample Name	Volume GW Used (mL.)	Media Type	Solid Mass (grams)	vol (mL) aqueous aliquot	Cum Aliquot Vol (mL)	Actual Vol at Sampling	Actual L/S Ratio	
1	7/15/98 10:48	0.0	4a-r4-t0-1a	500.964	GW Only	0.0	14.63	14.63	501.0	NA	
1	7/15/98 11:20	0.5	4a-r4-t30min-1	500.964	GW Only	0	7.42	22.05	486.3	NA	
1	7/15/98 12:20	1.5	4a-r4-t1.5h-1	500.964	GW Only	0	7.37	29.42	478.9	NA	
1	7/15/98 13:56	3.1	4a-r4-t3h-1	500.964	GW Only	0	7.35	36.77	471.5	NA	
1	7/15/98 15:50	5.0	4a-r4-t5h-1	500.964	GW Only	0	7.44	44.21	464.2	NA	
1	7/16/98 8:01	21.2	4a-r4-t20h-1	500.964	GW Only	0	7.35	51.56	456.8	NA	
1	7/16/98 10:42	23.9	4a-r4-t24h-1	500.964	GW Only	0	7.35	58.91	449.4	NA	
2	7/15/98 10:49	0.0	4a-r4-t0-2	496.24	GW Only	0.0	7.49	7.49	496.2	NA	
2	7/15/98 11:21	0.5	4a-r4-t30min-2a	496.24	GW Only	0	14.74	22.23	488.8	NA	
2	7/15/98 12:21	1.5	4a-r4-t1.5h-2	496.24	GW Only	0	7.45	29.68	474.0	NA	
2	7/15/98 13:57	3.1	4a-r4-t3h-2	496.24	GW Only	0	7.44	37.12	466.6	NA	
2	7/15/98 15:51	5.0	4a-r4-t5h-2	496.24	GW Only	0	7.38	44.5	459.1	NA	
2	7/16/98 8:02	21.2	4a-r4-t20h-2	496.24	GW Only	0	7.34	51.84	451.7	NA	
2	7/16/98 10:43	23.9	4a-r4-t24h-2	496.24	GW Only	0	7.27	59.11	444.4	NA	

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Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4a-R4	For additional comments, see Laboratory Notebook B000025								
MnO4- Calb. Slope:		0.022	STOCK SOLN ABS	0.517	DF:		1667	Conc (ppm):	38607.91	
Calibration Date: 6/10/98										
MnO4- Data										pH Data
Reactor No.	Volume Stock Mn Added (mL)	Initial MnO4- (mg/L)	Final MnO4- ABS	Final Spec DF	Final MnO4- (mg/L)	mg MnO4 Consumed in Interval	Cum. mg MnO4 Consumed	Cum mg MnO4 per gram	mg MnO4 in Aliquot	pH
1	0	0	0.003	1	NA	NA	NA	NA	NA	8.08
1	0	0	0.005	1	NA	NA	NA	NA	NA	8.08
1	0	0	0.004	1	NA	NA	NA	NA	NA	8.1
1	0	0	0.008	1	NA	NA	NA	NA	NA	8.09
1	0	0	0.008	1	NA	NA	NA	NA	NA	8.07
1	0	0	0.005	1	NA	NA	NA	NA	NA	8.07
1	0	0	0.008	1	NA	NA	NA	NA	NA	8.08
2	0	0	0.003	1	NA	NA	NA	NA	NA	8.02
2	0	0	0.003	1	NA	NA	NA	NA	NA	8.06
2	0	0	0.003	1	NA	NA	NA	NA	NA	8.06
2	0	0	0.004	1	NA	NA	NA	NA	NA	8.06
2	0	0	0.005	1	NA	NA	NA	NA	NA	8.06
2	0	0	0.003	1	NA	NA	NA	NA	NA	8.05
2	0	0	0.002	1	NA	NA	NA	NA	NA	8.06

C-74

C-75

Prepared by: S.R. Cline

LastUpdated: 10/23/98

C-76

Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4a-R4	For additional comments, see Laboratory Notebook B000025										38607.91
MnO4- Carb. Slope:	0.022	STOCK SOLN ABS	0.517	DF:							1667	Cone (ppm):
Calibration Date:	6/10/98											
pH Data												
Reactor No.	Volume Added (ml)	Initial MnO4- (mg/L)	Final MnO4- ABS	Final MnO4- Spec DF	Final MnO4- (mg/L)	MnO4- Consumed in Interval	MnO4- Cum. Consumed	MnO4- Cum. Consumed per gram	MnO4- in Aliquot	MnO4- in Aliquot	pH	pH
3	0	0.0	0.004	1	120.6	0.0	0.0	0.0	0.0	0.0	8.01	8.01
3	1.25	120.6	0.506	5	113.4	2.9	2.9	0.0	0.0	0.8	8.03	8.03
3	1.25	113.4	0.498	5	111.6	0.7	3.6	0.0	0.0	1.6	8.02	8.02
3	1.25	111.6	0.506	5	113.4	-0.7	2.9	0.0	0.0	0.8	8.03	8.03
3	1.25	113.4	0.498	5	111.6	0.7	3.6	0.0	0.0	0.8	8.03	8.03
3	1.25	111.6	0.447	5	100.1	4.2	7.8	0.1	0.1	0.7	8.3	8.3
3	1.25	100.1	0.481	5	107.8	-2.7	5.1	0.1	0.1	0.7	8.31	8.31
4	0	0.0	0.003	1	119.7	0.0	0.0	0.0	0.0	0.0	8.02	8.02
4	1.25	119.7	0.513	5	114.9	1.9	1.9	0.0	0.0	0.8	8.03	8.03
4	1.25	114.9	0.518	5	116.0	-0.4	1.5	0.0	0.0	0.8	8.02	8.02
4	1.25	116.0	0.512	5	114.7	0.5	2.0	0.0	0.0	1.7	8.02	8.02
4	1.25	114.7	0.507	5	113.6	0.4	2.4	0.0	0.0	0.8	8.03	8.03
4	1.25	113.6	0.503	5	112.7	0.3	2.7	0.0	0.0	0.8	8.23	8.23
4	1.25	112.7	0.492	5	110.2	0.9	3.6	0.0	0.0	0.8	8.25	8.25

Prepared by: S.R. Cline

Last Updated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4a-R4	For additional comments, see Laboratory Notebook B000025																			
Reactor No.	ORNL GC #	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)	Flag	Aq. C/Co	mg TCE Oxidized in Interval	Cum. mg TCE Oxidized	% of Init Aqueous TCE Oxidized In Interval	% of Total TCE Oxidized In Interval	Cum. Total TCE Oxidized	mg TCE in Aliquot							
3	1251	145		2.91	3.06	138		1.00	0.000	0.0	0.0%	0.0%	0.0%	0.00							
3	1258	13		2.86	3.13	12		0.08	0.050	0.1	90.3%	88.6%	88.6%	0.00							
3	1264	0		2.90	3.19	1		0.04	0.004	0.1	7.4%	7.3%	95.9%	0.00							
3	1271	0		2.89	3.28	1		0.00	0.000	0.1	0.0%	0.0%	95.9%	0.00							
3	1278	0		2.87	3.06	1		0.00	0.000	0.1	0.0%	0.0%	95.9%	0.00							
3	1285	0		2.87	3.09	1		0.01	0.000	0.1	0.0%	0.0%	95.9%	0.00							
3	1292	0		2.90	2.87	1		0.01	0.000	0.1	0.0%	0.0%	95.9%	0.00							
4	1252	152		2.90	3.28	134		1.00	0.000	0.0	0.0%	0.0%	0.0%	0.00							
4	1259	15		2.87	3.12	14		0.10	0.049	0.0	88.6%	84.7%	84.7%	0.00							
4	1266	0		2.86	3.24	1		0.01	0.005	0.1	9.1%	8.7%	93.4%	0.00							
4	1272	0		2.88	3.19	1		0.01	0.000	0.1	0.0%	0.0%	93.4%	0.00							
4	1279	0		2.87	3.15	1		0.01	0.000	0.1	0.0%	0.0%	93.4%	0.00							
4	1286	0		2.87	2.98	1		0.01	0.000	0.1	0.0%	0.0%	93.4%	0.00							
4	1293	0		2.88	3.04	1		0.01	0.000	0.1	0.0%	0.0%	93.4%	0.00							

Steven Robert Cline
NO, BUT ENTERED AS 1 PPM FOR
CALCULATIONS

Prepared by: S.R. Cline

Last Updated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4a-R4	For additional comments, see Laboratory Notebook B000025								
	MnO4- Calb. Slope:		0.022	STOCK SOLN ABS		0.517	DF:		1667	Conc (ppm):	38607.91
	Calibration Date: 6/10/98										
	MnO4- Data										pH Data
Reactor No.	Volume	Initial	Final	Final	Final	mg MnO4	Cum.	Cum	mg MnO4-		
	Stock Mn Added (ml)	MnO4- (mg/L)	MnO4- ABS	Spec DF	MnO4- (mg/L)	Consumed in Interval	mg MnO4 Consumed	mg MnO4 per gram	in Aliquot	pH	
5	0	0.0	0.003	1	1186.4	0.0	0.0	0.0	0.0	8.02	
5	12.5	1186.4	0.493	50	1104.5	33.3	33.3	0.3	8.2	8.14	
5	12.5	1104.5	0.488	50	1093.3	4.5	37.8	0.4	7.9	8.12	
5	12.5	1093.3	0.493	50	1104.5	-4.4	33.4	0.3	8.2	8.12	
5	12.5	1104.5	0.497	50	1113.4	-3.4	30.0	0.3	16.4	8.13	
5	12.5	1113.4	0.500	50	1120.2	-2.5	27.5	0.3	8.2	8.28	
5	12.5	1120.2	0.497	50	1113.4	2.4	29.9	0.3	8.1	8.28	
6	0	0.0	0.001	1	1186.1	0.0	0.0	0.0	0.0	8.01	
6	12.5	1186.1	0.533	50	1194.1	-3.2	-3.2	0.0	8.8	8.15	
6	12.5	1194.1	0.535	50	1198.6	-1.8	-5.0	-0.1	8.6	8.13	
6	12.5	1198.6	0.529	50	1185.1	5.3	0.2	0.0	8.7	8.13	
6	12.5	1185.1	0.532	50	1191.8	-2.6	-2.3	0.0	8.6	8.14	
6	12.5	1191.8	0.533	50	1194.1	-0.8	-3.2	0.0	16.9	8.31	
6	12.5	1194.1	0.522	50	1169.4	9.0	5.8	0.1	17.1	8.32	

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4a-R4	For additional comments, see Laboratory Notebook B000025															

Steven Robert Cline:
NO, BUT ENTERED AS 1 PPB FOR
PLOTING LOG SCALE

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4a-R4	For additional comments, see Laboratory Notebook B000025										160	Coc. (ppm)	160/91	For additional comments, see Laboratory 7			
Reactor No.	Sample Time	RXN Time	Sample Time	Volume (mL)	Media	Solid Mass (g)	Sampled Date	Actual Vol (mL)	Actual Dose (mg/L)	Actual Conc (ppm)	Stoichiometric Ratio	Stoichiometric Ratio	Stoichiometric Ratio	Stoichiometric Ratio	Stoichiometric Ratio	Stoichiometric Ratio	Stoichiometric Ratio	Stoichiometric Ratio
1	7/15/98 10:48	00:44:44-1b	00:44:44-1b	500.94	GW Only	0	7/15/98	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	7/15/98 11:22	05:44:44-2b	05:44:44-2b	499.11	GW Only	0	7/15/98	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	7/15/98 12:23	13:44:44-3a	13:44:44-3a	499.11	GW Only	0	7/15/98	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4	7/15/98 12:23	21:44:44-3b	21:44:44-3b	499.11	GW Only	0	7/15/98	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5	7/15/98 12:23	21:44:44-3b	21:44:44-3b	499.11	GW Only	0	7/15/98	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6	7/15/98 8:05	21:44:44-20a-5b	21:44:44-20a-5b	499.11	GW Only	0	7/15/98	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7	7/15/98 10:47	23:34:44-22b-5b	23:34:44-22b-5b	499.11	GW Only	0	7/15/98	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Extraction of the Remaining Reactor Contents																		
1	7/16/98 10:50	24:14:44-4a	24:14:44-4a	405.81	A. Basalt	100.034	7/16/98	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	7/16/98 10:50	24:14:44-4a	24:14:44-4a	405.81	A. Basalt	100.034	7/16/98	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	7/16/98 10:50	24:14:44-4a	24:14:44-4a	405.81	A. Basalt	100.034	7/16/98	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4	7/16/98 10:50	24:14:44-4a	24:14:44-4a	405.81	A. Basalt	100.034	7/16/98	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5	7/16/98 10:50	24:14:44-4a	24:14:44-4a	405.81	A. Basalt	100.034	7/16/98	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6	7/16/98 10:50	24:14:44-4a	24:14:44-4a	405.81	A. Basalt	100.034	7/16/98	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Extraction of the Charcoal Bed																		
1	7/16/98 10:50	44:14:44-1a	44:14:44-1a	Charcoal	NA	NA	7/16/98	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	7/16/98 10:50	44:14:44-1b	44:14:44-1b	Charcoal	NA	NA	7/16/98	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	7/16/98 10:50	44:14:44-2a	44:14:44-2a	Charcoal	NA	NA	7/16/98	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4	7/16/98 10:50	44:14:44-2b	44:14:44-2b	Charcoal	NA	NA	7/16/98	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5	7/16/98 10:50	44:14:44-3a	44:14:44-3a	Charcoal	NA	NA	7/16/98	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6	7/16/98 10:50	44:14:44-3b	44:14:44-3b	Charcoal	NA	NA	7/16/98	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7	7/16/98 10:50	44:14:44-4a	44:14:44-4a	Charcoal	NA	NA	7/16/98	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
8	7/16/98 10:50	44:14:44-4b	44:14:44-4b	Charcoal	NA	NA	7/16/98	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
9	7/16/98 10:50	44:14:44-5a	44:14:44-5a	Charcoal	NA	NA	7/16/98	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10	7/16/98 10:50	44:14:44-5b	44:14:44-5b	Charcoal	NA	NA	7/16/98	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11	7/16/98 10:50	44:14:44-6a	44:14:44-6a	Charcoal	NA	NA	7/16/98	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
12	7/16/98 10:50	44:14:44-6b	44:14:44-6b	Charcoal	NA	NA	7/16/98	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Additional Outlines																		
Initial Meas.	mg/mL	mg/mL	mg/mL	mg/mL	mg/mL	mg/mL	mg/mL	mg/mL	mg/mL	mg/mL	mg/mL	mg/mL	mg/mL	mg/mL	mg/mL	mg/mL	mg/mL	mg/mL
Flask (mg)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Prepared by: S.R. Clive

Last Update: 11/20/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Experiment: 4a-R5

For additional comments, see Laboratory Notebook B000025

Pages: 78-81

Solid Media	Initial TCE (ppb)	Co-Contaminant?	MnO4- Concs. (%)
C. Basalt	1000	NO	0.01 & 0.1

Experiment Start Date: 6/15/98

Comments:

See general procedure on pages 57-60 in the laboratory Notebook.

Deviations from general procedure:

NONE **NOTE: Small Amt of TCE in Blank solution!!!!!!** (8-12 ppb) (See 061998b data set)

This hexane was likely used in the preparation of the GC extracts/dilutions

SPIKE SOLUTION PREPARATION

Volume GW in Tedlar 2.99 liters

Volume Sat. TCE added 3 mL

3 mg

(Assuming 1000 ppm Saturated Conc.)

Predicted Spike Conc: 1003 ppb

GC Analysis of Spike Solution

ORNL GC #	Sample Name	Sample Time	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)
763	4a-r5-tba	6/17/98 15:10	1344		4.93	4.92	1347
764	4a-r5-tbb	6/17/98 15:10	1443		4.98	5.30	1354

Prepared by: S.R. Cline

Last Updated: 10/22/98

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Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4a-R5	For additional comments, see Laboratory Notebook B000025								
MnO4- Calb. Slope:		0.022	STOCK SOLN ABS	0.511	DF:		1667	Conc (ppm):	38160	
Calibration Date: 6/10/98										
MnO4- Data										pH Data
Reactor	Volume	Initial	Final	Final	Final	mg MnO4	Cum.	Cum	mg MnO4-	
Stock Mn	MnO4-	MnO4-	Spec	MnO4-	Consumed	mg MnO4	mg MnO4	mg MnO4	in Aliquot	pH
No.	Added (ml)	(mg/L)	ABS	DF	(mg/L)	in Interval	Consumed	per gram		
1	0	0	0.002	1	NA	NA	NA	NA	NA	8.13
1	0	0	0.003	1	NA	NA	NA	NA	NA	8.17
1	0	0	0.004	1	NA	NA	NA	NA	NA	8.15
1	0	0	0.002	1	NA	NA	NA	NA	NA	8.13
1	0	0	0.007	1	NA	NA	NA	NA	NA	8.14
1	0	0	0.004	1	NA	NA	NA	NA	NA	8.13
1	0	0	0.004	1	NA	NA	NA	NA	NA	8.13
2	0	0	0.002	1	NA	NA	NA	NA	NA	8
2	0	0	0.003	1	NA	NA	NA	NA	NA	8.17
2	0	0	0.004	1	NA	NA	NA	NA	NA	8.15
2	0	0	0.000	1	NA	NA	NA	NA	NA	8.14
2	0	0	0.003	1	NA	NA	NA	NA	NA	8.13
2	0	0	0.004	1	NA	NA	NA	NA	NA	8.15
2	0	0	0.003	1	NA	NA	NA	NA	NA	8.14

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C-85

	Exp.	4a-R5	For additional comments, see Laboratory Notebook B000025														
	ORNL	Extract	Flag	Hexane	Aqueous	Aqueous	Flag	Aq.	mg TCE	Cum.	% of Init A	% of Total	Cum %	mg TCE			
Reactor	GC #	Conc.		Volume	Volume	Conc.		C/Co	Oxidized	mg TCE	TCE Oxidi	TCE Oxidi	Total TCE	in Aliquot			
No.		(ppb)		(mL)	(mL)	(ppb)			in Interval	Oxidized	In Interval	In Interval	Oxidized				
1	765	1,403		2.98	3.17	1,319		NA	NA	NA	NA	NA	NA				0.02
1	772	1,385		2.95	3.13	1,307		NA	NA	NA	NA	NA	NA				0.01
1	779	1,326		2.93	3.07	1,264		NA	NA	NA	NA	NA	NA				0.01
1	786	1,310		2.85	2.95	1,264		NA	NA	NA	NA	NA	NA				0.01
1	793	1,331		2.87	3.13	1,222		NA	NA	NA	NA	NA	NA				0.01
1	800	1,316		2.87	2.89	1,310		NA	NA	NA	NA	NA	NA				0.01
1	807	1,349		2.83	3.00	1,270		NA	NA	NA	NA	NA	NA				0.01
2	767	1,376		2.96	3.19	1,276		NA	NA	NA	NA	NA	NA				0.01
2	773	1,389		2.96	3.12	1,318		NA	NA	NA	NA	NA	NA				0.02
2	780	1,452		2.87	3.15	1,320		NA	NA	NA	NA	NA	NA				0.01
2	787	1,294		2.90	2.87	1,310		NA	NA	NA	NA	NA	NA				0.01
2	794	1,383		2.87	3.08	1,290		NA	NA	NA	NA	NA	NA				0.01
2	801	1,443		2.87	3.11	1,329		NA	NA	NA	NA	NA	NA				0.01
2	808	1,302		2.86	3.04	1,224		NA	NA	NA	NA	NA	NA				0.01

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Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.		4a-R5	For additional comments, see Laboratory Notebook B000025							
MnO4- Calb. Slope:		0.022	STOCK SOLN ABS		0.511	DF:	1667	Conc (ppm):		38160
Calibration Date: 6/10/98										
MnO4- Data										pH Data
Reactor No.	Volume Added (ml)	Initial MnO4- (mg/L)	Final MnO4- ABS	Final Spec DF	Final MnO4- (mg/L)	mg MnO4 Consumed in Interval	Cum. mg MnO4 Consumed	Cum. mg MnO4 per gram	mg MnO4 in Aliquot	pH
3	0	0.0	0.002	1	119.3	0.0	0.0	0.0	0.0	8.17
3	1.25	119.3	0.472	5	105.7	5.4	5.4	0.1	0.8	8.1
3	1.25	105.7	0.452	5	101.3	1.8	7.2	0.1	1.4	8.11
3	1.25	101.3	0.438	5	98.1	1.2	8.4	0.1	0.7	8.11
3	1.25	98.1	0.439	5	98.3	-0.1	8.3	0.1	0.7	8.12
3	1.25	98.3	0.401	5	89.8	3.1	11.4	0.1	0.6	8.24
3	1.25	89.8	0.408	5	91.4	-0.6	10.8	0.1	0.6	8.26
4	0	0.0	0.003	1	115.1	0.0	0.0	0.0	0.0	8.17
4	1.25	115.1	0.459	5	102.8	5.1	5.1	0.1	0.7	8.09
4	1.25	102.8	0.444	5	99.5	1.4	6.5	0.1	0.7	8.09
4	1.25	99.5	0.432	5	96.8	1.1	7.5	0.1	1.3	8.1
4	1.25	96.8	0.417	5	93.4	1.3	8.8	0.1	0.6	8.11
4	1.25	93.4	0.399	5	89.4	1.5	10.4	0.1	0.6	8.21
4	1.25	89.4	0.406	5	91.0	-0.6	9.8	0.1	1.2	8.22

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4a-R5	For additional comments, see Laboratory Notebook B000025												
Reactor No.	ORNL GC #	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)	Flag	Aq. C/Co	mg TCE Oxidized in Interval	Cum. mg TCE Oxidized	% of Init A TCE Oxidized In Interval	% of Total TCE Oxidized In Interval	Cum % Total TCE Oxidized	mg TCE in Aliquot
3	768	1,317		2.96	3.08	1,263		1.00	0.000	0.0	0.0%	0.0%	0.0%	0.01
3	775	162		2.95	3.13	153		0.12	0.444	0.4	86.6%	84.3%	84.3%	0.00
3	781	23		2.98	3.03	22		0.02	0.051	0.5	10.0%	9.7%	94.0%	0.00
3	788	15		2.90	3.22	13		0.01	0.003	0.5	0.7%	0.6%	94.7%	0.00
3	795	8		2.85	3.08	7		0.01	0.002	0.5	0.5%	0.5%	95.1%	0.00
3	802	14		2.87	3.18	12		0.01	-0.002	0.5	-0.4%	-0.4%	94.8%	0.00
3	809	26		2.86	3.12	24		0.02	-0.004	0.5	-0.8%	-0.8%	93.9%	0.00
4	769	1,338		2.95	3.11	1,269		1.00	0.000	0.0	0.0%	0.0%	0.0%	0.01
4	776	157		2.94	3.02	153		0.12	0.463	0.5	86.8%	84.9%	84.9%	0.00
4	783	31		2.93	3.02	30		0.02	0.050	0.5	9.4%	9.2%	94.1%	0.00
4	789	15		2.91	3.04	14		0.01	0.006	0.5	1.2%	1.2%	95.3%	0.00
4	796	18		2.09	3.67	10		0.01	0.002	0.5	0.3%	0.3%	95.6%	0.00
4	803	19		2.85	3.11	17		0.01	-0.003	0.5	-0.5%	-0.5%	95.1%	0.00
4	810	19		2.82	2.83	19		0.02	-0.001	0.5	-0.2%	-0.1%	94.9%	0.00

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Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4a-R5	For additional comments, see Laboratory Notebook B000025										Sample Data							
Reactor No.	Sample Time	RXN Time (hrs)	Sample Name	Volume GW Used (mL)	Media Type	Solid Mass (grams)	vol (mL) aqueous aliquot	Cum Vol (mL)	Actual Vol at Sampling	Actual L/S Ratio									
5	6/18/98 11:03	0.0	4a-r5-10-5	384.79	C. Basalt	100.0	7.11	7.11	384.79	3.8									
5	6/18/98 11:36	0.5	4a-r5-130m-5	384.79	C. Basalt	100	7.05	14.16	390.18	3.9									
5	6/18/98 13:03	2.0	4a-r5-11.5h-5	384.79	C. Basalt	100	7.12	21.28	383.13	3.8									
5	6/18/98 14:15	3.2	4a-r5-13h-5	384.79	C. Basalt	100	7.1	28.38	376.01	3.8									
5	6/18/98 16:08	5.1	4a-r5-15h-5a	384.79	C. Basalt	100	14.15	42.53	368.91	3.7									
5	6/19/98 8:32	21.5	4a-r5-120h-5	384.79	C. Basalt	100	7.1	49.63	354.76	3.5									
5	6/19/98 11:03	24.0	4a-r5-124h-5	384.79	C. Basalt	100	6.9	56.53	347.66	3.5									
6	6/18/98 11:04	0.0	4a-r5-10-6	406.26	C. Basalt	100.1	7.12	7.12	406.26	4.1									
6	6/18/98 11:37	0.6	4a-r5-130m-6	406.26	C. Basalt	100.07	6.89	14.01	411.64	4.1									
6	6/18/98 13:03	2.0	4a-r5-11.5h-6	406.26	C. Basalt	100.07	6.84	20.85	404.75	4.0									
6	6/18/98 14:15	3.2	4a-r5-13h-6	406.26	C. Basalt	100.07	7.01	27.86	397.91	4.0									
6	6/18/98 16:09	5.1	4a-r5-15h-6	406.26	C. Basalt	100.07	6.71	34.57	390.9	3.9									
6	6/19/98 8:33	21.5	4a-r5-120h-6a	406.26	C. Basalt	100.07	13.68	48.25	384.19	3.8									
6	6/19/98 11:04	24.0	4a-r5-124h-6	406.26	C. Basalt	100.07	6.73	54.98	370.51	3.7									

Prepared by: S.R. Cline

Last Updated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4a-R5	For additional comments, see Laboratory Notebook B000025								
	MnO4- Calb. Slope:		0.022	STOCK SOLN ABS	0.511	DF:		1667	Conc (ppm):	38160	
	Calibration Date: 6/10/98										
	MnO4- Data										pH Data
	Volume	Initial	Final	Final	Final	mg MnO4	Cum.	Cum	mg MnO4-		
Reactor	Stock Mn	MnO4-	MnO4-	Spec	MnO4-	Consumed	mg MnO4	mg MnO4	in Aliquot	pH	
No.	Added (ml)	(mg/L)	ABS	DF	(mg/L)	in Interval	Consumed	per gram			
5	0	0.0	0.002	1	1222.5	0.0	0.0	0.0	0.0	8.15	
5	12.5	1222.5	0.547	50	1225.5	-1.1	-1.1	0.0	8.6	8.11	
5	12.5	1225.5	0.540	50	1209.8	6.0	4.9	0.0	8.6	8.1	
5	12.5	1209.8	0.546	50	1223.2	-5.1	-0.2	0.0	8.7	8.1	
5	12.5	1223.2	0.545	50	1221.0	0.8	0.6	0.0	17.3	8.1	
5	12.5	1221.0	0.539	50	1207.5	4.8	5.4	0.1	8.6	8.24	
5	12.5	1207.5	0.536	50	1200.8	2.3	7.7	0.1	8.3	8.25	
6	0	0.0	0.002	1	1158.8	0.0	0.0	0.0	0.0	8.14	
6	12.5	1158.8	0.531	50	1189.6	-12.7	-12.7	-0.1	8.2	8.09	
6	12.5	1189.6	0.522	50	1169.4	8.2	-4.5	0.0	8.0	8.07	
6	12.5	1169.4	0.522	50	1169.4	0.0	-4.5	0.0	8.2	8.07	
6	12.5	1169.4	0.522	50	1169.4	0.0	-4.5	0.0	7.8	8.07	
6	12.5	1169.4	0.528	50	1182.9	-5.2	-9.7	-0.1	16.2	8.14	
6	12.5	1182.9	0.522	50	1169.4	5.0	-4.7	0.0	7.9	8.15	

Prepared by: S.R. Cline

Last Updated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4a-R5	For additional comments, see Laboratory Notebook B000025															
Reactor No.	ORNL GC #	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)	Flag	Aq. C/Co	mg TCE Oxidized in Interval	Cum. mg TCE Oxidized	% of Init A TCE Oxid In Interval	% of Total TCE Oxid In Interval	Cum % Total TCE Oxidized	mg TCE in Aliquot			
5	770	1,267		2.96	2.98	1,259			0.000	0.0	0.0%	0.0%	0.0%	0.01			
5	777	0		2.92	3.06	1			0.491	0.5	101.3%	98.3%	98.3%	0.00			
5	784	0		2.91	2.92	1			0.000	0.5	0.0%	0.0%	98.3%	0.00			
5	791	16		2.89	2.91	16			0.01	0.006	0.5	-1.2%	-1.1%	97.2%	0.00		
5	797	0		2.40	3.00	1			0.00	0.005	0.5	1.1%	1.1%	98.3%	0.00		
5	804	0		2.87	2.93	1			0.00	0.000	0.5	0.0%	0.0%	98.3%	0.00		
5	812	0		2.85	3.19	1			0.00	0.000	0.5	0.0%	0.0%	98.3%	0.00		
6	771	1,554		2.92	3.45	1,317			1.00	0.000	0.0	0.0%	0.0%	0.0%	0.01		
6	778	13		2.95	2.87	13			0.01	0.537	0.5	100.3%	101.8%	101.8%	0.00		
6	785	16		2.91	3.06	16			0.01	-0.001	0.5	-0.2%	-0.2%	101.6%	0.00		
6	792	16		2.88	2.94	16			0.01	0.000	0.5	0.0%	0.0%	101.6%	0.00		
6	799	17		2.88	2.20	22			0.02	-0.003	0.5	-0.5%	-0.5%	101.1%	0.00		
6	805	18		2.85	3.11	16			0.01	0.002	0.5	0.4%	0.4%	101.6%	0.00		
6	813	17		2.85	3.20	15			0.01	0.000	0.5	0.1%	0.1%	101.7%	0.00		

Steven Robert Cline:
IND. BUT ENTERED AS 1 PPB FOR
EXTRACTING LOG SCALE 0.000

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Prepared by: S.R. Cline

Last Updated: 11/3/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Experiment: 4a-R6

For additional comments, see Laboratory Notebook B000025

Pages: 106-109,114

Solid Media	Initial TCE (ppb)	Co-Contaminant?	MnO4- Conc. (%)
A. Basalt	1000	NO	0.01 & 0.1

Experiment Start Date: 8/17/98

Comments:

See general procedure on pages 57-60 in the laboratory Notebook.

Deviations from general procedure:

Spike solution only incubated at 12C for 3 hours instead of overnite.

Leak in Tedlar Bag, flasks 5 and 6 only received 200 mL of spike directly from the Tedlar, the remaining vol for each was recovered from the tray.

SPIKE SOLUTION PREPARATION

Volume GW in Tedlar 2.81 liters

Volume Sat. TCE added 2.8 mL

2.8 mg (Assuming 1000 ppm Saturated Conc.)

Predicted Spike Conc: 998 ppb

GC Analysis of Spike Solution

ORNL GC #	Sample Name	Sample Time	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)
1727R	4a-r6-tba	8/18/98 13:44	2706		4.92	5.25	2535
1728R	4a-r6-tbb	8/18/98 13:45	2362		4.87	4.92	2337

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	Exp.	4a-R6	For additional comments, see Laboratory Notebook B000025							
Initial Data							Sample Data			
Reactor No.	Sample Time	RXN Time (hrs)	Sample Name	Volume GW Used (mL)	Media Type	Solid Mass (grams)	vol (mL) aqueous aliquot	Cum Aliquot Vol (mL)	Actual Vol at Sampling	Actual L/S Ratio
1	8/19/98 11:00	0.0	4a-r6-10-1a	510.17	GW Only	0.0	14.95	15.0	510.2	NA
1	8/19/98 11:30	0.5	4a-r6-t30min-1	510.17	GW Only	0.0	7.34	22.3	495.2	NA
1	8/19/98 12:36	1.6	4a-r6-t1.5h-1	510.17	GW Only	0.0	7.41	29.7	487.9	NA
1	8/19/98 14:05	3.1	4a-r6-t3h-1	510.17	GW Only	0.0	7.62	37.3	480.5	NA
1	8/19/98 16:04	5.1	4a-r6-t5h-1	510.17	GW Only	0.0	7.43	44.8	472.9	NA
1	8/20/98 8:10	21.2	4a-r6-t20h-1	510.17	GW Only	0.0	7.66	52.4	465.4	NA
1	8/20/98 11:00	24.0	4a-r6-t24h-1	510.17	GW Only	0.0	7.6	60.0	457.8	NA
2	8/19/98 11:02	0.0	4a-r6-10-2	472.81	GW Only	0.0	8.2	8.2	472.8	NA
2	8/19/98 11:31	0.5	4a-r6-t30min-2a	472.81	GW Only	0.0	14.38	22.6	464.6	NA
2	8/19/98 12:37	1.6	4a-r6-t1.5h-2	472.81	GW Only	0.0	7.33	29.9	450.2	NA
2	8/19/98 14:06	3.1	4a-r6-t3h-2	472.81	GW Only	0.0	7.48	37.4	442.9	NA
2	8/19/98 16:05	5.1	4a-r6-t5h-2	472.81	GW Only	0.0	7.26	44.7	435.4	NA
2	8/20/98 8:11	21.1	4a-r6-t20h-2	472.81	GW Only	0.0	7.34	52.0	428.2	NA
2	8/20/98 11:01	24.0	4a-r6-t24h-2	472.81	GW Only	0.0	7.35	59.3	420.8	NA

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4a-R6	For additional comments, see Laboratory Notebook B000025								
MnO4- Calb. Slope:		0.022	STOCK SOLN ABS		0.539	DF:		1667	Cone (ppm):	40250.8
Calibration Date: 6/10/98										
MnO4- Data										pH Data
Reactor No.	Volume Added (ml)	Initial MnO4- (mg/L)	Final MnO4- ABS	Final Spec DF	Final MnO4- (mg/L)	mg MnO4- Consumed in Interval	Cum. mg MnO4- Consumed	Cum mg MnO4- per gram	mg MnO4- in Aliquot	pH
1	0	0	0.004	1	NA	NA	NA	NA	NA	8.4
1	0	0	0.005	1	NA	NA	NA	NA	NA	8.37
1	0	0	0.006	1	NA	NA	NA	NA	NA	8.42
1	0	0	0.004	1	NA	NA	NA	NA	NA	8.38
1	0	0	0.006	1	NA	NA	NA	NA	NA	8.38
1	0	0	0.004	1	NA	NA	NA	NA	NA	8.28
1	0	0	0.009	1	NA	NA	NA	NA	NA	8.26
2	0	0	0.004	1	NA	NA	NA	NA	NA	8.41
2	0	0	0.004	1	NA	NA	NA	NA	NA	8.41
2	0	0	0.005	1	NA	NA	NA	NA	NA	8.41
2	0	0	0.004	1	NA	NA	NA	NA	NA	8.38
2	0	0	0.005	1	NA	NA	NA	NA	NA	8.38
2	0	0	0.005	1	NA	NA	NA	NA	NA	8.24
2	0	0	0.005	1	NA	NA	NA	NA	NA	8.24

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96-3

Prepared by: S.R. Cline

LastUpdated: 10/23/98

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	Exp.	4a-R6	For additional comments, see Laboratory Notebook B000025							
			Sample Data							
Reactor	Sample	RXN		Volume		Solid	vol (mL)	Cum	Actual	Actual
No.	Time	Time (hrs)	Sample Name	GW Used (mL)	Media Type	Mass (grams)	aqueous aliquot	Aliquot Vol (mL)	Vol at Sampling	L/S Ratio
3	8/19/98 11:03	0.0	4a-r6-10-3	388.15	A. Basalt	100.1	8.37	8.4	388.2	3.9
3	8/19/98 11:33	0.5	4a-r6-t30min-3	388.15	A. Basalt	100.1	6.88	15.3	381.0	3.8
3	8/19/98 12:38	1.6	4a-r6-t1.5h-3a	388.15	A. Basalt	100.1	13.94	29.2	374.2	3.7
3	8/19/98 14:07	3.1	4a-r6-t3h-3	388.15	A. Basalt	100.1	6.98	36.2	360.2	3.6
3	8/19/98 16:06	5.0	4a-r6-t5h-3	388.15	A. Basalt	100.1	7.22	43.4	353.2	3.5
3	8/20/98 8:12	21.1	4a-r6-t20h-3	388.15	A. Basalt	100.1	7.1	50.5	346.0	3.5
3	8/20/98 11:02	24.0	4a-r6-t24h-3a	388.15	A. Basalt	100.1	14.32	64.8	338.9	3.4
4	8/19/98 11:04	0.0	4a-r6-10-4	406.41	A. Basalt	100.3	7.32	7.3	406.4	4.1
4	8/19/98 11:34	0.5	4a-r6-t30min-4	406.41	A. Basalt	100.3	7	14.3	400.3	4.0
4	8/19/98 12:40	1.6	4a-r6-t1.5h-4	406.41	A. Basalt	100.3	7.4	21.7	393.3	3.9
4	8/19/98 14:08	3.1	4a-r6-t3h-4a	406.41	A. Basalt	100.3	14.27	36.0	385.9	3.8
4	8/19/98 16:07	5.1	4a-r6-t5h-4	406.41	A. Basalt	100.3	7.19	43.2	371.7	3.7
4	8/20/98 8:13	21.2	4a-r6-t20h-4	406.41	A. Basalt	100.3	7.32	50.5	364.5	3.6
4	8/20/98 11:04	24.0	4a-r6-t24h-4	406.41	A. Basalt	100.3	7.26	57.8	357.2	3.6

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4a-R6	For additional comments, see Laboratory Notebook B000025								
MnO4- Calb. Slope:		0.022	STOCK SOLN ABS		0.539	DF:		1667	Cone (ppm):	40250.8
Calibration Date: 6/10/98										
MnO4- Data										pH Data
Reactor	Volume	Initial	Final	Final	Final	mg MnO4-	Cum.	Cum	mg MnO4-	
No.	Stock Mn	MnO4-	MnO4-	Spec	MnO4-	Consumed	mg MnO4-	mg MnO4-	in Aliquot	pH
	Added (ml)	(mg/L)	ABS	DF	(mg/L)	in Interval	Consumed	per gram		
3	0	0.0	0.009	1	132.0	0.0	0.0	0.0	0.0	8.38
3	1.25	132.0	0.508	5	113.8	6.9	6.9	0.1	0.8	8.27
3	1.25	113.8	0.472	5	105.7	3.0	10.0	0.1	1.5	8.25
3	1.25	105.7	0.495	5	110.9	-1.9	8.1	0.1	0.8	8.24
3	1.25	110.9	0.494	5	110.7	0.1	8.2	0.1	0.8	8.24
3	1.25	110.7	0.480	5	107.5	1.1	9.3	0.1	0.8	8.19
3	1.25	107.5	0.483	5	108.2	-0.2	9.0	0.1	1.5	8.22
4	0	0.0	0.003	1	125.7	0.0	0.0	0.0	0.0	8.37
4	1.25	125.7	0.494	5	110.7	6.0	6.0	0.1	0.8	8.27
4	1.25	110.7	0.483	5	108.2	1.0	7.0	0.1	0.8	8.22
4	1.25	108.2	0.491	5	110.0	-0.7	6.3	0.1	1.6	8.23
4	1.25	110.0	0.487	5	109.1	0.3	6.6	0.1	0.8	8.23
4	1.25	109.1	0.476	5	106.6	0.9	7.5	0.1	0.8	8.18
4	1.25	106.6	0.552	5	123.7	-6.1	1.4	0.0	0.9	8.21

C-99

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4a-R6	For additional comments, see Laboratory Notebook B000025												
Reactor No.	ORNL GC #	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)	Flag	Aq. C/Co	mg TCE Oxidized in Interval	Cum. mg TCE Oxidized	% of Init A TCE Oxidi In Interval	% of Total TCE Oxidi In Interval	Cum % Total TCE Oxidized	mg TCE in Aliquot
3	1732R	2,578		2.86	3.20	2,304		1.00	0.000	0.0	0.0%	0.0%	0.0%	0.02
3	1739	267		2.83	3.11	243		0.11	0.785	0.8	87.8%	80.4%	80.4%	0.00
3	1745	57		2.93	3.15	53		0.02	0.071	0.9	7.9%	7.3%	87.7%	0.00
3	1752	17		2.82	2.99	16		0.01	0.013	0.9	1.5%	1.4%	89.0%	0.00
3	1759	10		2.86	3.33	8		0.00	0.003	0.9	0.3%	0.3%	89.3%	0.00
3	1766	7		2.83	2.97	6		0.00	0.001	0.9	0.1%	0.1%	89.4%	0.00
3	1773	21		2.88	3.08	20		0.01	-0.005	0.9	-0.5%	-0.5%	88.9%	0.00
4	1733R	2,493		2.91	3.12	2,324		1.00	0.000	0.0	0.0%	0.0%	0.0%	0.02
4	1740	272		2.84	3.04	253		0.11	0.829	0.8	87.8%	81.1%	81.1%	0.00
4	1747	54		2.85	3.10	50		0.02	0.080	0.9	8.5%	7.8%	88.9%	0.00
4	1753	6	U	2.82	3.02	5	U	0.00	0.017	0.9	1.8%	1.7%	90.6%	0.00
4	1760	0		2.87	3.09	1		0.00	0.002	0.9	0.2%	0.2%	90.7%	0.00
4	1767	0		2.87	3.21	1		0.00	0.000	0.9	0.0%	0.0%	90.7%	0.00
4	1775	0		2.85	3.08	1		0.00	0.000	0.9	0.0%	0.0%	90.7%	0.00

Steven Robert Cline:
ND, BUT ENTERED AS 1 PPB FOR
PLOTTING LOG SCALE

C-101

Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4a-R6	For additional comments, see Laboratory Notebook B000025							
	MnO4- Calb. Slope:		0.022	STOCK SOLN ABS		0.539	DF:	1667	Conc (ppm):	40250.8
	Calibration Date: 6/10/98									
	MnO4- Data									pH Data
	Volume	Initial	Final	Final	Final	mg MnO4-	Cum.	Cum	mg MnO4-	
Reactor	Stock Mn	MnO4-	MnO4-	Spec	MnO4-	Consumed	mg MnO4-	mg MnO4-	in Aliquot	pH
No.	Added (ml)	(mg/L)	ABS	DF	(mg/L)	in Interval	Consumed	per gram		
5	0	0.0	0.002	1	1190.0	0.0	0.0	0.0	0.0	8.35
5	12.5	1190.0	0.491	50	1100.0	38.1	38.1	0.4	7.9	8.39
5	12.5	1100.0	0.480	50	1075.4	10.2	48.3	0.5	8.0	8.37
5	12.5	1075.4	0.492	50	1102.2	-11.0	37.3	0.4	8.3	8.36
5	12.5	1102.2	0.490	50	1097.8	1.8	39.1	0.4	16.2	8.36
5	12.5	1097.8	0.497	50	1113.4	-6.1	33.1	0.3	8.2	8.29
5	12.5	1113.4	0.507	50	1135.8	-8.5	24.6	0.2	8.2	8.3
6	0	0.0	0.001	1	1298.3	0.0	0.0	0.0	0.0	8.34
6	12.5	1298.3	0.579	50	1297.1	0.4	0.4	0.0	9.3	8.39
6	12.5	1297.1	0.555	50	1243.4	20.5	20.9	0.2	9.3	8.37
6	12.5	1243.4	0.554	50	1241.1	0.8	21.7	0.2	9.0	8.35
6	12.5	1241.1	0.565	50	1265.8	-9.0	12.7	0.1	9.1	8.36
6	12.5	1265.8	0.571	50	1279.2	-4.8	7.9	0.1	18.5	8.29
6	12.5	1279.2	0.564	50	1263.5	5.4	13.3	0.1	9.2	8.3

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4a-R6	For additional comments, see Laboratory Notebook B000025											
												</		

Steven Robert Cline:
ND, BUT ENTERED AS 1 PPB FOR
PLOTING LOG SCALE

C-104

Prepared by: S.R. Cline

LastUpdated: 11/19/8

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Experiment: 4a-R7

For additional comments, see Laboratory Notebook B000025

Pages: 87-90

Solid Media	Initial TCE (ppb)	Co-Contaminant?	MnO4- Concs. (%)
Sed (1st)	100	NO	0.01 & 0.1

Experiment Start Date: 7/7/98

Comments:

See general procedure on pages 57-60 in the laboratory Notebook.

Deviations from general procedure:

Also extracted un-used orbo charcoal tubes to determine if Peak at 5.03 minutes is related to TCE spiking

SPIKE SOLUTION PREPARATION

Volume GW in Tedlar 2.62 liters

Volume Sat. TCE added 0.3 mL

0.3 mg (Assuming 1000 ppm Saturated Conc.)

Predicted Spike Conc: 114 ppb

GC Analysis of Spike Solution

ORNL GC #	Sample Name	Sample Time	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)
1029	4a-r7-tb-a	7/8/98 15:50	293		4.96	5.23	278
1030	4a-r7-tb-b	7/8/98 15:50	285		5.02	5.31	270

C-105

Prepared by: S.R. Cline

Last Updated: 10/22/98

C-106

Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4a-R7	For additional comments, see Laboratory Notebook B000025								
MnO4- Calb. Slope:		0.022	STOCK SOLN ABS	0.54	DF:		1667	Conc (ppm):	40325.47	
Calibration Date:	6/10/98									
MnO4- Data										pH Data
Reactor No.	Volume Added (ml)	Initial MnO4- (mg/L)	Final MnO4- ABS	Final Spec DF	Final MnO4- (mg/L)	mg MnO4 Consumed in Interval	Cum. mg MnO4 Consumed	Cum. mg MnO4 per gram	mg MnO4- in Aliquot	pH
1	0	0	0.002	1	NA	NA	NA	NA	NA	8.07
1	0	0	0.002	1	NA	NA	NA	NA	NA	8.1
1	0	0	0.004	1	NA	NA	NA	NA	NA	8.1
1	0	0	0.005	1	NA	NA	NA	NA	NA	8.1
1	0	0	0.004	1	NA	NA	NA	NA	NA	8.1
1	0	0	0.004	1	NA	NA	NA	NA	NA	8.13
1	0	0	0.004	1	NA	NA	NA	NA	NA	8.12
2	0	0	0.002	1	NA	NA	NA	NA	NA	8.1
2	0	0	0.003	1	NA	NA	NA	NA	NA	8.13
2	0	0	0.001	1	NA	NA	NA	NA	NA	8.12
2	0	0	0.002	1	NA	NA	NA	NA	NA	8.13
2	0	0	0.002	1	NA	NA	NA	NA	NA	8.12
2	0	0	0.004	1	NA	NA	NA	NA	NA	8.12
2	0	0	0.003	1	NA	NA	NA	NA	NA	8.14

C-107

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4a-R7	For additional comments, see Laboratory Notebook B000025											
	ORNL	Extract	Flag	Hexane	Aqueous	Aqueous	Flag	Aq.	mg TCE	Cum.	% of Init A	% of Total	Cum %	mg TCE
Reactor	GC #	Conc.		Volume	Volume	Conc.		C/Co	Oxidized	mg TCE	TCE Oxid	TCE Oxid	Total TCE	in Aliquot
No.		(ppb)		(mL)	(mL)	(ppb)			in Interval	Oxidized	In Interval	In Interval	Oxidized	
1	1031	269		2.91	3.11	252		NA	NA	NA	NA	NA	NA	0.00
1	1038	284		2.95	3.54	236		NA	NA	NA	NA	NA	NA	0.00
1	1045	264		2.97	3.29	238		NA	NA	NA	NA	NA	NA	0.00
1	1052	259		2.95	3.25	236		NA	NA	NA	NA	NA	NA	0.00
1	1059	270		2.92	3.31	238		NA	NA	NA	NA	NA	NA	0.00
1	1066	261		2.93	3.21	238		NA	NA	NA	NA	NA	NA	0.00
1	1073	266		2.95	3.39	232		NA	NA	NA	NA	NA	NA	0.00
2	1032	289		2.93	3.32	255		NA	NA	NA	NA	NA	NA	0.00
2	1039	281		2.95	3.34	249		NA	NA	NA	NA	NA	NA	0.00
2	1046	270		2.97	3.23	248		NA	NA	NA	NA	NA	NA	0.00
2	1053	278		2.94	3.34	244		NA	NA	NA	NA	NA	NA	0.00
2	1060	273		2.93	3.31	242		NA	NA	NA	NA	NA	NA	0.00
2	1067	275		2.93	3.28	245		NA	NA	NA	NA	NA	NA	0.00
2	1074	257		2.93	3.10	244		NA	NA	NA	NA	NA	NA	0.00

C-109

Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4a-R7	For additional comments, see Laboratory Notebook B000025										40325.47
	MnO4- Calb. Slope:	0.022	STOCK SOLN ABS									1667 Conc (ppm):
	Calibration Date: 6/10/98											
MnO4- Data												
Reactor No.	Volume Added (ml)	Initial MnO4- (mg/L)	Final MnO4- ABS	Final Spec DF	Final MnO4- (mg/L)	MnO4- Consumed in Interval	Cum. mg MnO4 Consumed	Cum. mg MnO4 in Aliquot	pH	pH Data		
3	0	0.0	0.001	1	122.9	0.0	0.0	0.0	0.0	7.89		
3	1.25	122.9	0.48	5	107.5	6.3	6.3	0.1	0.7	7.91		
3	1.25	107.5	0.451	5	101.0	2.6	8.9	0.1	1.4	7.94		
3	1.25	101.0	0.468	5	104.8	-1.5	7.4	0.1	0.7	7.88		
3	1.25	104.8	0.429	5	96.1	3.3	10.8	0.1	0.7	7.95		
3	1.25	96.1	0.433	5	97.0	-0.3	10.5	0.1	0.7	7.98		
3	1.25	97.0	0.44	5	98.6	-0.6	9.9	0.1	0.5	7.9		
4	0	0.0	0.003	1	131.1	0.0	0.0	0.0	0.0	7.9		
4	1.25	131.1	0.529	5	118.5	4.8	4.8	0.1	0.8	7.89		
4	1.25	118.5	0.53	5	118.7	-0.1	4.8	0.0	0.8	7.86		
4	1.25	118.7	0.51	5	114.3	1.7	6.4	0.1	1.5	7.88		
4	1.25	114.3	0.503	5	112.7	0.6	7.0	0.1	0.8	7.92		
4	1.25	112.7	0.471	5	105.5	2.5	9.5	0.1	0.7	7.99		
4	1.25	105.5	0.524	5	117.4	-4.1	5.4	0.1	0.8	7.97		

Prepared by: S.R. Cline

Last Updated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4a-R7	For additional comments, see Laboratory Notebook B000025															
Reactor No.	ORNL GC #	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)	Flag	Aq. C/Co	mg TCE Oxidized in Interval	Cum. mg TCE Oxidized	% of Init A TCE Oxidi In Interval	% of Total TCE Oxidi In Interval	Cum % Total TCE Oxidized	mg TCE in Aliquot				
3	1033	255		2.99	3.22	237		1.00	0.000	0.0	0.0%	0.0%	0.0%	0.00				
3	1041	28		2.96	3.32	25		0.10	0.087	0.1	88.4%	82.6%	82.6%	0.00				
3	1047	6	U	2.97	3.43	5	U	0.02	0.008	0.1	8.2%	7.6%	90.2%	0.00				
3	1054	0		2.94	3.21	1		0.00	0.000	0.1	1.6%	1.4%	91.6%	0.00				
3	1061	0		2.93	3.38	1		0.00	0.000	0.1	0.0%	0.0%	91.6%	0.00				
3	1068	0		2.95	2.98	1		0.00	0.000	0.1	0.0%	0.0%	91.6%	0.00				
3	1075	0		2.93	2.87	1		0.00	0.000	0.1	0.0%	0.0%	91.6%	0.00				
4	1034	241		2.98	3.09	233		1.00	0.000	0.0	0.0%	0.0%	0.0%	0.00				
4	1042	19		2.97	3.22	18		0.08	0.083	0.1	91.0%	83.7%	83.7%	0.00				
4	1049	5	U	2.93	3.37	4	U	0.02	0.005	0.1	5.7%	5.2%	88.9%	0.00				
4	1055	0		2.95	3.47	1		0.00	0.001	0.1	1.4%	1.3%	90.1%	0.00				
4	1062	0		2.94	3.23	1		0.00	0.000	0.1	0.0%	0.0%	90.1%	0.00				
4	1069	0		2.94	3.08	1		0.00	0.000	0.1	0.0%	0.0%	90.1%	0.00				
4	1076	0		2.92	2.96	1		0.00	0.000	0.1	0.0%	0.0%	90.1%	0.00				

Steven Robert Cline:
ND, BUT ENTERED AS 1 PPB FOR
PLOTTING LOG SCALE

C-112

Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4a-R7	For additional comments, see Laboratory Notebook B000025										40325.47
MnO4- Calb. Slope:	0.022	STOCK SOLN ABS	0.54	DF:	1667	Cone (ppm):						
Calibration Date:	6/10/98											
MnO4- Data												
Reactor No.	Volume Stock Added (ml)	Initial MnO4- (mg/L)	Final MnO4- ABS	Final Spec DF	Final MnO4- (mg/L)	MnO4- Consumed in Interval	Cum. MnO4 Consumed	Cum. MnO4 per gram	mg MnO4 in Aliquot	pH	pH Data	
5	0	0.0	0.004	1	1224.7	0.0	0.0	0.0	0.0	7.91		
5	12.5	1224.7	0.529	50	1185.1	16.3	16.3	0.2	8.0	7.79		
5	12.5	1185.1	0.512	50	1147.0	15.4	31.7	0.3	7.8	7.72		
5	12.5	1147.0	0.517	50	1158.2	-4.5	27.2	0.3	7.8	7.72		
5	12.5	1158.2	0.497	50	1113.4	17.5	44.8	0.5	15.1	7.74		
5	12.5	1113.4	0.494	50	1106.7	2.5	47.3	0.5	7.3	7.78		
5	12.5	1106.7	0.516	50	1156.0	-18.3	29.0	0.3	15.9	7.81		
6	0	0.0	0.002	1	1348.0	0.0	0.0	0.0	0.0	7.91		
6	12.5	1348.0	0.563	50	1261.3	32.4	32.4	0.4	8.4	7.78		
6	12.5	1261.3	0.566	50	1268.0	-2.5	29.9	0.3	8.8	7.72		
6	12.5	1268.0	0.572	50	1281.5	-4.8	25.1	0.3	8.6	7.72		
6	12.5	1281.5	0.555	50	1243.4	13.5	38.6	0.4	8.6	7.74		
6	12.5	1243.4	0.553	50	1238.9	1.6	40.1	0.4	17.2	7.78		
6	12.5	1238.9	0.557	50	1247.9	-3.0	37.1	0.4	8.4	7.81		

Prepared by: S.R. Cline

Last Updated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4a-R7	For additional comments, see Laboratory Notebook B000025												

Steven Robert Cline:
ND, BUT ENTERED AS 1 PPB FOR
PLOTING LOG SCALE.

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4a-R7	For additional comments, see Laboratory Notebook B000023										For additional comments, see Laboratory Notebook B000023																	
Sample Data																													
Reactor No.	Sample Time	RXN Time (hrs)	Sample Name	Volume (mL)	Media Type	Solid Mass (grams)	Sample Data				MnO ₄ - Data				pH Data				ORNL GC #	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)	Flag	% Diff	AVG (ppb)	STDEV (ppb)	
							vol (mL) aqueous aliquot	Cum Vol (mL)	Actual Vol at Sampling	Actual L/S Ratio	Volume Stock Added (mL)	Initial MnO ₄ - (mg/L)	Final MnO ₄ - (mg/L)	Final Spec DF	pH	Final MnO ₄ - (mg/L)													
Duplicate VOC Samples																						DUPLICATES				DUPLICATES			
1	7/9/98 11:42	0.1	4a-r7-10-1b	489.295	GW Only	0	6.71	NA	NA	NA	0	NA	0.003	1	NA	8.06	1037	288	2.98	3.46	248		1.6%	249.71	2.76				
2	7/9/98 12:31	0.9	4a-r7-130min-2b	478.168	GW Only	0	7.50	NA	NA	NA	0	NA	0.003	1	NA	8.13	1040	287	2.95	3.39	250		-0.5%	249.26	0.87				
3	7/9/98 13:35	1.9	4a-r7-11.5h-3b	415.232	Sed (1st)	97.107	6.71	NA	NA	NA	1.25	NA	0.49	5	109.8	7.86	1048	6	U	2.95	3.33	5	U	-1.0%	4.94	0.04			
4	7/9/98 15:03	3.4	4a-r7-13h-4b	389.721	Sed (1st)	96.963	6.50	NA	NA	NA	1.25	NA	0.516	5	115.6	7.87	1056	0		2.92	3.57	1		0.0%	1.00	0.00			
5	7/9/98 16:59	5.3	4a-r7-15h-5b	405.574	Sed (1st)	97.023	6.66	NA	NA	NA	12.5	NA	0.519	50	1162.7	7.74	1064	0		2.95	3.34	1		0.0%	1.00	0.00			
6	7/10/98 8:40	21.0	4a-r7-120h-6b	367.946	Sed (1st)	91.59	6.94	NA	NA	NA	12.5	NA	0.553	50	1238.9	7.79	1072	0		2.96	3.23	1		0.0%	1.00	0.00			
7	7/10/98 12:11	24.5	4a-r7-124h-5h	405.574	Sed (1st)	97.023	6.85	NA	NA	NA	12.5	NA	0.514	50	0.0	7.81	1078	0		2.92	2.84	1		0.0%	1.00	0.00			
Extraction of the Remaining Reactor Contents																						solids TCE (mg)							
1	7/10/98 12:40	25.0	4a-r7-13	415.232	Sed (1st)	97.107					NA	NA	NA	NA	NT	1092	0		400.33	416.54	0.0E+00								
2	7/10/98 12:43	25.1	4a-r7-14	389.721	Sed (1st)	96.963					NA	NA	NA	NA	NT	1093	0		399.55	394.01	0.0E+00								
3	7/10/98 12:47	25.1	4a-r7-15	405.574	Sed (1st)	97.023					NA	NA	NA	NA	NT	1094	0		399.06	410.54	0.0E+00								
4	7/10/98 12:50	25.1	4a-r7-16	367.946	Sed (1st)	91.59					NA	NA	NA	NA	NT	1095	0		399.00	380.75	0.0E+00								
Extraction of the Charcoal Beds																						Carbon TCE (mg)							
1	7/10/98 12:25		4a-r7-char-1a		Charcoal	NA					NA	NA	NA	NA	NT	1080	0		2.93	0.10	0.0E+00								
2	7/10/98 12:25		4a-r7-char-1b		Charcoal	NA					NA	NA	NA	NA	NT	1081	0		2.92	0.04	0.0E+00								
3	7/10/98 12:26		4a-r7-char-2a		Charcoal	NA					NA	NA	NA	NA	NT	1082	0		2.92	0.10	0.0E+00								
4	7/10/98 12:26		4a-r7-char-2b		Charcoal	NA					NA	NA	NA	NA	NT	1083	0		2.91	0.05	0.0E+00								
5	7/10/98 12:27		4a-r7-char-3a		Charcoal	NA					NA	NA	NA	NA	NT	1084	0		2.92	0.10	0.0E+00								
6	7/10/98 12:27		4a-r7-char-3b		Charcoal	NA					NA	NA	NA	NA	NT	1085	0		2.94	0.05	0.0E+00								
7	7/10/98 12:28		4a-r7-char-4a		Charcoal	NA					NA	NA	NA	NA	NT	1086	0		2.95	0.10	0.0E+00								
8	7/10/98 12:28		4a-r7-char-4b		Charcoal	NA					NA	NA	NA	NA	NT	1087	0		2.92	0.05	0.0E+00								
9	7/10/98 12:29		4a-r7-char-5a		Charcoal	NA					NA	NA	NA	NA	NT	1088	0		2.92	0.10	0.0E+00								
10	7/10/98 12:29		4a-r7-char-5b		Charcoal	NA					NA	NA	NA	NA	NT	1089	0		2.93	0.05	0.0E+00								
11	7/10/98 12:30		4a-r7-char-6a		Charcoal	NA					NA	NA	NA	NA	NT	1090	0		2.93	0.08	0.0E+00								
12	7/10/98 12:30		4a-r7-char-6b		Charcoal	NA					NA	NA	NA	NA	NT	1091	0		2.93	0.04	0.0E+00								
13	35/984.48/958		Clean char-b		Charcoal	NA					NA	NA	NA	NA	NA	1096	0		2.92	0.05	0.0E+00								
14	35/984.48/958		Clean char-a		Charcoal	NA					NA	NA	NA	NA	NA	1097	0		2.93	0.10	0.0E+00								
Additional Oxidant Information																													
Flask (mg)	Initial MnO ₄ -	Initial Load	Consumed	Consumed	AVG																								
		mg	mg (t=24 hrs)	mg/g	(mg/g)																								
1	0.0	0.000	NA	NA	NA																								
2	0.0	0.000	NA	NA	NA																								
3	50.4	0.10	9.98	0.02																									
4	50.4	0.10	5.28	0.01	0.02																								
5	504.1	0.99	28.28	0.06																									
6	504.1	1.08	37.44	0.08	0.07																								

Steven Robert Cline,
DO, BUT ENTERED AS 1000 FOR
PLOTING LOG SCALE

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Experiment: 4a-R8

For additional comments, see Laboratory Notebook B000025

Pages: 110-113

Solid Media	Initial TCE (ppb)	Co-Contaminant?	MnO4- Concs. (%)
Sed (2nd)	1000	NO	0.01 & 0.1

Experiment Start Date: 8/24/98

Comments:

See general procedure on pages 57-60 in the laboratory Notebook.

Deviations from general procedure:

This is a different "sediment fill material" than was used in Run 4a-r8

SPIKE SOLUTION PREPARATION

Volume GW in Tedlar 2.70 liters

Volume Sat. TCE added 2.7 mL

2.7 mg (Assuming 1000 ppm Saturated Conc.)

Predicted Spike Conc: 1000 ppb

GC Analysis of Spike Solution

ORNL GC #	Sample Name	Sample Time	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)
1794	4a-r8-tb-a	8/24/98 16:20	1912		4.90	5.08	1843
1795	4a-r8-tb-b	8/24/98 16:20	1989		4.89	5.01	1941

Prepared by: S.R. Cline

Last Updated: 10/22/98

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Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4a-R8	For additional comments, see Laboratory Notebook B000025								
MnO4- Calb. Slope:		0.022	STOCK SOLN ABS		0.508	DF:		1667	Conc (ppm):	37935.82
Calibration Date: 6/10/98										
MnO4- Data										pH Data
Reactor	Volume	Initial	Final	Final	Final	mg MnO4	Cum.	Cum	mg MnO4-	
No.	Stock Mn	MnO4-	MnO4-	Spec	MnO4-	Consumed	mg MnO4	mg MnO4	in Aliquot	pH
	Added (ml)	(mg/L)	ABS	DF	(mg/L)	in Interval	Consumed	per gram		
1	0	0	0.003	1	NA	NA	NA	NA	NA	8.12
1	0	0	0.020	1	NA	NA	NA	NA	NA	8.12
1	0	0	0.004	1	NA	NA	NA	NA	NA	8.11
1	0	0	0.004	1	NA	NA	NA	NA	NA	8.12
1	0	0	0.006	1	NA	NA	NA	NA	NA	8.08
1	0	0	0.004	1	NA	NA	NA	NA	NA	8
1	0	0	0.005	1	NA	NA	NA	NA	NA	8.09
2	0	0	0.004	1	NA	NA	NA	NA	NA	8.04
2	0	0	0.004	1	NA	NA	NA	NA	NA	8.06
2	0	0	0.003	1	NA	NA	NA	NA	NA	8.05
2	0	0	0.004	1	NA	NA	NA	NA	NA	8.06
2	0	0	0.004	1	NA	NA	NA	NA	NA	8.08
2	0	0	0.003	1	NA	NA	NA	NA	NA	7.98
2	0	0	0.005	1	NA	NA	NA	NA	NA	8.04

Prepared by: S.R. Cline

Last Updated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4a-R8	For additional comments, see Laboratory Notebook B000025												
Reactor No.	ORNL GC #	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)	Flag	Aq. C/Co	mg TCE Oxidized in Interval	Cum. mg TCE Oxidized	% of Init A TCE Oxidized In Interval	% of Total TCE Oxidized In Interval	Cum % Total TCE Oxidized	mg TCE in Aliquot
1	1796	2,226		2.87	3.23	1,974		NA	NA	NA	NA	NA	NA	0.03
1	1803	2,051		2.82	3.17	1,826		NA	NA	NA	NA	NA	NA	0.01
1	1810	1,935		2.86	3.12	1,779		NA	NA	NA	NA	NA	NA	0.01
1	1817	1,757		2.82	2.85	1,740		NA	NA	NA	NA	NA	NA	0.01
1	1824	1,962		2.87	3.26	1,728		NA	NA	NA	NA	NA	NA	0.01
1	1831	1,951		2.85	3.29	1,687		NA	NA	NA	NA	NA	NA	0.01
1	1838	1,933		2.88	3.24	1,717		NA	NA	NA	NA	NA	NA	0.01
2	1798	2,174		2.89	3.25	1,935		NA	NA	NA	NA	NA	NA	0.01
2	1804	2,147		2.81	3.20	1,881		NA	NA	NA	NA	NA	NA	0.03
2	1811	2,034		2.84	3.19	1,814		NA	NA	NA	NA	NA	NA	0.01
2	1818	2,123		2.83	3.28	1,830		NA	NA	NA	NA	NA	NA	0.01
2	1825	2,104		2.86	3.38	1,779		NA	NA	NA	NA	NA	NA	0.01
2	1832	2,083		2.87	3.28	1,825		NA	NA	NA	NA	NA	NA	0.01
2	1839	1,995		2.82	3.27	1,721		NA	NA	NA	NA	NA	NA	0.01

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Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4a-R8	For additional comments, see Laboratory Notebook B000025								
	MnO4- Calb. Slope:		0.022	STOCK SOLN ABS	0.508	DF:		1667	Conc (ppm):	37935.82	
	Calibration Date: 6/10/98										
	MnO4- Data										pH Data
Reactor No.	Volume Stock Mn Added (ml)	Initial MnO4- (mg/L)	Final MnO4- ABS	Final Spec DF	Final MnO4- (mg/L)	mg MnO4 Consumed in Interval	Cum. mg MnO4 Consumed	Cum mg MnO4 per gram	mg MnO4 in Aliquot	pH	
3	0	0.0	0.002	1	126.8	0.0	0.0	0.0	0.0	8.06	
3	1.25	126.8	0.469	5	105.1	8.1	8.1	0.1	0.7	8	
3	1.25	105.1	0.416	5	93.2	4.4	12.5	0.1	1.3	8	
3	1.25	93.2	0.417	5	93.4	-0.1	12.4	0.1	0.6	8	
3	1.25	93.4	0.41	5	91.9	0.5	13.0	0.1	0.6	8.01	
3	1.25	91.9	0.373	5	83.6	2.8	15.8	0.2	0.6	8	
3	1.25	83.6	0.383	5	85.8	-0.7	15.0	0.1	0.6	8.01	
4	0	0.0	0.004	1	125.3	0.0	0.0	0.0	0.0	8.03	
4	1.25	125.3	0.518	5	116.0	3.5	3.5	0.0	0.8	7.92	
4	1.25	116.0	0.443	5	99.2	6.2	9.7	0.1	0.7	7.94	
4	1.25	99.2	0.433	5	97.0	0.8	10.6	0.1	1.4	7.98	
4	1.25	97.0	0.425	5	95.2	0.6	11.2	0.1	0.6	7.97	
4	1.25	95.2	0.396	5	88.7	2.2	13.4	0.1	0.6	7.96	
4	1.25	88.7	0.4	5	89.6	-0.3	13.1	0.1	1.2	7.98	

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C-122

LastUpdated: 10/23/98

C-123

Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4a-R8	For additional comments, see Laboratory Notebook B000025							
	MnO4- Calb. Slope:		0.022	STOCK SOLN ABS		0.508	DF:	1667	Conc (ppm):	37935.82
	Calibration Date: 6/10/98									
	MnO4- Data									pH Data
	Volume	Initial	Final	Final	Final	mg MnO4	Cum.	Cum	mg MnO4-	
Reactor	Stock Mn	MnO4-	MnO4-	Spec	MnO4-	Consumed	mg MnO4	mg MnO4	in Aliquot	pH
No.	Added (ml)	(mg/L)	ABS	DF	(mg/L)	in Interval	Consumed	per gram		
5	0	0.0	0.004	1	1185.3	0.0	0.0	0.0	0.0	8
5	12.5	1185.3	0.549	50	1229.9	-17.8	-17.8	-0.2	8.6	7.75
5	12.5	1229.9	0.522	50	1169.4	23.8	5.9	0.1	8.6	7.74
5	12.5	1169.4	0.517	50	1158.2	4.3	10.3	0.1	8.5	7.75
5	12.5	1158.2	0.52	50	1165.0	-2.5	7.7	0.1	16.5	7.74
5	12.5	1165.0	0.539	50	1207.5	-15.5	-7.8	-0.1	8.3	7.75
5	12.5	1207.5	0.53	50	1187.4	7.2	-0.6	0.0	8.1	7.76
6	0	0.0	0.003	1	1154.5	0.0	0.0	0.0	0.0	8
6	12.5	1154.5	0.573	50	1283.7	-53.1	-53.1	-0.5	9.0	7.83
6	12.5	1283.7	0.538	50	1205.3	31.7	-21.4	-0.2	8.6	7.73
6	12.5	1205.3	0.544	50	1218.7	-5.3	-26.7	-0.3	8.3	7.75
6	12.5	1218.7	0.556	50	1245.6	-10.5	-37.2	-0.4	9.1	7.73
6	12.5	1245.6	0.531	50	1189.6	21.4	-15.8	-0.2	16.8	7.74
6	12.5	1189.6	0.529	50	1185.1	1.7	-14.2	-0.1	8.7	7.76

Prepared by: S.R. Cline

Last Updated: 10/23/98

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Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.		4a-RR	For additional comments, see Laboratory Notebook B000025										For additional comments, see Laboratory Notebook B000025										For additional comments, see Laboratory Notebook B000025									
													Metals: Catb. Shye: 0.022 STUCK SOLN ABS 0.500 DF: 1667 Conc (ppm) 17935.81																			
													Calibration Date: N/A																			
													pH Data																			
Reactor No.	Sample Time	Rxn Time (hrs)	Sample Name	Volume GW Used (mL)	Media Type	Solid Mass (grams)	Sample Data				Volume Stock Mn Added (mL)	Initial MnO4- (mg/L)	Final MnO4- ABS	Final Spec DF	Final MnO4- (mg/L)	pH	ORNL GC #	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)	Flag	% Diff	AVG (ppb)	STDEV (ppb)						
							Vol (mL)	Aliquot Vol (mL)	Actual Vol at Sampling	Actual US Ratio																						
Duplicate VOC Samples																																
1	8/25/98 10:31	0.5	4a-r8-1b	494.19	GW Only	0	7.25	NA	NA	NA	0	NA	0.003	1	NA	8.05	1797	2,155			2.89	3.23	1,930		2.3%	1952.01	31.4					
2	8/25/98 11:02	0.5	4a-r8-100m-2b	498.91	GW Only	0	7.09	NA	NA	NA	0	NA	0.004	1	NA	8.04	1805	2,110			2.81	3.13	1,894		-0.7%	1887.55	8.6					
3	8/25/98 12:43	2.2	4a-r8-11.5h-3b	379.71	Sed (2nd)	102.06	7.17	NA	NA	NA	1.25	NA	0.425	5	93.2	7.96	1813	21			2.83	3.24	19		38.7%	24.61	8.3					
4	8/25/98 14:04	3.5	4a-r8-13h-4b	384.05	Sed (2nd)	100.09	6.71	NA	NA	NA	1.25	NA	0.442	5	99.0	7.97	1821	11			2.86	2.98	11		-27.2%	9.48	1.6					
5	8/25/98 16:05	5.5	4a-r8-15h-5b	394.8	Sed (2nd)	99.95	7.30	NA	NA	NA	12.5	NA	0.555	50	1247.4	7.73	1829	0			1.29	3.08	1		0.0%	1.00	0.0					
6	8/26/98 8:46	22.2	4a-r8-120h-6b	405.09	Sed (2nd)	104.53	7.33	NA	NA	NA	12.5	NA	0.533	50	1194.1	7.74	1837	0			2.88	3.24	1		0.0%	1.00	0.0					
4	8/26/98 10:49	24.2	4a-r8-124h-4b	384.05	Sed (2nd)	100.1	6.73	NA	NA	NA	1.25	NA	0.401	5	89.8	7.98	1842	0			2.82	3.07	1		0.0%	1.00	0.0					
Extraction of the Remaining Reactor Contents																																
1																																
2																																
3	8/26/98 11:11	24.6	4a-r8-F3	379.71	Sed (2nd)	102.06					NA	NA	NA	NA	NA	NT	1857	0			402.64	391.18	0.0E+00									
4	8/26/98 11:12	24.6	4a-r8-F4	384.05	Sed (2nd)	100.09					NA	NA	NA	NA	NA	NT	1858	0			401.98	385.79	0.0E+00									
5	8/26/98 11:13	24.6	4a-r8-F5	394.8	Sed (2nd)	99.95					NA	NA	NA	NA	NA	NT	1859	0			402.77	418.11	0.0E+00									
6	8/26/98 11:14	24.6	4a-r8-F6	405.09	Sed (2nd)	104.53					NA	NA	NA	NA	NA	NT	1860	0			403.06	430.28	0.0E+00									
Extraction of the Charcoal Beds																																
1	8/26/98 11:02		4a-r8-char-1a		Charcoal	NA					NA	NA	NA	NA	NA	NT	1845	0			2.90	0.01	0.0E+00									
1	8/26/98 11:02		4a-r8-char-1b		Charcoal	NA					NA	NA	NA	NA	NA	NT	1846	0			2.89	0.03	0.0E+00									
2	8/26/98 11:04		4a-r8-char-2a		Charcoal	NA					NA	NA	NA	NA	NA	NT	1847	0			2.86	0.08	0.0E+00									
2	8/26/98 11:04		4a-r8-char-2b		Charcoal	NA					NA	NA	NA	NA	NA	NT	1848	0			2.87	0.03	0.0E+00									
3	8/26/98 11:05		4a-r8-char-3a		Charcoal	NA					NA	NA	NA	NA	NA	NT	1849	0			2.86	0.08	0.0E+00									
3	8/26/98 11:06		4a-r8-char-3b		Charcoal	NA					NA	NA	NA	NA	NA	NT	1850	0			2.88	0.03	0.0E+00									
4	8/26/98 11:07		4a-r8-char-4a		Charcoal	NA					NA	NA	NA	NA	NA	NT	1851	0			2.89	0.08	0.0E+00									
4	8/26/98 11:07		4a-r8-char-4b		Charcoal	NA					NA	NA	NA	NA	NA	NT	1852	0			2.84	0.02	0.0E+00									
5	8/26/98 11:08		4a-r8-char-5a		Charcoal	NA					NA	NA	NA	NA	NA	NT	1853	0			2.80	0.08	0.0E+00									
5	8/26/98 11:08		4a-r8-char-5b		Charcoal	NA					NA	NA	NA	NA	NA	NT	1854	0			2.84	0.03	0.0E+00									
6	8/26/98 11:10		4a-r8-char-6a		Charcoal	NA					NA	NA	NA	NA	NA	NT	1855	0			2.90	0.06	0.0E+00									
6	8/26/98 11:10		4a-r8-char-6b		Charcoal	NA					NA	NA	NA	NA	NA	NT	1856	0			2.87	0.02	0.0E+00									
Additional Oxidant Information																																
Flask	Initial MnO4- (mg)	Initial Load (mg)	Consumed (mg)	Consumed (mg)	Consumed (mg)	Consumed (mg)	Consumed (mg)	Consumed (mg)	Consumed (mg)	Consumed (mg)	Consumed (mg)	Consumed (mg)	Consumed (mg)	Consumed (mg)	Consumed (mg)	Consumed (mg)	Consumed (mg)	Consumed (mg)	Consumed (mg)	Consumed (mg)	Consumed (mg)	Consumed (mg)	Consumed (mg)	Consumed (mg)	Consumed (mg)	Consumed (mg)	Consumed (mg)	Consumed (mg)	Consumed (mg)			
1	0.0	0.000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA			
2	0.0	0.000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA			
3	47.4	0.10	15.33	0.03																												
4	47.4	0.10	13.50	0.03																												
5	474.2	0.95	-0.81	0.00																												
6	474.2	0.92	-12.58	-0.02	-0.01																											

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Experiment: 4b-R1

For additional comments, see Laboratory Notebook B000025

Pages: 98-101

Solid Media	Initial TCE (ppb)	Co-Contaminant?	MnO4- Conc. (%)
NONE	10,000	NO	0.01 & 0.1

Experiment Start Date: 8/10/98

Comments:

See general procedure on pages 95-97 in the laboratory Notebook.

Deviations from general procedure:

NOTE: Small Amt of TCE in Blank solution!!!!!!

T=0 and controls ran at DF=20 Hexane not found in the blank for the repeat runs, therefore at least the repeat DILUTIONS are TCE free

SPIKE SOLUTION PREPARATION

Volume GW in Tedlar 3.05 liters

Volume Sat. TCE added 31 mL

31 mg (Assuming 1000 ppm Saturated Conc.)

Predicted Spike Conc: 10056 ppb

GC Analysis of Spike Solution

ORNL GC #	Sample Name	Sample Time	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)
1461	4b-r1-tb-a	8/11/98 10:58	16303		4.84	5.22	15112
1462	4b-r1-tb-b	8/11/98 10:58	17007		4.88	5.19	15978

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Prepared by: S.R. Cline

. LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4b-R1	For additional comments, see Laboratory Notebook B000025								
	MnO4- Calb. Slope:	0.022	STOCK SOLN ABS	0.274	DF:	3333	Conc (ppm):	40922.89			
	Calibration Date: 6/10/98										
	MnO4- Data									pH Data	
	Volume	Initial	Final	Final	Final	mg MnO4	Cum.	Cum	mg MnO4-		
Reactor	Stock Mn	MnO4-	MnO4-	Spec	MnO4-	Consumed	mg MnO4	mg MnO4	in Aliquot	pH	
No.	Added (ml)	(mg/L)	ABS	DF	(mg/L)	in Interval	Consumed	per mL GW			
1	0	0	0.000	1	NA	NA	NA	NA	NA	8.62	
1	0	0	0.004	1	NA	NA	NA	NA	NA	8.61	
1	0	0	0.004	1	NA	NA	NA	NA	NA	8.61	
1	0	0	0.002	1	NA	NA	NA	NA	NA	8.6	
1	0	0	0.005	1	NA	NA	NA	NA	NA	8.61	
1	0	0	0.004	1	NA	NA	NA	NA	NA	8.59	
1	0	0	0.004	1	NA	NA	NA	NA	NA	8.6	
2	0	0	0.001	1	NA	NA	NA	NA	NA	8.62	
2	0	0	0.005	1	NA	NA	NA	NA	NA	8.63	
2	0	0	0.004	1	NA	NA	NA	NA	NA	8.61	
2	0	0	0.002	1	NA	NA	NA	NA	NA	8.63	
2	0	0	0.003	1	NA	NA	NA	NA	NA	8.6	
2	0	0	0.004	1	NA	NA	NA	NA	NA	8.6	
2	0	0	0.005	1	NA	NA	NA	NA	NA	8.62	

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Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R1	For additional comments, see Laboratory Notebook B000025																		
Reactor No.	ORNL GC #	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)	Flag	Aq. C/Co	mg TCE Oxidized in Interval	Cum. mg TCE Oxidized	% of Init Aqueous TCE Oxidized in Interval	% of Total TCE Oxidized in Interval	Cum % Total TCE Oxidized	mg TCE in Aliquot						
1	1463	14,997		2.95	3.35	13,177		NA	NA	NA	NA	NA	NA	0.19						
1	1470	15,290		2.95	3.17	14,223		NA	NA	NA	NA	NA	NA	0.11						
1	1477	14,077		2.92	2.89	14,209		NA	NA	NA	NA	NA	NA	0.11						
1	1484	15,883		2.90	3.20	14,390		NA	NA	NA	NA	NA	NA	0.11						
1	1491	14,006		2.88	3.19	12,673		NA	NA	NA	NA	NA	NA	0.10						
1	1498	12,957		2.89	2.86	13,081		NA	NA	NA	NA	NA	NA	0.10						
1	1505	14,930		2.89	3.25	13,303		NA	NA	NA	NA	NA	NA	0.20						
2	1465	15,783		2.95	3.25	14,300		NA	NA	NA	NA	NA	NA	0.11						
2	1471	15,358		2.96	3.15	14,419		NA	NA	NA	NA	NA	NA	0.21						
2	1478	15,505		2.91	3.25	13,861		NA	NA	NA	NA	NA	NA	0.10						
2	1485	14,923		2.91	3.13	13,873		NA	NA	NA	NA	NA	NA	0.10						
2	1492	14,768		2.92	3.15	13,698		NA	NA	NA	NA	NA	NA	0.10						
2	1499	15,112		2.87	3.37	12,861		NA	NA	NA	NA	NA	NA	0.10						
2	1506	15,655		2.84	3.30	13,479		NA	NA	NA	NA	NA	NA	0.10						

Prepared by: S.R. Cline

Last Updated: 10/23/98

Exp.	4b-R.I	For additional comments, see Laboratory Notebook B000025							
Reactor No.	Sample Time	RXN Time (hrs)	SAMPLE DATA						
			Volume GW Used (mL)	Media Type	Solid Mass (grams)	aqueous aliquot vol (mL)	Cum Aliquot Vol (mL)	Actual Vol at Sampling	Actual L/S Ratio
3	8/11/98 11:22	0.0	498.33	GW Only	0.0	7.47	7.47	498.3	NA
3	8/11/98 12:03	0.7	498.33	GW Only	0	6.89	14.36	492.1	NA
3	8/11/98 13:06	1.7	498.33	GW Only	0	14.16	28.52	485.2	NA
3	8/11/98 14:32	3.2	498.33	GW Only	0	6.95	35.47	471.1	NA
3	8/11/98 16:24	5.0	498.33	GW Only	0	7.24	42.71	464.1	NA
3	8/12/98 8:21	21.0	498.33	GW Only	0	6.66	49.37	456.9	NA
3	8/12/98 11:36	24.2	498.33	GW Only	0	6.96	56.33	450.2	NA
4	8/11/98 11:23	0.0	512.83	GW Only	0.0	6.94	6.94	512.8	NA
4	8/11/98 12:04	0.7	512.83	GW Only	0	7.23	14.17	507.1	NA
4	8/11/98 13:08	1.7	512.83	GW Only	0	7.09	21.26	499.9	NA
4	8/11/98 14:33	3.2	512.83	GW Only	0	14.87	36.13	492.8	NA
4	8/11/98 16:25	5.0	512.83	GW Only	0	7.38	43.51	478.0	NA
4	8/12/98 8:22	21.0	512.83	GW Only	0	6.74	50.25	470.6	NA
4	8/12/98 11:38	24.2	512.83	GW Only	0	7.5	57.75	463.8	NA

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4b-R1	For additional comments, see Laboratory Notebook B000025								
	MnO4- Calb. Slope:		0.022	STOCK SOLN ABS		0.274 DF:			3333 Conc (ppm):	40922.89	
	Calibration Date: 6/10/98										
	MnO4- Data										pH Data
Reactor No.	Volume Added (ml)	Initial MnO4- (mg/L)	Final MnO4- ABS	Final Spec DF	Final MnO4- (mg/L)	mg MnO4 Consumed in Interval	Cum. mg MnO4 Consumed	Cum mg MnO4 per mL GW	mg MnO4 in Aliquot	pH	
3	0	0.0	0.002	1	103.9	0	0	0.00	0	8.62	
3	1.25	103.9	0.174	5	39.0	32	32	0.06	0.3	8.24	
3	1.25	39.0	0.169	5	37.9	1	33	0.07	0.5	8.05	
3	1.25	37.9	0.15	5	33.6	2	35	0.07	0.2	7.89	
3	1.25	33.6	0.168	5	37.6	-2	33	0.07	0.3	7.89	
3	1.25	37.6	0.162	5	36.3	1	33	0.07	0.2	7.85	
3	1.25	36.3	0.125	5	28.0	4	37	0.07	0.2	7.8	
4	0	0.0	0.001	1	100.9	0	0	0.00	0	8.63	
4	1.25	100.9	0.172	5	38.5	32	32	0.06	0.3	8.22	
4	1.25	38.5	0.163	5	36.5	1	33	0.06	0.3	7.93	
4	1.25	36.5	0.149	5	33.4	2	34	0.07	0.5	7.8	
4	1.25	33.4	0.154	5	34.5	-1	34	0.07	0.3	7.76	
4	1.25	34.5	0.136	5	30.5	2	36	0.07	0.2	7.7	
4	1.25	30.5	0.119	5	26.7	2	37	0.07	0.2	7.72	

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R1	For additional comments, see Laboratory Notebook B000025															
Reactor No.	ORNL GC #	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)	Flag	Aq. C/Co	mg TCE Oxidized in Interval	Cum. mg TCE Oxidized	% of Init A TCE Oxidized	% of Total TCE Oxidized	Cum % Total TCE Oxidized	mg TCE in Aliquot			
3	1466	15,198		2.96	3.13	14,362		1.00	0.0	0.0	0.0%	0.0%	0.0%	0.11			
3	1473R	2,853		2.94	3.21	2,609		0.18	5.8	5.8	80.8%	80.8%	80.8%	0.02			
3	1479R	1,749		2.91	3.15	1,614		0.11	0.5	6.3	6.7%	6.7%	87.6%	0.02			
3	1486R	1,129		2.90	3.00	1,091		0.08	0.2	6.5	3.4%	3.4%	91.0%	0.01			
3	1493	626		2.89	3.12	582		0.04	0.2	6.7	3.3%	3.3%	94.3%	0.00			
3	1500	278		2.90	3.25	249		0.02	0.2	6.9	2.1%	2.1%	96.4%	0.00			
3	1508	339		2.82	3.14	304		0.02	0.0	6.9	-0.4%	-0.4%	96.1%	0.00			
4	1467	16,081		2.94	3.22	14,687		1.00	0.0	0.0	0.0%	0.0%	0.0%	0.10			
4	1474R	3,171		2.93	3.25	2,858		0.19	6.0	6.0	79.6%	79.6%	79.6%	0.02			
4	1481R	1,974		2.90	3.17	1,810		0.12	0.5	6.5	7.0%	7.0%	86.6%	0.01			
4	1487R	1,225		2.91	2.99	1,193		0.08	0.3	6.8	4.0%	4.0%	90.6%	0.02			
4	1494	631		2.90	3.12	586		0.04	0.3	7.1	3.9%	3.9%	94.5%	0.00			
4	1501	240		2.88	3.21	216		0.01	0.2	7.3	2.3%	2.3%	96.8%	0.00			
4	1509	266		2.85	3.05	250		0.02	0.0	7.3	-0.2%	-0.2%	96.6%	0.00			

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Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R1	For additional comments, see Laboratory Notebook B000025										40922.89
MnO4- Calib. Slope:	0.022	STOCK SOLN ABS	0.274	DF:							3333	Conc (ppm):
Calibration Date:	6/10/98											
MnO4- Data												
Reactor No.	Volume Stock Mn Added (ml)	Initial MnO4- (mg/L)	Final MnO4- ABS	Final Spec DF	Final MnO4- (mg/L)	Final Consumed in Interval	Cum. mg MnO4 Consumed	Cum. mg MnO4 per mL GW	mg MnO4 in Aliquot	pH	pH Data	
5	0	0.0	0.002	1	1014.7	0	0	0.00	0	8.63		
5	12.5	1014.7	0.189	50	423.4	298	298	0.60	3.1	7.81		
5	12.5	423.4	0.191	50	427.9	-2	296	0.59	3.1	7.73		
5	12.5	427.9	0.19	50	425.7	1	297	0.60	3.2	7.71		
5	12.5	425.7	0.194	50	434.6	-4	293	0.59	6.5	7.7		
5	12.5	434.6	0.194	50	434.6	0	293	0.59	3.2	7.67		
5	12.5	434.6	0.184	50	412.2	10	303	0.61	3.1	7.72		
6	0	0.0	0.001	1	1000.5	0	0	0.00	0	8.63		
6	12.5	1000.5	0.202	50	452.5	280	280	0.55	3.3	7.73		
6	12.5	452.5	0.204	50	457.0	-2	278	0.55	3.3	7.7		
6	12.5	457.0	0.209	50	468.2	-6	272	0.54	3.5	7.71		
6	12.5	468.2	0.204	50	457.0	5	278	0.55	3.4	7.68		
6	12.5	457.0	0.203	50	454.8	1	279	0.55	6.7	7.67		
6	12.5	454.8	0.190	50	425.7	14	293	0.58	3.2	7.69		

Prepared by: S.R. Cline

Last Updated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4b-R1	For additional comments, see Laboratory Notebook B000025											

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

[illegible]

Prepared by: S.R. Cline

LaTeX/Updated: 11/20/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R2	For additional comments, see Laboratory Notebook B000025										
C4-4b-R2-10-1a												
Reactor No.	Sample Time	RXN Time (hrs)	Sample Name	Volume GW Used (mL)	Media		Solid Mass (grams)	Sample Data			Actual Vol at Sampling	Actual L/S Ratio
					Type	Type		aqueous aliquot	Aliquot Vol (mL)	Cum		
1	8/13/98 11:30	0.0	4b-R2-10-1a	514.07	GW Only		0.0	14.61	14.61		514.1	NA
1	8/13/98 12:10	0.7	4b-R2-130min-1	514.07	GW Only		0	7.3	21.91		499.5	NA
1	8/13/98 13:20	1.8	4b-R2-11.5h-1	514.07	GW Only		0	7.36	29.27		492.2	NA
1	8/13/98 14:45	3.3	4b-R2-13h-1	514.07	GW Only		0	7.33	36.6		484.8	NA
1	8/13/98 16:50	5.3	4b-R2-15h-1	514.07	GW Only		0	7.6	44.2		477.5	NA
1	8/14/98 8:11	20.7	4b-R2-120h-1	514.07	GW Only		0	7.17	51.37		469.9	NA
1	8/14/98 11:30	24.0	4b-R2-124h-1	514.07	GW Only		0	6.26	57.63		462.7	NA
2	8/13/98 11:32	0.0	4b-R2-10-2	498.894	GW Only		0.0	7.22	7.22		498.9	NA
2	8/13/98 12:11	0.7	4b-R2-130min-2a	498.894	GW Only		0	14.47	21.69		491.7	NA
2	8/13/98 13:21	1.8	4b-R2-11.5h-2	498.894	GW Only		0	7.45	29.14		477.2	NA
2	8/13/98 14:46	3.2	4b-R2-13h-2	498.894	GW Only		0	7.25	36.39		469.8	NA
2	8/13/98 16:51	5.3	4b-R2-15h-2	498.894	GW Only		0	7.4	43.79		462.5	NA
2	8/14/98 8:12	20.7	4b-R2-120h-2	498.894	GW Only		0	7.07	50.86		455.1	NA
2	8/14/98 11:31	24.0	4b-R2-124h-2	498.894	GW Only		0	7.2	58.06		448.0	NA

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R2	For additional comments, see Laboratory Notebook B000025								
MnO4- Calb. Slope:		0.022	STOCK SOLN ABS:	NA	DF:	NA	Conc (ppm):			
Calibration Date: 6/10/98										
MnO4- Data										pH Data
Reactor No.	KMnO4 Added (mg)	Initial MnO4- (mg/L)	Final MnO4- ABS	Final Spec DF	Final MnO4- (mg/L)	mg MnO4 Consumed in Interval	Cum. mg MnO4 Consumed	Cum mg MnO4 per mL GW	mg MnO4- in Aliquot	pH
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.58
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.56
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.54
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.53
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.53
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.66
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.66
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.57
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.57
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.55
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.53
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.53
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.67
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.69

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	Exp.	4b-R2	For additional comments, see Laboratory Notebook B000025													
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Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R2	For additional comments, see Laboratory Notebook B000025								
MnO4- Calb. Slope:	0.022	STOCK SOLN ABS:	NA	DF:	NA	Conc (ppm):				
Calibration Date: 6/10/98										
MnO4- Data										pH Data
Reactor No.	KMnO4 Added (mg)	Initial MnO4- (mg/L)	Final MnO4- ABS	Final Spec DF	Final MnO4- (mg/L)	mg MnO4 Consumed in Interval	Cum. mg MnO4 Consumed	Cum. mg MnO4 per mL GW	mg MnO4 in Aliquot	pH
3	0	0	NA	NA	10149.9	0	0	0.00	0	8.57
3	6605.9	10150	0.606	250	6788	1648	1648	3.31	49.6	8.39
3	6605.9	6788	0.815	250	9129	-1130	517	1.04	129.1	8.43
3	6605.9	9129	0.189	1000	8468	310	827	1.66	58.5	8.44
3	6605.9	8468	0.409	500	9163	-321	506	1.02	64.0	8.45
3	6605.9	9163	0.436	500	9768	-275	231	0.47	67.2	8.57
3	6605.9	9768	0.475	500	10641	-391	-160	-0.32	74.1	8.57
4	0	0	NA	NA	10090	0	0	0.00	0	8.58
4	6594.4	10090	0.462	250	5175	2419	2419	4.84	36.8	8.25
4	6594.4	5175	0.847	250	9488	-2092	327	0.65	69.9	8.4
4	6594.4	9488	0.199	1000	8916	273	600	1.20	132.1	8.39
4	6594.4	8916	0.406	500	9096	-83	517	1.04	65.2	8.41
4	6594.4	9096	0.391	500	8760	153	670	1.34	63.2	8.52
4	6594.4	8760	0.424	500	9499	-332	339	0.68	69.3	8.52

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Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4b-R2	For additional comments, see Laboratory Notebook B000025															

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Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R2	For additional comments, see Laboratory Notebook B000025								
MnO4- Calb. Slope:		0.022	STOCK SOLN ABS:	NA	DF:	NA	Conc (ppm):			
Calibration Date: 6/10/98										
MnO4- Data										pH Data
Reactor No.	KMnO4 Added (mg)	Initial MnO4- (mg/L)	Final MnO4- ABS	Final Spec DF	Final MnO4- (mg/L)	mg MnO4 Consumed in Interval	Cum. mg MnO4 Consumed	Cum mg MnO4 per mL GW	mg MnO4 in Aliquot	pH
5	0	0	NA	NA	30621	0	0	0.00	0	8.58
5	20001.8	30621	0.322	500	7214	11516	11516	23.07	52.2	8.7
5	20001.8	7214	1.185	500	26548	-9372	2144	4.29	196.2	8.8
5	20001.8	26548	0.582	1000	26077	225	2368	4.74	195.1	8.81
5	20001.8	26077	0.598	1000	26794	-337	2031	4.07	396.8	8.82
5	20001.8	26794	0.611	1000	27377	-265	1766	3.54	209.4	8.93
5	20001.8	27377	0.605	1000	27108	120	1886	3.78	195.7	8.91
6	0	0	NA	NA	30328	0	0	0.00	0	8.57
6	20015.3	30328	0.408	500	9140	10531	10531	20.89	67.2	8.75
6	20015.3	9140	1.232	500	27601	-9040	1491	2.96	208.7	8.83
6	20015.3	27601	0.599	1000	26839	367	1859	3.69	201.6	8.84
6	20015.3	26839	0.540	1000	24195	1255	3113	6.18	181.7	8.86
6	20015.3	24195	0.642	1000	28766	-2135	978	1.94	421.1	8.97
6	20015.3	28766	0.629	1000	28183	264	1242	2.46	410.6	8.96

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Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4b-R2	For additional comments, see Laboratory Notebook B000025															

Steven Robert Cline:
ND, BUT ENTERED AS 1 PPB FOR
PLOTING LOG SCALE

Steven Robert Cline:
ND, BUT ENTERED AS 1 PPB FOR
PLOTING LOG SCALE

[illegible]

Last Updated: 11/2/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Experiment: 4b-R3

For additional comments, RMAL Laboratory Research Book

Solid Media	Initial TCE (ppb)	Co-Contaminant?	MnO4- Concs. (%)
NONE	100,000	NO	.01&.1

Experiment Start Date: 7/29/98

Comments:

NOTE: use of Neat TCE to make spiking solution instead of an aqueous saturated TCE solution.

Extracted the entire reactor contents after the end of the test. Was not really necessary.

SPIKE SOLUTION PREPARATION

Prepared a 100 ppm TCE spiking solution in Tedlar bag using 2500gm of sparged groundwater and 280uL of pure phase TCE. Placed bag in incubator set at 12 C.

GC Analysis of Spike Solution

ORNL GC #	Sample Name	Sample Time	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)
1313	4B-R3-TB-A	7/30/98 8:20	148,124		5.05	5.02	149,113
1314	4B-R3-TB-B	7/30/98 8:20	145,203		5.08	4.99	147,669

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Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R3	For additional comments, RMAL Laboratory Research Book								
MnO4- Calb. Slope:		0.046	STOCK Conc.(ppm):	49.5	DF:	800	Conc (ppm)	39600		
Calibration Date: 5/5/98										
MnO4- Data									pH Data	
Reactor	Volume	Initial	Aliquot	Final	Final	mg MnO4	Cum.	Cum	mg MnO4-	
No.	Stock MnO4- Added (mL)	MnO4- (mg/L)	MnO4- (mg/L)	Spec DF	MnO4- (mg/L)	Consumed in Interval	mg MnO4 Consumed	mg MnO4 per mL GW	in Aliquot	pH
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.07
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.1
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.04
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.09
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.01
1	0	0	NA	NA	NA	NA	NA	NA	NA	7.93
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.01
1	0	0	NA	NA	NA	NA	NA	NA	NA	7.77
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.17
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.1
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.09
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.26
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.11
2	0	0	NA	NA	NA	NA	NA	NA	NA	7.99
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.01
2	0	0	NA	NA	NA	NA	NA	NA	NA	7.83

Prepared by: S.R. Cline

Last Updated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R3	For additional comments, RMAL Laboratory Research Book														
Reactor No.	ORNL GC #	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)	Flag	Aq. C/Co	mg TCE Oxidized in Interval	Cum. mg TCE Oxidized	% of Init A TCE Oxidized In Interval	% of Total TCE Oxidized In Interval	Cum % Total TCE Oxidized	mg TCE in Aliquot		
1	1317	113,576		3.05	3.21	107,847		NA	NA	NA	NA	NA	NA	2.16		
1	1331	93,690		3.12	2.89	101,228		NA	NA	NA	NA	NA	NA	1.01		
1	1345	99,569		3.13	3.08	101,277		NA	NA	NA	NA	NA	NA	1.01		
1	1359	117,379		2.99	3.45	101,664		NA	NA	NA	NA	NA	NA	1.02		
1	1373	101,637		3.03	2.90	106,387		NA	NA	NA	NA	NA	NA	1.06		
1	1387R	110,164		3.08	3.66	92,665		NA	NA	NA	NA	NA	NA	0.93		
1	1401	116,840		2.98	2.73	127,665		NA	NA	NA	NA	NA	NA	2.55		
1	1415	128,397		3.06	3.048	128,992		NA	NA	NA	NA	NA	NA	1.29		
2	1318	111,151		3.06	3.18	106,944		NA	NA	NA	NA	NA	NA	1.07		
2	1332	96,822		3.12	2.97	101,839		NA	NA	NA	NA	NA	NA	2.04		
2	1346	107,080		3.14	3.37	99,745		NA	NA	NA	NA	NA	NA	1.00		
2	1360	114,541		3.02	3.51	98,449		NA	NA	NA	NA	NA	NA	0.98		
2	1374	97,893		3.01	2.89	102,049		NA	NA	NA	NA	NA	NA	1.02		
2	1388R	122,937		3.05	2.97	126,607		NA	NA	NA	NA	NA	NA	1.27		
2	1402	112,272		3.05	2.70	126,904		NA	NA	NA	NA	NA	NA	1.27		
2	1416	114,110		3.08	2.743	128,016		NA	NA	NA	NA	NA	NA	2.56		

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Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R3	For additional comments, RMAL Laboratory Research Book								
MnO4- Calb. Slope:		0.046	STOCK Conc.(ppm):	49.5	DF:		800	Conc (ppm)	39600	
Calibration Date: 5/5/98										
MnO4- Data										pH Data
Reactor	Volume	Initial	Aliquot	Final	Final	mg MnO4	Cum.	Cum	mg MnO4-	
No.	Stock Mn	MnO4-	MnO4-	Spec	MnO4-	Consumed	mg MnO4	mg MnO4	in Aliquo	pH
	Added (mL)	(mg/L)	(mg/L)	DF	(mg/L)	in Interval	Consumed	per mL GW		
3	0	0	NA	NA	101.0	0	0	0.00	0	8.17
3	1	101.0	29.50	1	29.5	28	28	0.07	0.3	6.78
3	1	29.5	10.50	1	10.5	7	35	0.09	0.2	6.03
3	1	10.5	2.37	1	2.4	3	38	0.10	0.0	6.31
3	1	2.4	1.01	1	1.0	0	39	0.10	0.0	6.08
3	1	1.0	0.61	1	0.6	0	39	0.10	0.0	6.42
3	1	0.6	0.45	1	0.5	0	39	0.10	0.0	6.1
3	1	0.5	1.10	1	1.1	0	39	0.10	0.0	6.67
4	0	0	NA	NA	101.0	0	0	0.00	0	8.18
4	1	101.0	27.60	1	27.6	29	29	0.07	0.3	6.79
4	1	27.6	11.50	1	11.5	6	35	0.09	0.1	6.11
4	1	11.5	2.55	1	2.6	3	38	0.10	0.1	6.41
4	1	2.6	1.07	1	1.1	1	39	0.10	0.0	6.2
4	1	1.1	0.58	1	0.6	0	39	0.10	0.0	6.47
4	1	0.6	0.50	1	0.5	0	39	0.10	0.0	6.17
4	1	0.5	1.1	1	1.1	0	39	0.10	0.0	6.71

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Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R3	For additional comments, RMAL Laboratory Research Book																		
Reactor No.	ORNL GC #	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)	Flag	Aq. C/Co	mg TCE Oxidized in Interval	Cum. mg TCE Oxidized	% of Init A TCE Oxid In Interval	% of Total TCE Oxid In Interval	Cum % Total TCE Oxidized	mg TCE in Aliquot	mg TCE					
3	1319	100,293		3.05	2.89	106,024			0.0	0.0	0.0%	0.0%	0.0%	1.06						
3	1333R	50,690		3.13	3.25	48,844			0.46	22.4	22.4	52.7%	52.7%	0.49						
3	1347R	43,307		3.13	3.45	39,385			0.37	3.6	26.0	8.5%	8.5%	0.79						
3	1361	28,860	E	3.03	3.07	28,421	E		0.27	4.0	30.0	9.3%	9.3%	0.28						
3	1375R	36,530		3.03	3.42	32,396			0.31	-1.4	28.6	-3.3%	-3.3%	0.32						
3	1389R	32,635		3.07	3.16	31,692			0.30	0.2	28.8	0.6%	0.6%	0.32						
3	1403R	28,983		3.07	2.68	33,202			0.31	-0.5	28.3	-1.2%	-1.2%	0.33						
3	1417	31,349		3.09	3.177	30,499			0.29	0.9	29.2	2.0%	2.0%	0.30						
4	1320	96,366		3.05	2.74	107,060			1.00	0.0	0.0	0.0%	0.0%	1.07						
4	1334R	44,869		3.12	2.51	55,777			0.52	20.1	20.1	46.8%	46.8%	0.56						
4	1348R	41,370		3.11	3.22	40,041			0.37	6.0	26.1	14.0%	14.0%	0.40						
4	1362R	35,512		3.02	3.18	33,701			0.31	2.4	28.5	5.5%	5.5%	0.67						
4	1376R	34,518		3.04	3.21	32,699			0.31	0.4	28.8	0.8%	0.8%	0.33						
4	1390R	31,688		3.08	3.00	32,503			0.30	0.1	28.9	0.2%	0.2%	0.33						
4	1404R	31,117		3.06	2.95	32,273			0.30	0.1	29.0	0.2%	0.2%	0.32						
4	1418	34,406		3.09	3.28	32,375			0.30	0.0	28.9	-0.1%	-0.1%	0.32						

Prepared by: S.R. Cline

Last Updated: 10/23/98

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Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R3	For additional comments, RMAL Laboratory Research Book										800	Conc (ppm)	39600
MnO4- Calb. Slope:		0.046	STOCK Conc. (ppm):		49.5	DF:								
Calibration Date:	5/5/98													
pH Data														
Reactor No.	Volume	Initial MnO4- Stock (mL)	Initial MnO4- (mg/L)	Aliquot MnO4- (mg/L)	Final Spec DF	Final MnO4- (mg/L)	Final MnO4- Consumed in Interval	Cum. MnO4- Consumed	Cum. MnO4- per mL GW	mg MnO4- in Aliquo	pH			
5	5	10	990.0	49.8	17	846.60	57	57	0.14	8.5	6.26			
5	5	10	846.6	49.6	17	843.20	1	59	0.15	8.4	5.93			
5	5	10	843.2	48.8	17	829.60	5	64	0.16	8.3	6.35			
5	5	10	829.6	49.4	17	839.80	-4	60	0.15	16.8	6.11			
5	5	10	839.8	47.7	17	810.90	10	70	0.18	8.1	6.17			
5	5	10	810.9	47.5	17	807.50	1	71	0.18	8.1	6.04			
5	5	10	807.5	47.2	17	802.40	2	73	0.18	8.0	6.44			
6	6	10	987.5	48.9	17	831.30	63	63	0.16	8.3	6.26			
6	6	10	831.3	49.4	17	839.80	-3	59	0.15	8.4	6			
6	6	10	839.8	48.7	17	827.90	5	64	0.16	8.3	6.39			
6	6	10	827.9	49.5	17	841.50	-5	59	0.15	8.4	6.13			
6	6	10	841.5	48.0	17	816.00	9	68	0.17	16.3	6.21			
6	6	10	816.0	48.1	17	817.70	-1	67	0.17	8.2	6.05			
6	6	10	817.7	47.4	17	805.80	4	71	0.18	8.1	6.41			

Prepared by: S.R. Cline

Last Updated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.		4b-R3	For additional comments, RMAL Laboratory Research Book																
Reactor No.	ORNL GC #	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)	Flag	Aq. C/Co	mg TCE Oxidized in Interval	Cum. mg TCE Oxidized	% of Init A TCE Oxidized In Interval	% of Total TCE Oxidized In Interval	Cum % Total TCE Oxidized	mg TCE in Aliquot					
5	1321	99,109		3.07	2.92	104,107			0.0	0.0	0.0%	0.0%	0.0%	1.04					
5	1335	0		3.11	3.04	1			41.6	41.6	100.0%	100.0%	100.0%	0.00					
5	1349	0		3.12	2.84	1			0.0	41.6	0.0%	0.0%	100.0%	0.00					
5	1363	0		3.02	2.99	1			0.0	41.6	0.0%	0.0%	100.0%	0.00					
5	1377	0		3.03	3.26	1			0.0	41.6	0.0%	0.0%	100.0%	0.00					
5	1391	0		3.03	2.74	1			0.0	41.6	0.0%	0.0%	100.0%	0.00					
5	1405	0		3.06	3.60	1			0.0	41.6	0.0%	0.0%	100.0%	0.00					
5	1419	0		3.09	3.259	1			0.0	41.6	0.0%	0.0%	100.0%	0.00					
6	1322	102,240		3.09	3.24	97,517			1.00	0.0	0.0%	0.0%	0.0%	0.98					
6	1336	0		3.13	3.05	1			0.00	39.1	100.0%	100.0%	100.0%	0.00					
6	1350	0		3.11	3.57	1			0.00	0.0	0.0%	0.0%	100.0%	0.00					
6	1364	0		3.02	2.73	1			0.00	0.0	0.0%	0.0%	100.0%	0.00					
6	1378	0		3.04	3.45	1			0.00	0.0	0.0%	0.0%	100.0%	0.00					
6	1392	0		3.07	2.90	1			0.00	0.0	0.0%	0.0%	100.0%	0.00					
6	1406	0		3.08	2.90	1			0.00	0.0	0.0%	0.0%	100.0%	0.00					
6	1420	0		3.09	3.68	1			0.00	0.0	0.0%	0.0%	100.0%	0.00					

Steven Robert Cline:
ND, BUT ENTERED AS 1 PPM FOR
CALCULATING LOG SCALE

Prepared by: S.R. Cline

Last Updated: 10/23/98

Prepared by: S.R. Cline

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Experiment: 4b-R4

For additional comments, RMAL Laboratory Research Book

Solid Media	Initial TCE (ppb)	Co-Contaminant?	MnO4- Concs. (%)
NONE	100,000	NO	1 & 3

Experiment Start Date: 7/29/98

Comments:

SPIKE SOLUTION PREPARATION

Prepared a 100 ppm TCE spiking solution in Tedlar bag using 2500gm of sparged groundwater and 280uL of pure phase TCE. Placed bag in incubator set at 12 C.

GC Analysis of Spike Solution

ORNL GC #	Sample Name	Sample Time	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)
1315	4B-R4-TB-A	7/30/98 8:20	139,895		5.11	4.85	147,334
1316	4B-R4-TB-B	7/30/98 8:20	133,723		5.12	4.67	146,730

Prepared by: S.R. Cline

LastUpdated: 10/22/98

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Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4b-R4	For additional comments, RMAL Laboratory Research Book							
	MnO4- Calb. Slope:		0.046	STOCK	NA	DF:	NA	CONC:	Conc (ppm):	
	Calibration Date: 5/5/98									
	MnO4- Data									pH Data
	KMnO4	Initial	Aliquot	Final	Final	mg MnO4	Cum.	Cum.	mg MnO4-	
Reactor	Added	MnO4-	MnO4-	Spec	MnO4-	Consumed	mg MnO4	mg MnO4	in Aliquot	pH
No.	(mg)	(mg/L)	(mg/L)	DF	(mg/L)	in Interval	Consumed	per mL GW		
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.37
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.29
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.25
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.38
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.32
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.08
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.00
1	0	0	NA	NA	NA	NA	NA	NA	NA	7.91
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.35
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.38
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.26
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.4
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.36
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.09
2	0	0	NA	NA	NA	NA	NA	NA	NA	8
2	0	0	NA	NA	NA	NA	NA	NA	NA	7.92

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Prepared by: S.R. Cline

LastUpdated: 10/23/98

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Prepared by: S.R. Cline

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Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R4	For additional comments, RMAL Laboratory Research Book								
MnO4- Calb. Slope:		0.046	STOCK	NA	DF:	NA	CONC:	Conc (ppm):		
Calibration Date:	5/5/98									
MnO4- Data										pH Data
Reactor	KMnO4	Initial	Aliquot	Final	Final	mg MnO4	Cum.	Cum	mg MnO4-	
No.	Added	MnO4-	MnO4-	Spec	MnO4-	Consumed	mg MnO4	mg MnO4	in Aliquot	pH
	(mg)	(mg/L)	(mg/L)	DF	(mg/L)	in Interval	Consumed	per mL GW		
3	0	0	NA	NA	10197	0	0	0.00	0	8.38
3	5280	10197	12.4	801	9932	103	103	0.26	99.3	6.67
3	5280	9932	25.4	401	10185	-96	7	0.02	203.7	6.38
3	5280	10185	24.7	401	9905	101	108	0.27	99.0	6.71
3	5280	9905	25.4	401	10185	-98	10	0.02	101.9	6.62
3	5280	10185	25.3	401	10145	14	23	0.06	101.5	6.73
3	5280	10145	24.9	401	9985	53	76	0.19	99.8	6.59
3	5280	9985	25.4	401	10185	-64	12	0.03	101.9	6.86
4	0	0	NA	NA	10197	0	0	0.00	0	8.36
4	5280	10197	12.4	801	9932	103	103	0.26	99.3	6.61
4	5280	9932	25.1	401	10065	-50	53	0.13	100.7	6.32
4	5280	10065	25.2	401	10105	-15	38	0.09	202.1	6.71
4	5280	10105	25.8	401	10346	-84	-46	-0.12	103.5	6.6
4	5280	10346	25.3	401	10145	68	22	0.05	101.5	6.72
4	5280	10145	25.1	401	10065	26	48	0.12	100.7	6.61
4	5280	10065	25.2	401	10105	-13	35	0.09	101.1	6.73

Prepared by: S.R. Cline

Last Updated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4b-R4	For additional comments, RMAL Laboratory Research Book												
	ORNL	Extract	Flag	Hexane	Aqueous	Aqueous	Fla	Aq.	mg TCE	Cum.	% of Init A	% of Total	Cum %	mg TCE	
Reactor	GC #	Conc.		Volume	Volume	Conc.		C/Co	Oxidized	mg TCE	TCE Oxidi	TCE Oxidi	Total TCE	in Aliquot	
No.		(ppb)		(mL)	(mL)	(ppb)			in Interval	Oxidized	In Interval	In Interval	Oxidized		
3	1326	101,352		3.09	2.83	110,587		1.00	0.0	0.0	0.0%	0.0%	0.0%	1.11	
3	1340	0		3.15	3.31	1	Steven Robert Cline: ND, BUT ENTERED AS 1 PPB FOR PLOTTING LOG SCALE			43.1	97.5%	97.5%	97.5%	0.00	
3	1354	0		3.07	3.01	1			43.1	0.0%	0.0%	97.5%	0.00		
3	1368	0		3.03	3.27	1		0.00	0.0	43.1	0.0%	0.0%	97.5%	0.00	
3	1382	0		3.05	3.22	1		0.00	0.0	43.1	0.0%	0.0%	97.5%	0.00	
3	1396	0		3.07	3.26	1		0.00	0.0	43.1	0.0%	0.0%	97.5%	0.00	
3	1410	0		3.08	2.93	1		0.00	0.0	43.1	0.0%	0.0%	97.5%	0.00	
3	1424	0		3.12	2.93	1		0.00	0.0	43.1	0.0%	0.0%	97.5%	0.00	
4	1327	102,991		3.09	2.95	108,200		1.00	0.0	0.0	0.0%	0.0%	0.0%	1.08	
4	1341	0		3.14	3.50	1		0.00	42.2	42.2	97.5%	97.5%	97.5%	0.00	
4	1355	0		3.12	3.09	1		0.00	0.0	42.2	0.0%	0.0%	97.5%	0.00	
4	1369	0		3.02	2.62	1		0.00	0.0	42.2	0.0%	0.0%	97.5%	0.00	
4	1383	0		3.06	3.31	1		0.00	0.0	42.2	0.0%	0.0%	97.5%	0.00	
4	1397	0		3.05	3.03	1		0.00	0.0	42.2	0.0%	0.0%	97.5%	0.00	
4	1411	0		3.07	3.28	1		0.00	0.0	42.2	0.0%	0.0%	97.5%	0.00	
4	1425	0		3.12	3.31	1		0.00	0.0	42.2	0.0%	0.0%	97.5%	0.00	

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	Exp.	4B-R4	For additional comments, RMAL Laboratory Research Book											
								Sample Data						
Reactor	Sample	RXN Time	Sample	Volume GW Used	Media	Solid Mass	vol (mL) aqueous aliquot	Cum Aliquot Vol (mL)	Actual Vol at Sampling	Actual L/S Ratio				
No.	Time	(hrs)	Name	(mL)	Type	(grams)	aliquot	Vol (mL)						
5	6/24/98 8:45	0.0	4B-R4-T0-5	400	GW Only	0.0	10	10	400.0	NA				
5	6/24/98 9:15	0.5	4B-R4-T30MIN-5	400	GW Only	0	10	20	390.0	NA				
5	6/24/98 10:45	2.0	4B-R4-T2HR-5	400	GW Only	0	10	30	380.0	NA				
5	6/24/98 12:45	4.0	4B-R4-T4HR-5	400	GW Only	0	10	40	370.0	NA				
5	6/24/98 14:45	6.0	4B-R4-T6HR-5A	400	GW Only	0	20	60	360.0	NA				
5	6/25/98 7:02	22.3	4B-R4-T20HR-5	400	GW Only	0	10	70	340.0	NA				
5	6/25/98 8:45	24.0	4B-R4-T24HR-5	400	GW Only	0	10	80	330.0	NA				
5	8/3/98 9:05	96.0	4B-R4-T96HR-5	400	GW Only	0	10	90	320.0	NA				
6	6/24/98 8:45	0.0	4B-R4-T0-6	400	GW Only	0.0	10	10	400.0	NA				
6	6/24/98 9:15	0.5	4B-R4-T30MIN-6	400	GW Only	0	10	20	390.0	NA				
6	6/24/98 10:45	2.0	4B-R4-T2HR-6	400	GW Only	0	10	30	380.0	NA				
6	6/24/98 12:45	4.0	4B-R4-T4HR-6	400	GW Only	0	10	40	370.0	NA				
6	6/24/98 14:45	6.0	4B-R4-T6HR-6	400	GW Only	0	10	50	360.0	NA				
6	6/25/98 7:02	22.3	4B-R4-T20HR-6A	400	GW Only	0	20	70	350.0	NA				
6	6/25/98 8:45	24.0	4B-R4-T24HR-6	400	GW Only	0	10	80	330.0	NA				
6	8/3/98 9:05	96.0	4B-R4-T96HR-6	400	GW Only	0	10	90	320.0	NA				

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R4	For additional comments, RMAL Laboratory Research Book										Cone (ppm):	
	MnO4- Calib. Slope:	0.046	STOCK	NA	DF:	NA	CONC:						
	Calibration Date: 5/5/98												
	MnO4- (mg/L)												
	KMnO4	Initial	Final	Final	Spec	MnO4- (mg/L)	Final	mg MnO4 Consumed in Interval	Cum. mg MnO4 Consumed per mL GW	Cum	mg MnO4 in Aliquot	pH	pH Dat
Reactor No.	MnO4- (mg)	MnO4- (mg/L)	MnO4- (mg/L)	DF	DF	DF	DF	DF	DF	DF	DF	DF	DF
5	0	0	NA	NA	NA	30899	30899	0	0	0.00	0	8.39	
5	16000	30899	34.6	801	27715	27715	1242	1242	3.10	277.1	7		
5	16000	27715	37.6	801	30118	30118	-913	329	0.82	301.2	6.85		
5	16000	30118	38.0	801	30438	30438	-119	210	0.53	304.4	7.19		
5	16000	30438	38.6	801	30919	30919	-173	37	0.09	618.4	7.1		
5	16000	30919	37.0	801	29637	29637	436	473	1.18	296.4	7.3		
5	16000	29637	38.1	801	30518	30518	-291	182	0.46	305.2	7.13		
5	16000	30518	37.4	801	29957	29957	179	362	0.90	299.6	7.35		
6	0	0	NA	NA	30899	30899	0	0	0.00	0	8.4		
6	16000	30899	35.4	801	28355	28355	992	992	2.48	283.6	7.03		
6	16000	28355	37.7	801	30198	30198	-700	292	0.73	302.0	6.92		
6	16000	30198	37.7	801	30198	30198	0	292	0.73	302.0	7.22		
6	16000	30198	38.6	801	30919	30919	-260	32	0.08	309.2	7.19		
6	16000	30919	38.0	801	30438	30438	168	201	0.50	608.8	7.32		
6	16000	30438	38.1	801	30518	30518	-26	174	0.44	305.2	7.19		
6	16000	30518	37.9	801	30358	30358	51	225	0.56	303.6	7.41		

Prepared by: S.R. Cline

Last Updated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R4	For additional comments, RMAL Laboratory Research Book											
Reactor No.	ORNL GC #	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)	Fla Aq. C/Co	mg TCE Oxidized in Interval	Cum. mg TCE Oxidized	% of Init A TCE Oxidized In Interval	% of Total TCE Oxidized In Interval	Cum % Total TCE Oxidized	mg TCE in Aliquot
5	1328	109,939		3.08	3.17	107,035	1.00	0.0	0.0	0.0%	0.0%	0.0%	1.07
5	1342	0		3.12	3.23	1	0.00	41.7	41.7	97.5%	97.5%	97.5%	0.00
5	1356	0		3.11	3.27	1	0.00	0.0	41.7	0.0%	0.0%	97.5%	0.00
5	1370	0		3.05	3.34	1	Steven Robert Cline: ND, BUT ENTERED AS 1 PPB FOR PLOTTING LOG SCALE		41.7	0.0%	0.0%	97.5%	0.00
5	1384	0		3.05	2.83	1			41.7	0.0%	0.0%	97.5%	0.00
5	1398	0		3.06	3.35	1			0.0	0.0%	0.0%	97.5%	0.00
5	1412	0		3.07	3.19	1			0.0	0.0%	0.0%	97.5%	0.00
5	1426	0		3.10	3.05	1	0.00	0.0	41.7	0.0%	0.0%	97.5%	0.00
6	1329	117,695		3.10	3.55	102,897	1.00	0.0	0.0	0.0%	0.0%	0.0%	1.03
6	1343	0		3.12	3.36	1	0.00	40.1	40.1	97.5%	97.5%	97.5%	0.00
6	1357	0		3.11	3.30	1	0.00	0.0	40.1	0.0%	0.0%	97.5%	0.00
6	1371	0		3.05	3.32	1	0.00	0.0	40.1	0.0%	0.0%	97.5%	0.00
6	1385	0		3.05	3.66	1	0.00	0.0	40.1	0.0%	0.0%	97.5%	0.00
6	1399	0		3.07	3.02	1	0.00	0.0	40.1	0.0%	0.0%	97.5%	0.00
6	1413	0		3.06	3.28	1	0.00	0.0	40.1	0.0%	0.0%	97.5%	0.00
6	1427	0		3.10	3.70	1	0.00	0.0	40.1	0.0%	0.0%	97.5%	0.00

Prepared by: S.R. Cline

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Experiment: 4b-R5

For additional comments, see Laboratory Notebook B000025

Pages: 115-119

Solid Media	Initial TCE (ppb)	Co-Contaminant?	MnO4- Concs. (%)
NONE	100,000	YES @ 10ppm	0.01 & 0.1

Experiment Start Date: 8/26/98

Comments:

See general procedure on pages 95-97 in the laboratory Notebook.

Sequence stopped for approx 38 hrs (immediately before GC sample 1871)

SPIKE SOLUTION PREPARATION

Volume GW in Tedlar 3.08 liters

Pure TCE ADDED 0.2 mL

291200 ug

Predicted Spike Conc: 94563 ppb TCE

Also added 25uL of each contaminant for approx init conc of 10,000 ppb each.

GC Analysis of Spike Solution

ORNL	Sample	Extract	Flag	Hexane	Aqueous	Aqueous
GC #	Name	Conc.		Volume	Volume	Conc.
		(ppb)		(mL)	(mL)	(ppb)
1861b	4b-R5-1b-a	1,1DCE:	1956	4.95	5.53	1,749
1862b	4b-R5-1b-b		2038	4.99	5.09	1,995
1861b	4b-R5-1b-a	Trans-1,2DCE:	3672.57	4.95	5.53	3,284
1862b	4b-R5-1b-b		3784.27	4.99	5.09	3,706
1861b	4b-R5-1b-a	Cis-1,2DCE:	7555.39	4.95	5.53	6,756
1862b	4b-R5-1b-b		5325.27	4.99	5.09	5,215
1861	4b-R5-1b-a	TCE:	19773.91	4.95	5.53	17,682
1862	4b-R5-1b-b		20339.63	4.99	5.09	19,920

Prepared by: S.R. Cline

LastUpdated: 10/22/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.		4b-R5		For additional comments, see Laboratory Notebook B000025									

Prepared by: S.R. Cline

Last Updated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

For additional comments, see Laboratory Notebook B000025													
Exp.	4b-R5	0.022 STICK SOLN ABS										1667 Conc (ppm)	3991.43
MnO ₄ Cal. Sols:		0.522 DF:											
Calibration Date: 6/10/98													
MnO ₄ Stock													
Reactor	Volume	Initial	Final	Final	Final	Final	Final	Final	Final	Final	Final	pH	pH
No.	MnO ₄	MnO ₄	MnO ₄	MnO ₄	MnO ₄	MnO ₄	MnO ₄	MnO ₄	MnO ₄	MnO ₄	MnO ₄	MnO ₄	MnO ₄
	Added	(mg/L)	ABS	Spec	DF	Interval	Consumed	per mL	GW				
1	0	0	0.004	1 NA	1 NA	NA	NA	NA	NA	NA	NA	8.65	
1	0	0	0.003	1 NA	1 NA	NA	NA	NA	NA	NA	NA	8.48	
1	0	0	0.004	1 NA	1 NA	NA	NA	NA	NA	NA	NA	8.46	
1	0	0	0.004	1 NA	1 NA	NA	NA	NA	NA	NA	NA	8.44	
1	0	0	0.005	1 NA	1 NA	NA	NA	NA	NA	NA	NA	8.46	
1	0	0	0.003	1 NA	1 NA	NA	NA	NA	NA	NA	NA	8.44	
1	0	0	0.003	1 NA	1 NA	NA	NA	NA	NA	NA	NA	8.46	
2	0	0	0.003	1 NA	1 NA	NA	NA	NA	NA	NA	NA	8.5	
2	0	0	0.004	1 NA	1 NA	NA	NA	NA	NA	NA	NA	8.5	
2	0	0	0.003	1 NA	1 NA	NA	NA	NA	NA	NA	NA	8.46	
2	0	0	0.003	1 NA	1 NA	NA	NA	NA	NA	NA	NA	8.45	
2	0	0	0.005	1 NA	1 NA	NA	NA	NA	NA	NA	NA	8.46	
2	0	0	0.004	1 NA	1 NA	NA	NA	NA	NA	NA	NA	8.44	
2	0	0	0.004	1 NA	1 NA	NA	NA	NA	NA	NA	NA	8.46	

Prepared by: S.R. Cline

Last Updated: 10/23/98

[illegible]

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4h-R5	For additional comments, see Laboratory Notebook B100025										Sample Data										
Reactor Sample No.	Sample Time	RXN Time (hrs)	Sample Name	Volume (mL)	Media Type	Solid (grams)	Aliquot (mL)	Cum (mL)	Actual Vol at Sampling	Actual L/S												
3	8/27/98 11:04		0.0 4b-r5-10-3	500.36	GW Only	0.0	7.15	7.15	500.4 NA													
3	8/27/98 11:39		0.5 4b-r5-10min-3	500.35	GW Only	0	6.9	14.05	494.5 NA													
3	8/27/98 12:32		1.5 4b-r5-11.5h-3h	500.36	GW Only	0	6.75	20.8	487.8 NA													
3	8/27/98 14:04		3.0 4b-r5-1h-3	500.36	GW Only	0	6.93	27.73	480.8 NA													
3	8/27/98 16:02		5.0 4b-r5-15h-3	500.36	GW Only	0	6.83	34.58	473.9 NA													
3	8/28/98 8:12		21.1 4b-r5-20h-3	500.36	GW Only	0	6.59	41.17	467.0 NA													
3	8/28/98 11:07		24.9 4b-r5-12h-3	500.36	GW Only	0	6.67	47.84	460.4 NA													
4	8/27/98 11:05		0.0 4b-r5-10-4	498.71	GW Only	0.0	7.21	7.21	498.7 NA													
4	8/27/98 11:40		0.5 4b-r5-10min-4	498.71	GW Only	0	7.17	14.38	482.6 NA													
4	8/27/98 12:34		1.5 4b-r5-11.5h-4	498.71	GW Only	0	7.45	21.83	485.6 NA													
4	8/27/98 14:05		3.0 4b-r5-1h-4	498.71	GW Only	0	7.38	29.21	478.1 NA													
4	8/27/98 16:03		5.0 4b-r5-15h-4	498.71	GW Only	0	7.4	36.61	470.6 NA													
4	8/28/98 8:13		21.1 4b-r5-20h-4	498.71	GW Only	0	7.02	43.63	463.4 NA													
4	8/28/98 11:08		24.9 4b-r5-12h-4	498.71	GW Only	0	7.44	51.07	458.3 NA													

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4b-R5	For additional comments, see Laboratory Notebook B000025								
	MnO4- Calb. Slope:		0.022	STOCK SOLN ABS:		0.522	DF:		1667	Conc (ppm):	38981.43
	Calibration Date: 6/10/98										
	MnO4- Data										pH Data
Reactor	Volume	Initial	Final	Final	Final	mg MnO4	Cum.	Cum	mg MnO4-		
No.	Stock Mr	MnO4-	MnO4-	Spec	MnO4-	Consumed	mg MnO4	mg MnO4	in Aliquot	pH	
	Added (m	(mg/L)	ABS	DF	(mg/L)	in Interval	Consumed	per mL GW			
3	0	0.0	0.003	1	98.5	0	0	0.00	0	8.51	
3	1.25	98.5	0.307	5	68.8	15	15	0.03	0.5	7.63	
3	1.25	68.8	0.246	5	55.1	7	21	0.04	0.4	7.57	
3	1.25	55.1	0.218	5	48.8	3	24	0.05	0.3	7.47	
3	1.25	48.8	0.19	5	42.6	3	27	0.05	0.3	7.54	
3	1.25	42.6	0.404	2	36.2	3	30	0.06	0.2	7.49	
3	1.25	36.2	0.406	2	36.4	0	30	0.06	0.2	7.53	
4	0	0.0	0.003	1	98.9	0	0	0.00	0	8.5	
4	1.25	98.9	0.323	5	72.4	13	13	0.03	0.5	7.5	
4	1.25	72.4	0.26	5	58.2	7	20	0.04	0.4	7.35	
4	1.25	58.2	0.218	5	48.8	4	24	0.05	0.4	7.3	
4	1.25	48.8	0.199	5	44.6	2	26	0.05	0.3	7.38	
4	1.25	44.6	0.426	2	38.2	3	29	0.06	0.3	7.33	
4	1.25	38.2	0.43	2	38.5	0	29	0.06	0.3	7.36	

Prepared by: S.R. Cline

Last Updated: 10/23/98

[illegible]

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4b-R5	For additional comments, see Laboratory Notebook B000025													
													Sample Data			
Reactor	Sample	RXN	Sample	Volume	Solid	vol (mL)	Cum	Actual	Actual							
No.	Time	Time	Name	GW Used (mL)	Media Type	Mass (grams)	aliquot	Alloquot Vol (mL)	Vol at Sampling	L/S Ratio						
5	8/27/98 11:06	0.0	4b-r5-10-5	506.82	GW Only	0.0	6.99	6.99	506.8	NA						
5	8/27/98 11:41	0.6	4b-r5-130min-5	506.82	GW Only	0	7.28	14.27	512.3	NA						
5	8/27/98 12:35	1.5	4b-r5-11.5h-5	506.82	GW Only	0	7.23	21.5	505.1	NA						
5	8/27/98 14:07	3.0	4b-r5-13h-5	506.82	GW Only	0	7.25	28.75	497.8	NA						
5	8/27/98 16:04	5.0	4b-r5-15h-5a	506.82	GW Only	0	7.3	36.05	490.6	NA						
5	8/28/98 8:14	21.1	4b-r5-120h-5	506.82	GW Only	0	7.11	43.16	483.3	NA						
5	8/28/98 11:09	24.0	4b-r5-124h-5a	506.82	GW Only	0	7	50.36	476.2	NA						
6	8/27/98 11:07	0.0	4b-r5-10-6	501.33	GW Only	0.0	7.18	7.18	501.3	NA						
6	8/27/98 11:42	0.6	4b-r5-130min-6	501.33	GW Only	0	7.09	14.27	506.7	NA						
6	8/27/98 12:36	1.5	4b-r5-11.5h-6	501.33	GW Only	0	7.43	21.7	499.6	NA						
6	8/27/98 14:08	3.0	4b-r5-13h-6	501.33	GW Only	0	7.38	29.08	492.1	NA						
6	8/27/98 16:06	5.0	4b-r5-15h-6	501.33	GW Only	0	7.49	36.57	484.8	NA						
6	8/28/98 8:15	21.1	4b-r5-120h-6a	501.33	GW Only	0	7.1	43.67	477.3	NA						
6	8/28/98 11:11	24.1	4b-r5-124h-6	501.33	GW Only	0	7.31	50.98	470.2	NA						

Prepared by: S.R. Cline

Last Updated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R5	For additional comments, see Laboratory Notebook B000025										1667 Conc. (ppm)	38981.43
	MnO4- Calc. Slope:	0.022 STOCK SOLN ABS	0.522 DF										
	Calibration Date: 6/10/98												
Reactor No.	Volume Stock Added (ml)	Initial MnO4- (mg/L)	Final MnO4- ABS	Final MnO4- Spec DF	Final MnO4- (mg/L)	Final MnO4- Consuming in Interval	Cum. Consuming in Interval	Cum. MnO4- mg Consumed per mL GW	ing MnO4- in Aliquot	pH	pH Data		
5	0	0.0	0.004	1	951.1	0	0	0.00	0	8.5			
5	12.5	951.1	0.368	50	824.4	65	65	0.13	6.0	7.22			
5	12.5	824.4	0.373	50	835.6	-6	59	0.12	6.0	7.22			
5	12.5	835.6	0.37	50	828.9	3	63	0.12	6.0	7.17			
5	12.5	828.9	0.36	50	806.5	11	74	0.15	5.9	7.13			
5	12.5	806.5	0.373	50	835.6	-14	59	0.12	5.9	7.2			
5	12.5	835.6	0.372	50	833.4	1	61	0.12	6.0	7.27			
6	0	0.0	0.004	1	961.7	0	0	0.00	0	8.5			
6	12.5	961.7	0.390	50	873.7	45	45	0.09	6.2	7.09			
6	12.5	873.7	0.404	50	905.1	-16	29	0.06	6.7	7.14			
6	12.5	905.1	0.400	50	896.1	4	33	0.07	6.6	7.08			
6	12.5	896.1	0.399	50	893.9	1	34	0.07	6.7	7.07			
6	12.5	893.9	0.395	50	884.9	4	39	0.08	6.3	7.12			
6	12.5	884.9	0.397	50	889.4	-2	37	0.07	6.5	7.13			

Prepared by: S.R. Cline

Last Updated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R5	For additional comments, see Laboratory Notebook B000025																			
Reactor No.	ORNL GC #	I-DCE (ppb)	ORNL GC #	TransDCE (ppb)	ORNL GC #	ORNL GC #	ORNL GC #	ORNL GC #	ORNL GC #	ORNL GC #	ORNL GC #	ORNL GC #	ORNL GC #	ORNL GC #	ORNL GC #	ORNL GC #	ORNL GC #	ORNL GC #	ORNL GC #	ORNL GC #	ORNL GC #
3	1868b	1915	1868b	4117	1868b	4117	1868b	4117	1868b	4117	1868b	4117	1868b	4117	1868b	4117	1868b	4117	1868b	4117	1868b
3	1875	0	1875	0	1875	0	1875	0	1875	0	1875	0	1875	0	1875	0	1875	0	1875	0	1875
3	1882	0	1882	0	1882	0	1882	0	1882	0	1882	0	1882	0	1882	0	1882	0	1882	0	1882
3	1889	0	1889	0	1889	0	1889	0	1889	0	1889	0	1889	0	1889	0	1889	0	1889	0	1889
3	1895	0	1895	0	1895	0	1895	0	1895	0	1895	0	1895	0	1895	0	1895	0	1895	0	1895
3	1902	0	1902	0	1902	0	1902	0	1902	0	1902	0	1902	0	1902	0	1902	0	1902	0	1902
3	1909	0	1909	0	1909	0	1909	0	1909	0	1909	0	1909	0	1909	0	1909	0	1909	0	1909
6	1868b	1941	1868b	3817	1868b	3817	1868b	3817	1868b	3817	1868b	3817	1868b	3817	1868b	3817	1868b	3817	1868b	3817	1868b
6	1876	0	1876	0	1876	0	1876	0	1876	0	1876	0	1876	0	1876	0	1876	0	1876	0	1876
6	1883	0	1883	0	1883	0	1883	0	1883	0	1883	0	1883	0	1883	0	1883	0	1883	0	1883
6	1890	0	1890	0	1890	0	1890	0	1890	0	1890	0	1890	0	1890	0	1890	0	1890	0	1890
6	1897	0	1897	0	1897	0	1897	0	1897	0	1897	0	1897	0	1897	0	1897	0	1897	0	1897
6	1903	0	1903	0	1903	0	1903	0	1903	0	1903	0	1903	0	1903	0	1903	0	1903	0	1903
6	1911	0	1911	0	1911	0	1911	0	1911	0	1911	0	1911	0	1911	0	1911	0	1911	0	1911

Prepared by: S.R. Cline

Last Updated: 10/2/98

Exp.	4h-R5	For additional comments, see Laboratory Notebook BBOX025										0.02	STUCK SULF. ABS.	0.522	DE	1647	Cover (µm)	38981.413
Reactor No.	Sample Time	RXN Time (hrs)	Sample Name	Volume (mL)	Media Type	Solid (gms)	Sample Data			Actual Vol (mL)	Actual US (mL)	Actual Vol (mL)	Initial Stock M (mg/L)	Final Stock M (mg/L)	Initial M (mg/L)	Final M (mg/L)	Initial pH	Final pH
							Vol (mL)	Conc (mg/L)	Conc (mg/L)									
1	8/27/98 11:02	0.0	4b-r5-10-1b	492.24	GW Only	0	7.28	NA	NA	NA	NA	0.003	1	NA	8.51			
2	8/27/98 11:38	0.6	4b-r5-10min-2b	499.63	GW Only	0	7.18	NA	NA	NA	NA	0.258	5	57.4	7.43			
3	8/27/98 12:33	1.5	4b-r5-11.5h-3b	500.36	GW Only	0	7.38	NA	NA	NA	NA	1.25	NA	49.3	7.25			
4	8/27/98 14:06	3.0	4b-r5-13h-4b	498.71	GW Only	0	7.32	NA	NA	NA	NA	1.33	NA	0.397	50	880.4	7.1	
5	8/27/98 16:05	5.0	4b-r5-15h-5b	506.82	GW Only	0	7.38	NA	NA	NA	NA	13.3	NA	0.368	50	891.6	7.1	
6	8/28/98 8:16	21.2	4b-r5-120h-6b	501.33	GW Only	0	7.12	NA	NA	NA	NA	13.3	NA	0.392	50	878.2	7.18	
1	8/28/98 11:10	24.1	4b-r5-124h-5b	506.82	GW Only	0	7	NA	NA	NA	NA	13.3	NA	0.392	50	878.2	7.18	
1	NOT EXTRACTED																	
2	NOT EXTRACTED																	
3	NOT EXTRACTED																	
4	NOT EXTRACTED																	
5	NOT EXTRACTED																	
6	NOT EXTRACTED																	
1	8/28/98 11:12	4b-R5-char-1a	Charcoal	NA														
2	8/28/98 11:12	4b-R5-char-1b	Charcoal	NA														
1	8/28/98 11:13	4b-R5-char-2a	Charcoal	NA														
2	8/28/98 11:13	4b-R5-char-2b	Charcoal	NA														
1	8/28/98 11:14	4b-R5-char-3a	Charcoal	NA														
3	8/28/98 11:14	4b-R5-char-3b	Charcoal	NA														
4	8/28/98 11:15	4b-R5-char-4a	Charcoal	NA														
5	8/28/98 11:16	4b-R5-char-5a	Charcoal	NA														
6	8/28/98 11:17	4b-R5-char-6a	Charcoal	NA														
1	8/28/98 11:17	4b-R5-char-6b	Charcoal	NA														
Additional Oxidant Information																		
Flask (mg)	Initial Load (mg/mL)	Consumed (mg)	Consumed (mg/24 hrs)	AVG (mg/g)														
1	0.00	0.000	NA	NA														
2	0.00	0.000	NA	NA														
3	48.7	0.10	30.7	0.06														
4	48.7	0.10	29.7	0.06														
5	487.3	0.95	60.3	0.12														

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R5	For additional comments, see Laboratory Notebook B000025																							
Reactor No.	ORNL GC #	1-IDCE Extract (ppb)	Flag	ORNL GC #	TransDC Extract (ppb)	Flag	ORNL GC #	CisDCE Extract (ppb)	Flag	ORNL GC #	TCE Extract (ppb)	Flag	Hexane/Aqueous Volume (mL)	Aqueous Volume (mL)	1-IDCE Aqueous (ppb)	Flag	TransDCE Aqueous (ppb)	Flag	CisDCE Aqueous (ppb)	Flag	TCE Aqueous (ppb)	Flag	% Diff	AVG (ppb)	STDEV (ppb)
	Duplicate VOC Samples																								
1	1864b	2,088		1864b	3,796		1864b	5,916		1864	22,577		2.88	3.25	1,918		3,487		5,433		20,735		-7%	20,037	987
2	1872b	1,973		1872b	3,747		1872b	5,224		1872	22,966		3.00	3.33	1,779		3,377		4,708		20,700		3%	21,048	492
3	1880	18		1880	0		1880	80		1880r	1,276		2.96	3.06	18		1		77		1,233		-1%	1,225	12
4	1888	0		1888	0		1888	0		1888	394		2.99	3.12	1		1		1		378		-6%	367	14
5	1896	0		1896	0		1896	0		1896	4 U		2.97	3.20	1		1		1		3 U		38%	5	1
6	1904	0		1904	0		1904	0		1904	2 U		2.95	3.30	1		1		1		2 U		42%	2	1
7	1910	0		1910	0		1910	0		1910	3 U		2.91	3.10	1		1		1		3 U		33%	3	1
Extraction of the Remaining Reactor Contents																									
1	NOT EXTRACTED																								
2	NOT EXTRACTED																								
3	NOT EXTRACTED																								
4	NOT EXTRACTED																								
5	NOT EXTRACTED																								
6	NOT EXTRACTED																								
Extraction of the Charcoal Beds																									
													Mass Carbon (g) TCE (mg)												
1	1912	nd-diluted		1912	nd-diluted		1912	nd-diluted		1912	2 U		2.92	0.08	7.2E-06										
1	1913	0		1913	0		1913	0		1913	0		2.92	0.03	0.0E+00										
2	1914	nd-diluted		1914	nd-diluted		1914	nd-diluted		1914	1 U		2.93	0.08	3.3E-06										
2	1915	0		1915	0		1915	0		1915	0 U		2.92	0.03	1.2E-06										
3	1916	nd-diluted		1916	nd-diluted		1916	nd-diluted		1916	1 U		2.91	0.09	3.8E-06										
3	1917	0		1917	0		1917	0		1917	0 U		2.92	0.03	1.1E-06										
4	1918	nd-diluted		1918	nd-diluted		1918	nd-diluted		1918	0		2.93	0.08	0.0E+00										
4	1919	0		1919	0		1919	0		1919	0 U		2.92	0.03	0.0E+00										
5	1920	nd-diluted		1920	nd-diluted		1920	nd-diluted		1920	0		2.91	0.08	0.0E+00										
5	1921	0		1921	0		1921	0		1921	0 U		2.91	0.02	0.0E+00										
6	1922	nd-diluted		1922	nd-diluted		1922	nd-diluted		1922	0		2.92	0.08	0.0E+00										
6	1923	0		1923	0		1923	0		1923	0 U		2.93	0.03	0.0E+00										
Flask																									
1																									
2																									
3																									
4																									
5																									
6																									

Steven Robert Cline
NO, BUT ENTERED AS 1 FOR
FOR PLOTTING LOG SCALE

Mass

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Experiment: 4b-R6

For additional comments, see Laboratory Notebook B000025

Pages: 120-124

Solid Media	Initial TCE (ppb)	Co-Contaminant?	MnO4- Conc. (%)
NONE	100,000	YES @ 10ppm	1 & 3

Experiment Start Date: 8/31/98

Comments:

bigger t=0 values for latter flasks may be due to TCE not in solution during dist. From tedlar bag

SPIKE SOLUTION PREPARATION

Volume GW in Tedlar 2.99 liters

Pure TCE 0.2 mL

291200 ug

Predicted Spike Conc: 97391 ppb

GC Analysis of Spike Solution

ORNL	Sample	Extract	Flag	Hexane	Aqueous	Aqueous
GC #	Name	Conc.		Volume	Volume	Conc.
		(ppb)	9/1/98 11:10	(mL)	(mL)	(ppb)
1924	4b-R6-tb-a	1,1DCE:	16585	4.48	4.84	15,338
1925	4b-R6-tb-b		18329	4.60	5.28	15,965
1924	4b-R6-tb-a	Trans-1,2DCE:	18060.24	4.48	4.84	16,702
1925	4b-R6-tb-b		19320.30	4.60	5.28	16,829
1924	4b-R6-tb-a	Cis-1,2DCE:	11212.25	4.48	4.84	10,369
1925	4b-R6-tb-b		13609.59	4.60	5.28	11,855
1924	4b-R6-tb-a	TCE:	12084.78	4.48	4.84	11,176
1925	4b-R6-tb-b		13127.57	4.60	5.28	11,435

Prepared by: S.R. Cline

Last Updated: 10/22/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4b-R6	For additional comments, see Laboratory Notebook B000025									
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Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R6	For additional comments, see Laboratory Notebook B000025					Conc (ppm):	
MnO4- Calb. Slope:		0.022		STOCK SOLN ABS:	NA	DF:	NA	
Calibration Date: 6/10/98								
MnO4- 1000								
Reactor No.	KMnO4	Initial	Final	Final	Final	mg MnO4 Consumed in Interval	Cum. mg MnO4 Consumed per mL GW	pH
	Added (mg)	MnO4- (mg/L)	MnO4- ABS	Spec DF	MnO4- (mg/L)			pH
	1	0	0	NA	NA	NA	NA	8.42
	1	0	0	NA	NA	NA	NA	8.43
	1	0	0	NA	NA	NA	NA	8.37
	1	0	0	NA	NA	NA	NA	8.37
	1	0	0	NA	NA	NA	NA	8.37
	1	0	0	NA	NA	NA	NA	8.42
	1	0	0	NA	NA	NA	NA	8.4
	2	0	0	NA	NA	NA	NA	8.42
2	0	0	NA	NA	NA	NA	8.42	
2	0	0	NA	NA	NA	NA	8.39	
2	0	0	NA	NA	NA	NA	8.39	
2	0	0	NA	NA	NA	NA	8.38	
2	0	0	NA	NA	NA	NA	8.42	
2	0	0	NA	NA	NA	NA	8.4	

Prepared by: S.R. Cline

Last Updated: 10/23/98

[illegible]

Prepared by: S.R. Cline

LastUpdated: 10/23/98

[illegible]

[illegible]

Prepared by: S.R. Cline

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4h-R6	For additional comments, see Laboratory Notebook B100025										Conc. (ppm)	pH
MnO4 ⁻	Calib. Slope:	0.022	STOCK SOLN ABS:	NA	DF:	NA	DF:	NA	DF:	NA	DF:	Conc. (ppm)	pH
Calibration Date: 6/10/98													
Reactor No.	KMnO4 Added (mg)	MnO4 ⁻ (mg/L)	Initial MnO4 ⁻ (mg/L)	Final MnO4 ⁻ (mg/L)	Final Spec DF	Final MnO4 ⁻ (mg/L)	MnO4 ⁻ Consumed in Interval	Cum. Consumed	Cum. mg MnO4 ⁻ in Aliquot	mg MnO4 ⁻ in Aliquot	pH		
5	0	0	NA	NA	NA	32053	0	0	0.00	0	8.42		
5	20002	32053	0.240	1000	1000	10754	10011	10011	20.98	75.4	7.1		
5	20002	10754	0.487	1000	1000	21821	-5124	4887	10.24	153.8	7.26		
5	20002	21821	0.553	1000	1000	24778	-1348	3538	7.42	172.2	7.3		
5	20002	24778	0.547	1000	1000	24569	121	3659	7.67	165.7	7.32		
5	20002	24569	0.591	1000	1000	26481	-872	2787	5.84	176.1	7.27		
5	20002	26481	0.540	1000	1000	24195	995	3783	7.93	163.3	7.26		
6	0	0	NA	NA	NA	31756	0	0	0.00	0	8.43		
6	20003	31756	0.323	1000	1000	14472	8200	8200	17.03	101.2	7.06		
6	20003	14472	0.440	1000	1000	19715	-2450	5749	11.94	147.1	7.32		
6	20003	19715	0.559	1000	1000	25047	-2452	3297	6.85	180.1	7.38		
6	20003	25047	0.592	1000	1000	26525	-669	2627	5.46	190.7	7.36		
6	20003	26525	0.573	1000	1000	25674	379	3007	6.24	182.0	7.62		
6	20003	25674	0.557	1000	1000	24957	314	3321	6.90	177.7	7.62		

Prepared by: S.R. Cline

Last Updated: 10/23/98

C-191

Prepared by: S.R. Cline

Last Updated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R6	For additional comments, see Laboratory Notebook BIKR025															0.022 STOCK 50%N ABS:	NA	DF	NA	Coc (ppm)
Reactor Nc.	Sample Time	RXN Time (hrs)	Sample Name	Volume GW Used (mL)	Media Type	Solid Mass (grams)	Aqueous aliquot (mL)	Com Vol (mL)	Actual Vol at U/S	Actual Sampling Ratio	KDinO4 Added (mg/L)	Initial MinO4- (mg/L)	Final MinO4- (mg/L)	Final ABS	Final DF	Final MinO4- (mg/L)	pH				
Depleted VOC Samples																					
1	9/198 11:15	0.0	4b-R6-10-1b	488.49	GW Only	0	6.97	NA	NA	NA	0	NA	NA	NA	NA	NA	8.42				
2	9/198 11:42	0.4	4b-R6-130m-2b	485.07	GW Only	0	6.99	NA	NA	NA	6604	NA	0.453	500	101.49	7.29					
3	9/198 12:40	1.4	4b-R6-11-5b-3b	482.63	GW Only	0	7.16	NA	NA	NA	6649	NA	0.468	500	10.85	7.23					
4	9/198 14:04	2.8	4b-R6-13b-4b	490.72	GW Only	0	7.12	NA	NA	NA	2002	NA	0.579	1000	25.91	7.29					
5	9/198 16:12	4.9	4b-R6-15b-5b	477.05	GW Only	0	7.18	NA	NA	NA	2003	NA	0.569	1000	25.905	7.6					
6	9/298 9:21	22.0	4b-R6-20b-6b	481.52	GW Only	0	7.2	NA	NA	NA	2003	NA	0.552	1000	24.733	7.60					
6	9/298 11:10	23.8	4b-R6-24b-6b	481.52	GW Only	0.0	7.21	NA	NA	NA	2003	NA	0.552	1000	24.733	7.60					
Extraction of the Remaining Reactor Contents																					
1	NOT EXTRACTED																				
2	NOT EXTRACTED																				
3	NOT EXTRACTED																				
4	NOT EXTRACTED																				
5	NOT EXTRACTED																				
6	NOT EXTRACTED																				
Extraction of the Charcoal Bed																					
1	9/298 11:12	4b-R6-CHAR-1A																			
1	9/298 11:12	4b-R6-CHAR-1B																			
2	9/298 11:14	4b-R6-CHAR-2A																			
2	9/298 11:14	4b-R6-CHAR-2B																			
3	9/298 11:15	4b-R6-CHAR-3A																			
3	9/298 11:15	4b-R6-CHAR-3B																			
4	9/298 11:16	4b-R6-CHAR-4A																			
4	9/298 11:16	4b-R6-CHAR-4B																			
5	9/298 11:17	4b-R6-CHAR-5A																			
5	9/298 11:17	4b-R6-CHAR-5B																			
6	9/298 11:18	4b-R6-CHAR-6A																			
6	9/298 11:18	4b-R6-CHAR-6B																			
Additional Oxidant Information																					
Flask	Initial MinO4- (mg)	Initial Lead mg/mL or mg/g	Consumed mg @1=24 hrs	Consumed mg/mL or mg/g	AVG (mg/g)																
1	0.0	0.0	0.000	NA	NA																
2	0.0	0.000	NA	NA	NA																
3	4974	10.5	213	0.4																	
4	4978	10.3	90	0.2	0.32																
5	15065	32.1	3693	7.9																	
6	15066	31.8	3226	6.8	7.33																

Prepared by: S.R. Cline

Last Updated: 11/2008

C-193

LastUpdated: 11/3/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Experiment: 4b-R7

For additional comments, RMA Laboratory Research Book

Solid Media	Initial TCE (ppb)	Co-Contaminant?	MnO ₄ - Concs. (%)
NONE	**DNAPL	NO	.01&.1

Experiment Start Date: 8/12/98

Comments:

Per Procedure: Pure TCE added directly into each Reactor/Flask, A Single Spike Solution Could Not Be Prepared

NOTE: All 8/12 & 8/14 final dilutions in GC vials placed under refrigeration to be analyzed 8-17-98.

SPIKE SOLUTION PREPARATION

8/12/98

NA, See Above

Predicted Spike Concentrations

Resulting

Reactor No.	TCE Added (mg)	GW Added (mL)	Aq. Conc (ppb)
1	797.5	400	1,993,750
2	815.1	400	2,037,750
3	807.2	400	2,018,000
4	794.5	400	1,986,250
5	805.5	400	2,013,750
6	807.7	400	2,019,250

NOTE: Aqueous Solubility of TCE is only approx. 1,100 mg/L (1,100,000 ppb)
Thus, some TCE is present in each react as DNAPL

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.		4b-R7	For additional comments, RMAL Laboratory Research Book							
							Sample Data			
Reactor No.	Sample Time	RXN Time (hrs)	Sample Name	Volume GW Used (mL)	Media Type	Solid Mass (grams)	vol (mL) aqueous aliquot	Cum Aliquot Vol (mL)	Actual Vol at Sampling	Actual L/S Ratio
1	8/13/98 8:45	0.0	4B-R7-T0-1A	400	GW Only		20	20	400.0	NA
1	8/13/98 9:15	0.5	4B-R7-T30MIN-1	400	GW Only	0	10	30	380.0	NA
1	8/13/98 10:45	2.0	4B-R7-T2HR-1	400	GW Only	0	10	40	370.0	NA
1	8/13/98 12:45	4.0	4B-R7-T4HR-1	400	GW Only	0	10	50	360.0	NA
1	8/13/98 14:45	6.0	4B-R7-T6HR-1	400	GW Only	0	10	60	350.0	NA
1	8/14/98 7:00	22.2	4B-R7-T20HR-1	400	GW Only	0	10	70	340.0	NA
1	8/14/98 8:45	24.0	4B-R7-T24HR-1A	400	GW Only	0	20	90	330.0	NA
1	8/17/98 8:45	96.0	4B-R7-T96hr	400	GW Only	0	10	100	310.0	NA
2	8/13/98 8:45	0.0	4B-R7-T0-2	400	GW Only		10	10	400.0	NA
2	8/13/98 9:15	0.5	4B-R7-T30MIN-2A	400	GW Only	0	20	30	390.0	NA
2	8/13/98 10:45	2.0	4B-R7-T2HR-2	400	GW Only	0	10	40	370.0	NA
2	8/13/98 12:45	4.0	4B-R7-T4HR-2	400	GW Only	0	10	50	360.0	NA
2	8/13/98 14:45	6.0	4B-R7-T6HR-2	400	GW Only	0	10	60	350.0	NA
2	8/14/98 7:00	22.2	4B-R7-T20HR-2	400	GW Only	0	10	70	340.0	NA
2	8/14/98 8:45	24.0	4B-R7-T24HR-2	400	GW Only	0	10	80	330.0	NA
2	8/17/98 8:45	96.0	4B-R7-T96hr-2a	400	GW Only	0	20	100	320.0	NA

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R7	For additional comments, RMAL Laboratory Research Book					800	Conc (ppm):	
	MnO4- Calb. Slope:	0.046 STOCK Conc. (ppm):					49.5 DF:		
	Calibration Date: 5/5/98								
	MnO4- Data								pH Data
Reactor	Volume	Initial	Aliquot	Final	Final	mg MnO4- Consumed	Cum.	mg MnO4- in Aliquot	pH
No.	Stock MnO4- Added (mL)	MnO4- (mg/L)	MnO4- (mg/L)	Spec DF	MnO4- (mg/L)	in Interval		per mL GW	
1	0	0	NA	NA	NA	NA	NA	NA	8
1	0	0	NA	NA	NA	NA	NA	NA	8
1	0	0	NA	NA	NA	NA	NA	NA	8
1	0	0	NA	NA	NA	NA	NA	NA	8
1	0	0	NA	NA	NA	NA	NA	NA	7.79
1	0	0	NA	NA	NA	NA	NA	NA	7.51
1	0	0	NA	NA	NA	NA	NA	NA	7.36
1	0	0	NA	NA	NA	NA	NA	NA	7.85
2	0	0	NA	NA	NA	NA	NA	NA	8.16
2	0	0	NA	NA	NA	NA	NA	NA	8.22
2	0	0	NA	NA	NA	NA	NA	NA	8.15
2	0	0	NA	NA	NA	NA	NA	NA	8.01
2	0	0	NA	NA	NA	NA	NA	NA	7.8
2	0	0	NA	NA	NA	NA	NA	NA	7.45
2	0	0	NA	NA	NA	NA	NA	NA	7.36
2	0	0	NA	NA	NA	NA	NA	NA	8.04

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4b-R7	For additional comments, RMAL Laboratory Research Book														

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4b-R7	For additional comments, RMAL Laboratory Research Book								
						</					

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R7	For additional comments, RMAL Laboratory Research Book								
MnO4- Calb. Slope:		0.046	STOCK Conc.(ppm):	49.5	DF:		800	Conc (ppm):	39600	
Calibration Date: 5/5/98										
MnO4- Data										pH Data
Reactor No.	Volume Added (mL)	Initial MnO4- (mg/L)	Aliquot MnO4- (mg/L)	Final Spec DF	Final MnO4- (mg/L)	mg MnO4 Consumed in Interval	Cum. mg MnO4 Consumed	Cum. mg MnO4 per mL GW	mg MnO4 in Aliquot	pH
3	0	0	NA	NA	101.3	0.0	0.0	0.00	0.0	8.23
3	1	101.3	0.5	1	0.5	39.4	39.4	0.10	0.0	5.98
3	1	0.5	0.6	1	0.6	0.0	39.4	0.10	0.0	6.01
3	1	0.6	0.3	1	0.3	0.1	39.5	0.10	0.0	5.69
3	1	0.3	0.4	1	0.4	0.0	39.4	0.10	0.0	5.57
3	1	0.4	0.5	1	0.5	0.0	39.4	0.10	0.0	5.86
3	1	0.5	0.3	1	0.3	0.1	39.5	0.10	0.0	5.68
3	1	0.3	0.2	1	0.2	0.0	39.5	0.10	0.0	6.15
4	0	0	NA	NA	101.3	0.0	0.0	0.00	0.0	8.27
4	1	101.3	0.5	1	0.5	39.4	39.4	0.10	0.0	6.01
4	1	0.5	0.6	1	0.6	0.0	39.4	0.10	0.0	5.94
4	1	0.6	0.2	1	0.2	0.1	39.5	0.10	0.0	5.81
4	1	0.2	0.4	1	0.4	-0.1	39.5	0.10	0.0	5.7
4	1	0.4	0.5	1	0.5	0.0	39.4	0.10	0.0	5.96
4	1	0.5	0.2	1	0.2	0.1	39.5	0.10	0.0	5.64
4	1	0.2	0.3	1	0.3	0.0	39.5	0.10	0.0	5.98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R7	For additional comments, RMAL Laboratory Research Book														
Reactor No.	ORNL GC #	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)	Flag	Aq. C/Co	mg TCE Oxidized in Interval	Cum. mg TCE Oxidized	% of Init A TCE Oxidi In Interval	% of Total TCE Oxidi In Interval	Cum % Total TCE Oxidized	mg TCE in Aliquot		
3	1526	1044550		2.73	2.73	1,045,246		1.00	0.0	0.0	0.0%	0.0%	0.0%	10.45		
3	1540	882570		3.01	2.78	956,951		0.92	34.5	34.5	8.3%	4.3%	4.3%	9.57		
3	1554	808923		3.04	2.46	999,315		0.96	-16.1	18.4	-3.9%	-2.0%	2.3%	19.99		
3	1568	963152		3.01	2.82	1,026,489		0.98	-9.8	8.6	-2.3%	-1.2%	1.1%	10.26		
3	1582	992963		2.99	2.93	1,018,366		0.97	3.6	12.1	0.8%	0.4%	1.5%	10.16		
3	1596	1181473		2.97	3.32	1,057,768		1.01	-14.1	-2.0	-3.4%	-1.7%	-0.2%	10.58		
3	1610	1409355		3.08	3.25	1,337,492		1.28	-92.6	-94.6	-22.1%	-11.5%	-11.7%	13.37		
3	1624	1185487		3.02	3.35	1,069,558		1.02	86.0	-8.6	20.6%	10.7%	-1.1%	10.70		
4	1527	1029105		2.82	2.73	1,064,449		1.00	0.0	0.0	0.0%	0.0%	0.0%	10.64		
4	1541	891062		3.02	2.84	947,827		0.89	45.6	45.6	10.7%	5.7%	5.7%	9.48		
4	1555	897705		3.04	2.83	966,935		0.91	-7.3	38.3	-1.7%	-0.9%	4.8%	9.67		
4	1569	1136703		3.00	3.02	1,126,346		1.06	-59.1	-20.8	-13.9%	-7.4%	-2.6%	22.53		
4	1583	954175		3.02	2.74	1,050,377		0.99	26.7	5.8	6.3%	3.4%	0.7%	10.50		
4	1597	1350831		2.98	3.65	1,102,508		1.04	-17.8	-11.9	-4.2%	-2.2%	-1.5%	11.03		
4	1611	1361851		3.09	3.02	1,393,828		1.31	-96.4	-108.4	-22.6%	-12.1%	-13.6%	13.94		
4	1625	1310613		3.02	3.45	1,147,632		1.08	79.0	-29.3	18.6%	9.9%	-3.7%	11.48		

[illegible]

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R7	For additional comments, RMAL Labortory Research Book							
MnO4- Calb. Slope:		0.046	STOCK Conc.(ppm):	49.5	DF:	800	Conc (ppm):	39600	
Calibration Date: 5/5/98									
MnO4- Data									pH Dat
Reactor	Volume	Initial	Aliquot	Final	Final	mg MnO4	Cum.	Cum	mg MnO4-
No.	Stock MnO4- Added (mL)	MnO4- (mg/L)	MnO4- (mg/L)	Spec DF	MnO4- (mg/L)	Consumed in Interval	mg MnO4 Consumed	mg MnO4 per mL GW	pH
5	0	0	NA	NA	990.0	0.0	0.0	0.00	0.0
5	10	990.0	0.4	1	0.40	395.8	395.8	0.99	0.0
5	10	0.4	0.4	1	0.42	0.0	395.8	0.99	0.0
5	10	0.4	0.3	1	0.33	0.0	395.9	0.99	0.0
5	10	0.3	0.5	1	0.47	-0.1	395.8	0.99	0.0
5	10	0.5	0.3	1	0.34	0.0	395.9	0.99	0.0
5	10	0.3	0.3	1	0.27	0.0	395.9	0.99	0.0
5	10	0.3	0.1	1	0.13	0.0	395.9	0.99	0.0
6	0	0	NA	NA	990.00	0.0	0.0	0.00	0.0
6	10	990.0	0.4	1	0.40	395.8	395.8	0.99	0.0
6	10	0.4	0.4	1	0.43	0.0	395.8	0.99	0.0
6	10	0.4	0.3	1	0.34	0.0	395.9	0.99	0.0
6	10	0.3	0.4	1	0.39	0.0	395.8	0.99	0.0
6	10	0.4	0.3	1	0.29	0.0	395.9	0.99	0.0
6	10	0.3	0.3	1	0.28	0.0	395.9	0.99	0.0
6	10	0.3	0.3	1	0.26	0.0	395.9	0.99	0.0

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Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R7	For additional comments, RMAL Laboratory Research Book														
Reactor No.	ORNL GC #	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)	Flag	Aq. C/Co	mg TCE Oxidized in Interval	Cum. mg TCE Oxidized	% of Init A TCE Oxidi In Interval	% of Total TCE Oxidi In Interval	Cum % Total TCE Oxidized	mg TCE in Aliquot		
5	1528	1012182		2.81	2.62	1,087,063		1.00	0.0	0.0	0.0%	0.0%	0.0%	10.87		
5	1542	572884		3.00	3.01	572,417		0.53	205.9	205.9	47.3%	25.6%	25.6%	5.72		
5	1556	543041		3.06	2.61	637,141		0.59	-25.2	180.6	-5.8%	-3.1%	22.4%	6.37		
5	1570	633796		3.01	2.87	664,178		0.61	-10.3	170.3	-2.4%	-1.3%	21.1%	6.64		
5	1584	673605		3.01	2.90	701,209		0.65	-13.7	156.6	-3.2%	-1.7%	19.4%	14.02		
5	1598	981730		2.98	3.41	856,462		0.79	-54.3	102.3	-12.5%	-6.7%	12.7%	8.56		
5	1612	1066664		3.10	3.00	1,102,048		1.01	-83.5	18.8	-19.2%	-10.4%	2.3%	11.02		
5	1626	1081256		3.03	3.47	942,486		0.87	52.7	71.5	12.1%	6.5%	8.9%	9.42		
6	1529	1227748		2.82	3.37	1,026,160		1.00	0.0	0.0	0.0%	0.0%	0.0%	10.26		
6	1543	581220		3.03	3.07	575,215		0.56	180.4	180.4	43.9%	22.3%	22.3%	5.75		
6	1557	617511		3.05	3.09	609,334		0.59	-13.3	167.1	-3.2%	-1.6%	20.7%	6.09		
6	1571	719594		3.00	3.30	654,111		0.64	-17.0	150.1	-4.1%	-2.1%	18.6%	6.54		
6	1585	761699		3.02	3.39	678,956		0.66	-9.2	140.9	-2.2%	-1.1%	17.4%	6.79		
6	1599	942782		2.97	3.16	885,616		0.86	-74.4	66.5	-18.1%	-9.2%	8.2%	17.71		
6	1613	981734		3.09	2.83	1,071,865		1.04	-63.3	3.1	-15.4%	-7.8%	0.4%	10.72		
6	1627	1096497		3.04	3.50	952,265		0.93	39.5	42.6	9.6%	4.9%	5.3%	9.52		

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Exp.		4B-R7	For additional comments, RMAI, Laboratory Research Book										Met M. Cntr. Shpg.	0.004 STOCK Conc (ppm)			49.5 DF	Rec'd Conc (ppm)	10000									
													Calibration Date: 5/5/98															
													pH Data															
Reactive No.	Sample Time	RXN	Sample Time (hrs)	Sample Name	Volume GW Used (mL)	Media Type	Solid Mass (grams)	Vol (mL)	Conc aqueous aliquot	Actual Vol at Sampling	Actual US Ratio	Volume Stock MnO4-	Initial MnO4- (mg/L)	Aliquot MnO4- (mg/L)	Final Spec DF	Final MnO4- (mg/L)	pH	IRN Extract GC # Conc (ppm)	Flag	Hexane Volume (mL)	Aspouost Volume (mL)	Aspouost Conc (ppm)	Flag	#-DIT	AVG (ppb)	STDEV (ppb)		
		Extraction of the Charcoal RMAI																										
1	8/17/98 8:45			4B-R7-CHAR-1A		Charcoal	NA					NA	NA	NA	NA	NA	NT	1637	243		5.06	0.10	0.8845					
1	8/17/98 8:45			4B-R7-CHAR-1B		Charcoal	NA					NA	NA	NA	NA	NA	NT	1637	243		5.06	0.04	0.0012					
2	8/17/98 8:45			4B-R7-CHAR-2A		Charcoal	NA					NA	NA	NA	NA	NA	NT	1639	238		5.10	0.10	0.3151					
2	8/17/98 8:45			4B-R7-CHAR-2B		Charcoal	NA					NA	NA	NA	NA	NA	NT	1639	238		5.07	0.05	0.0012					
3	8/17/98 8:45			4B-R7-CHAR-3A		Charcoal	NA					NA	NA	NA	NA	NA	NT	1640	49098		5.07	0.10	0.2491					
3	8/17/98 8:45			4B-R7-CHAR-3B		Charcoal	NA					NA	NA	NA	NA	NA	NT	1641	237		5.08	0.04	0.0012					
4	8/17/98 8:45			4B-R7-CHAR-4A		Charcoal	NA					NA	NA	NA	NA	NA	NT	1642R	567715		5.08	0.10	2.8859					
4	8/17/98 8:45			4B-R7-CHAR-4B		Charcoal	NA					NA	NA	NA	NA	NA	NT	1643	289		5.12	0.04	0.0015					
5	8/17/98 8:45			4B-R7-CHAR-5A		Charcoal	NA					NA	NA	NA	NA	NA	NT	1644	414003		5.11	0.07	2.1139					
5	8/17/98 8:45			4B-R7-CHAR-5B		Charcoal	NA					NA	NA	NA	NA	NA	NT	1645	445		5.05	0.05	0.0022					
6	8/17/98 8:45			4B-R7-CHAR-6A		Charcoal	NA					NA	NA	NA	NA	NA	NT	1646R	876319		5.08	0.10	4.4360					
6	8/17/98 8:45			4B-R7-CHAR-6B		Charcoal	NA					NA	NA	NA	NA	NA	NT	1647	524		5.05	0.04	0.0028					
Additional Oxidant Information																												
Initial Met M.		Initial Load (mg/mL re)	Consumed (mg/mL re)	mg after 24 hrs	AVG (mg/g)																							
Flask	(mg)	mg/g	NA	NA	NA																							
1	0.00	0.1000	NA	NA	NA																							
2	0.00	0.1000	NA	NA	NA																							
3	39.6	0.10	39.5	0.10	0.10																							
4	39.6	0.10	39.5	0.10	0.10																							
5	396.0	0.99	395.9	0.99	0.99																							
6	396.0	0.99	395.9	0.99	0.99																							

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Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Experiment: 4B-R8

For additional comments, RMAL Labortory Research Book

Solid Media	Initial TCE (ppb)	Co-Contaminant?	MnO4- Concs. (%)
NONE	**DNAPL	NO	1 & 3

Experiment Start Date: 8/12/98

Comments:

Per Procedure: Pure TCE added directly into each Reactor/Flask, A Single Spike Solution Could Not Be Prepared

Note: 4b-R8-5 and 4b-R8-6 produced significant off-gassing during the 1st 30 min check

Note: After T=4hrs, Reactor 4b-R8-3 developed a crack. Contents moved to back-up reactor without orbo tube.

SPIKE SOLUTION PREPARATION

NA, See Above

Predicted Spike Concentrations

Resulting

Reactor No.	TCE Added (mg)	GW Added (mL)	Aq. Conc (ppb)
1	811.7	400	2,029,250
2	805.8	400	2,014,500
3	809.5	400	2,023,750
4	817.1	400	2,042,750
5	805.9	400	2,014,750
6	809.2	400	2,023,000

NOTE: Aqueous Solubility of TCE is only approx. 1,100 mg/L (1,100,000 ppb)
Thus, some TCE is present in each react as DNAPL

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Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4B-R8	For additional comments, RMAL Laboratory Research Book								
MnO4- Calb. Slope:		0.046	STOCK SOLN ABS:	NA	DF:	NA	Conc (ppm):			
Calibration Date: 5/5/98										
MnO4- Data										pH Data
Reactor No.	KMnO4 Added (mg)	Initial MnO4- (mg/L)	Aliquot MnO4- (mg/L)	Final Spec DF	Final MnO4- (mg/L)	mg MnO4- Consumed in Interval	Cum. mg MnO4- Consumed	Cum mg MnO4- per mL GW	mg MnO4- in Aliquot	pH
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.11
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.06
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.03
1	0	0	NA	NA	NA	NA	NA	NA	NA	7.82
1	0	0	NA	NA	NA	NA	NA	NA	NA	7.83
1	0	0	NA	NA	NA	NA	NA	NA	NA	7.32
1	0	0	NA	NA	NA	NA	NA	NA	NA	7.28
1	0	0	NA	NA	NA	NA	NA	NA	NA	7.88
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.12
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.08
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.08
2	0	0	NA	NA	NA	NA	NA	NA	NA	7.85
2	0	0	NA	NA	NA	NA	NA	NA	NA	7.84
2	0	0	NA	NA	NA	NA	NA	NA	NA	7.31
2	0	0	NA	NA	NA	NA	NA	NA	NA	7.35
2	0	0	NA	NA	NA	NA	NA	NA	NA	7.89

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Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4B-R8	For additional comments, RMAL Labortory Research Book														
		</															

C-208

C-209

Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4B-R8	For additional comments, RMAL Laboratory Research Book										Conc (ppm):	
	MnO4- Calb. Slope:	0.046 STOCK SOLN ABS: NA										NA	
	Calibration Date: 5/5/98												
	MnO4- Data											pH Data	
	KMnO4	Initial	Final	Final	Final	Final	Final	Final	Final	Final	Final		
Reactor	Added	MnO4-	MnO4-	Spec	MnO4-	Consumed	MnO4	Cum.	Cum	mg MnO4-	mg MnO4-		
No.	(mg)	(mg/L)	(mg/L)	DF	(mg/L)	in Interval	Consumed	per mL GW				pH	
3	0	0	NA	NA	10301	0	0	0	0.00	0	0	8.12	
3	5334	10301	19	401	7619	1046	1046	1046	2.61	76.2	2.76		
3	5334	7619	19	401	7779	-61	985	985	2.46	155.6	2.78		
3	5334	7779	19	401	7539	87	1072	1072	2.68	75.4	2.65		
3	5334	7539	18	401	7138	140	1212	1212	3.03	71.4	2.57		
3	5334	7138	17	401	6777	123	1335	1335	3.34	67.8	2.71		
3	5334	6777	17	401	6657	40	1374	1374	3.44	66.6	3.08		
3	5334	6657	16	401	6496	51	1426	1426	3.56	65.0	1.9		
4	0	0	NA	NA	10301	0	0	0	0.00	0	8.17		
4	5334	10301	18	401	7298	1171	1171	1171	2.93	73.0	2.69		
4	5334	7298	19	401	7779	-183	988	988	2.47	77.8	2.71		
4	5334	7779	19	401	7619	59	1048	1048	2.62	152.4	2.58		
4	5334	7619	19	401	7419	70	1118	1118	2.79	74.2	2.56		
4	5334	7419	17	401	6857	191	1309	1309	3.27	68.6	2.63		
4	5334	6857	17	401	6657	66	1375	1375	3.44	66.6	2.98		
4	5334	6657	16	401	6336	103	1477	1477	3.69	63.4	1.83		

Prepared by: S.R. Cline

Last Updated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4B-R8	For additional comments, RMAL Laboratory Research Book														
Reactor No.	ORNL GC #	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)	Flag	Aq. C/Co	mg TCE Oxidized in Interval	Cum. mg TCE Oxidized	% of Init A TCE Oxidized In Interval	% of Total TCE Oxidized In Interval	Cum % Total TCE Oxidized	mg TCE in Aliquot		
3	1533	1,082,282		2.62	2.81	1,009,570		1.00	0.0	0.0	0.0%	0.0%	0.0%	10.10		
3	1547	956		3.04	3.19	912		0.00	393.4	393.4	97.4%	48.6%	48.6%	0.01		
3	1561	383		3.07	2.89	407		0.00	0.2	393.6	0.0%	0.0%	48.6%	0.01		
3	1575	243		3.02	3.44	214		0.00	0.1	393.6	0.0%	0.0%	48.6%	0.00		
3	1589	319		3.01	4.13	232		0.00	0.0	393.6	0.0%	0.0%	48.6%	0.00		
3	1603	142		2.98	3.46	122		0.00	0.0	393.7	0.0%	0.0%	48.6%	0.00		
3	1617	0		3.16	2.93	1			0.0	393.7	0.0%	0.0%	48.6%	0.00		
3	1631	0		3.06	3.51	1			0.0	393.7	0.0%	0.0%	48.6%	0.00		
4	1534	1,091,112		2.62	2.79	1,026,943		1.00	0.0	0.0	0.0%	0.0%	0.0%	10.27		
4	1548	1,009		3.03	2.98	1,024		0.00	400.1	400.1	97.4%	49.0%	49.0%	0.01		
4	1562	341		3.05	3.02	345		0.00	0.3	400.4	0.1%	0.0%	49.0%	0.00		
4	1576	200		3.00	3.28	183		0.00	0.1	400.4	0.0%	0.0%	49.0%	0.00		
4	1590	252		2.98	3.54	212		0.00	0.0	400.4	0.0%	0.0%	49.0%	0.00		
4	1604	133		2.97	3.43	115		0.00	0.0	400.4	0.0%	0.0%	49.0%	0.00		
4	1618	56		3.14	3.06	57		0.00	0.0	400.5	0.0%	0.0%	49.0%	0.00		
4	1632	0		3.05	3.39	1		0.00	0.0	400.5	0.0%	0.0%	49.0%	0.00		

Steven Robert Cline:
ND, BUT ENTERED AS 1 PPB FOR
PLOTING LOG SCALE

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Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4B-R8	For additional comments, RMAL Laboratory Research Book								
MnO4- Calb. Slope:		0.046	STOCK SOLN ABS:	NA	DF:	NA	Conc (ppm):			
Calibration Date:	5/5/98									
MnO4- Data									pH Data	
Reactor	KMnO4	Initial	Aliquot	Final	Final	mg MnO4	Cum.	Cum	mg MnO4-	
No.	Added	MnO4-	MnO4-	Spec	MnO4-	Consumed	mg MnO4	mg MnO4	in Aliquot	pH
	(mg)	(mg/L)	(mg/L)	DF	(mg/L)	in Interval	Consumed	per mL GW		
5	0	0	NA	NA	30900	0	0	0.00	0	8.18
5	16000.7	30900	34	801	27314	1399	1399	3.50	273.1	2.89
5	16000.7	27314	35	801	27715	-152	1246	3.12	277.1	2.95
5	16000.7	27715	34	801	27474	89	1335	3.34	274.7	2.84
5	16000.7	27474	34	801	27394	29	1364	3.41	547.9	2.86
5	16000.7	27394	33	801	26673	245	1609	4.02	266.7	2.95
5	16000.7	26673	33	801	26673	0	1609	4.02	266.7	3.36
5	16000.7	26673	33	801	26033	205	1814	4.54	260.3	2.23
6	0	0	NA	NA	30900	0	0	0.00	0	8.15
6	16000.7	30900	34	801	27074	1492	1492	3.73	270.7	2.89
6	16000.7	27074	34	801	27554	-183	1310	3.27	275.5	3.02
6	16000.7	27554	33	801	26353	445	1754	4.39	263.5	2.93
6	16000.7	26353	34	801	27474	-404	1351	3.38	274.7	2.93
6	16000.7	27474	34	801	26834	224	1575	3.94	536.7	2.93
6	16000.7	26834	33	801	26593	79	1654	4.14	265.9	3.36
6	16000.7	26593	33	801	26753	-51	1603	4.01	267.5	2.27

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4B-R8	For additional comments, RMAL Laboratory Research Book											

Steven Robert Cline:
ND, BUT ENTERED AS 1 PPB FOR
PLOTING LOG SCALE

Reg	%Diff	Avg (mph)
	-3.8%	1007.716
	-0.5%	1056.598
	-1.0%	4018.1
	-36.8%	216.1
	14.6%	218.1
	0.0%	1
	-2.0%	1213.18

Steven Robert Chao
 VFO, BUT ENTERED AS 1.00 FOR
 PUTTING LOG SCALE

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Experiment: 4b-R11

For additional comments, RMAL Laboratory Research Book

Solid Media	Initial TCE (ppb)	Co-Contaminant?	MnO4- Concs. (%)
Sludge	10,000	NO	.01 & .1

Experiment Start Date: 6/9/98

Comments:

The spike goal for this experiment in Table 2-7 was originally 100 ppm.

However, it turned out to be approx 40 ppm, but continued with the run, Thus, this is essentially Run 9 in the original Table 2-7.

SPIKE SOLUTION PREPARATION

Prepared a 100 ppm TCE spiking solution in Tedlar bag using 2272.7gm of sparged groundwater and 227.3mL of saturated (1100 ppm) TCE solution. Placed bag in incubator set at 12 C.

GC Analysis of Spike Solution

ORNL GC #	Sample Name	Sample Time	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)
696	4B-R11-TB-A	6/10/98 10:30	42,920		5.04	5.00	43,266
697	4B-R11-TB-B	6/10/98 10:30	41,653		5.07	5.00	42,247

Prepared by: S.R. Cline

Last Updated: 10/22/98

C-217

Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R11	For additional comments, RMAL Laboratory Research Book								
MnO4- Calb. Slope:		0.046	STOCK	Conc.(ppm):	50.1	DF:	800	Conc (ppm):	40080	
Calibration Date: 5/5/98										
MnO4- Data										pH Data
Reactor	Volume	Initial	Aliquot	Final	Final	mg MnO4	Cum.	Cum	mg MnO4-	
No.	Stock MnO4	MnO4-	MnO4-	Spec	MnO4-	Consumed	mg MnO4	mg MnO4	in Aliquot	pH
	Added (mL)	(mg/L)	(mg/L)	DF	(mg/L)	in Interval	Consumed	per gram		
1	0	0	NA	NA	NA	NA	NA	NA	NA	7.98
1	0	0	NA	NA	NA	NA	NA	NA	NA	8
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.01
1	0	0	NA	NA	NA	NA	NA	NA	NA	7.99
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.01
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.07
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.13
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.08
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.1
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.1
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.1
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.11
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.13
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.19

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R11	For additional comments, RMAL Laboratory Research Book															
		</															

Prepared by: S.R. Cline

Last Updated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R11	For additional comments, RMAL Laboratory Research Book								
MnO4- Calb. Slope:		0.046	STOCK	Conc.(ppm):	50.1	DF:	800	Conc (ppm):	40080	
Calibration Date: 5/5/98										
										pH Data
Volume	Initial	Aliquot	Final	Final	mg MnO4	Cum.	Cum	mg MnO4-		
Reactor	Stock MnO4	MnO4-	MnO4-	Spec	MnO4-	Consumed	mg MnO4	mg MnO4	in Aliquot	pH
No.	Added (mL)	(mg/L)	(mg/L)	DF	(mg/L)	in Interval	Consumed	per gram		
3	0	0	NA	NA	102.7	0	0	0	0	7.21
3	0.948	102.7	0.04	1	0.0	38.0	38.0	0.4	0.0	7.13
3	0.948	0.0	0.50	1	0.5	-0.2	37.8	0.4	0.0	7.1
3	0.948	0.5	0.34	1	0.3	0.1	37.9	0.4	0.0	7.11
3	0.948	0.3	0.30	1	0.3	0.0	37.9	0.4	0.0	7.13
3	0.948	0.3	0.99	1	1.0	-0.2	37.7	0.4	0.0	7.2
3	0.948	1.0	0.97	1	1.0	0.0	37.7	0.4	0.0	7.32
4	0	0	NA	NA	102.7	0.0	0.0	0.0	0.0	7.2
4	0.953	102.7	0.27	1	0.3	38.1	38.1	0.4	0.0	7.2
4	0.953	0.3	0.36	1	0.4	0.0	38.1	0.4	0.0	7.16
4	0.953	0.4	0.31	1	0.3	0.0	38.1	0.4	0.0	7.19
4	0.953	0.3	0.25	1	0.3	0.0	38.1	0.4	0.0	7.2
4	0.953	0.3	0.84	1	0.8	-0.2	37.9	0.4	0.0	7.26
4	0.953	0.8	1.03	1	1.0	-0.1	37.9	0.4	0.0	7.39

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R11	For additional comments, RMAL Labortory Research Book												
Reactor No.	ORNL GC #	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)	Flag	Aq. C/Co	mg TCE Oxidized in Interval	Cum. mg TCE Oxidized	% of Init Aq TCE Oxidized In Interval	% of Total TCE Oxidized In Interval	Cum % Total TCE Oxidized	mg TCE in Aliquot
3	700	17,264		3.05	3.49	15,127		1.00	0.0	0.0	0.0%	0.0%	0.0%	0.15
3	707	12,457		3.06	3.39	11,271		0.75	1.4	1.4	24.9%	12.3%	12.3%	0.11
3	714	13,673		3.03	3.73	11,134		0.74	0.0	1.5	0.9%	0.4%	12.8%	0.22
3	721	14,137		3.08	3.52	12,359		0.82	-0.4	1.1	-7.3%	-3.6%	9.2%	0.12
3	728	14,335		3.06	3.61	12,155		0.80	0.1	1.1	1.2%	0.6%	9.7%	0.12
3	735	14,698		3.04	3.48	12,849		0.85	-0.2	0.9	-3.9%	-1.9%	7.8%	0.13
3	742	13,021		3.07	3.15	12,697		0.84	0.0	1.0	0.8%	0.4%	8.2%	0.13
4	701	14,827		3.06	3.22	14,109		1.00	0.0	0.0	0.0%	0.0%	0.0%	0.14
4	708	12,553		3.06	3.47	11,076		0.79	1.1	1.1	21.0%	9.7%	9.7%	0.11
4	715	13,040		3.07	3.73	10,713		0.76	0.1	1.3	2.4%	1.1%	10.8%	0.11
4	722	11,665		3.08	2.97	12,072		0.86	-0.5	0.8	-8.9%	-4.1%	6.7%	0.24
4	729	14,688		3.08	3.85	11,748		0.83	0.1	0.9	2.0%	0.9%	7.6%	0.12
4	736	12,394		3.07	3.43	11,090		0.79	0.2	1.1	3.9%	1.8%	9.5%	0.11
4	743	11,347		3.08	2.93	11,910		0.84	-0.3	0.8	-4.8%	-2.2%	7.3%	0.12

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Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.		4b-R11		For additional comments, RMAL Laboratory Research Book									
MnO4- Calb. Slope:		0.046		STOCK Conc. (ppm):		50.1		DF:		800		Conc (ppm):	40080
Calibration Date: 5/5/98													
MnO4- Conc													pH Data:
Reactor	Volume	Initial	Aliquot	Final	Final	mg MnO4	Cum.	Cum	mg MnO4-				
	Stock MnO4	MnO4-	MnO4-	Spec	MnO4-	Consumed	mg MnO4	mg MnO4	in Aliquot				pH
No.	Added (mL)	(mg/L)	(mg/L)	DF	(mg/L)	in Interval	Consumed	per gram					
5	0	0	NA	NA	1029.6	0.0	0.0	0.0	0.0	0.0	7.11		
5	9.65	1029.6	90.8	2	181.6	318.6	318.6	3.4	1.8	7.08			
5	9.65	181.6	0.0	1	0.0	66.4	384.9	4.1	0.0	7.25			
5	9.65	0.0	0.2	1	0.2	0.0	384.9	4.1	0.0	7.31			
5	9.65	0.2	0.4	1	0.4	-0.1	384.8	4.1	0.0	7.3			
5	9.65	0.4	1.0	1	1.0	-0.2	384.6	4.1	0.0	7.4			
5	9.65	1.0	1.0	1	1.0	0.0	384.6	4.1	0.0	7.52			
6	0	0	NA	NA	1033.9	0.0	0.0	0.0	0.0	7			
6	9.4	1033.9	0.1	1	0.1	376.7	376.7	4.2	0.0	7.02			
6	9.4	0.1	0.1	1	0.1	0.0	376.7	4.2	0.0	7.23			
6	9.4	0.1	0.2	1	0.2	0.0	376.7	4.2	0.0	7.26			
6	9.4	0.2	0.2	1	0.2	0.0	376.7	4.2	0.0	7.28			
6	9.4	0.2	0.8	1	0.8	-0.2	376.5	4.2	0.0	7.38			
6	9.4	0.8	1.1	1	1.1	-0.1	376.4	4.2	0.0	7.55			

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4b-R11	For additional comments, RMAL Laboratory Research Book												
	ORNL	Extract	Flag	Hexane	Aqueous	Aqueous	Flag	Aq.	mg TCE	Cum.	% of Init Aq	% of Total	Cum %	mg TCE	
Reactor	GC #	Conc.		Volume	Volume	Conc.		C/Co	Oxidized	mg TCE	TCE Oxidized	TCE Oxidized	Total TCE	in Aliquot	
No.		(ppb)		(mL)	(mL)	(ppb)			in Interval	Oxidized	In Interval	In Interval	Oxidized		
5	702	15,813		3.04	3.73	12,885		1.00	0.0	0.0	0.0%	0.0%	0.0%	0.13	
5	709	2,670		3.07	3.72	2,198		0.17	4.0	4.0	82.9%	35.0%	35.0%	0.02	
5	716	5,401		3.07	3.56	4,664		0.36	-0.9	3.1	-18.6%	-7.9%	27.2%	0.05	
5	723	6,209		3.08	3.58	5,341		0.41	-0.2	2.9	-5.0%	-2.1%	25.1%	0.05	
5	730	6,141		3.08	3.28	5,758		0.45	-0.1	2.7	-3.0%	-1.3%	23.8%	0.12	
5	737	6,676		3.07	3.13	6,532		0.51	-0.3	2.5	-5.2%	-2.2%	21.6%	0.07	
5	744	7,595		3.08	3.30	7,074		0.55	-0.2	2.3	-3.5%	-1.5%	20.1%	0.07	
6	703	14,399		3.06	3.75	11,739		1.00	0.0	0.0	0.0%	0.0%	0.0%	0.12	
6	710	6,370		3.07	3.50	5,589		0.48	2.2	2.2	52.3%	20.1%	20.1%	0.06	
6	717	8,134		3.07	3.46	7,226		0.62	-0.6	1.7	-13.5%	-5.2%	14.9%	0.07	
6	724	7,967		3.09	3.40	7,247		0.62	0.0	1.7	-0.2%	-0.1%	14.9%	0.07	
6	731	7,105		3.08	2.90	7,552		0.64	-0.1	1.6	-2.4%	-0.9%	13.9%	0.08	
6	738	9,290		3.07	3.15	9,058		0.77	-0.5	1.1	-11.4%	-4.4%	9.6%	0.18	
6	745	17,724		3.08	3.25	16,795		1.43	-2.4	-1.3	-55.0%	-21.2%	-11.6%	0.17	

C-225

Last updated: 11/2008

Prepared by: S.R. Cline

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Experiment: 4b-R12

For additional comments, RMAL Laboratory Research Book

Solid Media	Initial TCE (ppb)	Co-Contaminant?	MnO4- Concs. (%)
Sludge	100,000	NO	1 & 3

Experiment Start Date: 6/16/98

Comments:

SPIKE SOLUTION PREPARATION

Prepared a 100 ppm TCE spiking solution in Tedlar bag using 2222.2 gm of sparged groundwater and 277.8 mL of saturated TCE spiking solution. Contents were analyzed and analysis proved solution concentration average of 60 ppm. Added an additional 375 mL of saturated TCE and let equilibrate overnight at 12 C.

GC Analysis of Spike Solution

ORNL GC #	Sample Name	Sample Time	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)
830	4b-R12-TB-A	6/16/98 8:00	110,301		4.50	5.00	99,285
831	4b-R12-TB-B	6/16/98 8:00	98,512		5.07	4.93	101,296

C-228

Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R12	For additional comments, RMAL Labortory Research Book								
MnO4- Calb. Slope:		0.046	STOCK SOLN ABS:	NA	DF:	NA	Conc (ppm):	NA		
Calibration Date: 5/5/98										
										pH Data
Reactor No.	KMnO4 Added (mg)	Initial MnO4- (mg/L)	Aliquot MnO4- (mg/L)	Spec DF	Final MnO4- (mg/L)	mg MnO4- Consumed in Interval	Cum. mg MnO4- Consumed	Cum mg MnO4- per gram	mg MnO4- in Aliquot	pH
1	0	0	NA	NA	NA	NA	NA	NA	NA	7.88
1	0	0	NA	NA	NA	NA	NA	NA	NA	7.98
1	0	0	NA	NA	NA	NA	NA	NA	NA	7.97
1	0	0	NA	NA	NA	NA	NA	NA	NA	7.96
1	0	0	NA	NA	NA	NA	NA	NA	NA	7.96
1	0	0	NA	NA	NA	NA	NA	NA	NA	7.94
1	0	0	NA	NA	NA	NA	NA	NA	NA	7.94
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.03
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.02
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.01
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.02
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.02
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.04
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.08

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4b-R12	For additional comments, RMAL Laboratory Research Book											

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LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4b-R12	For additional comments, RMAL Labortory Research Book							
	MnO4- Calb. Slope:		0.046	STOCK SOLN ABS:	NA	DF:	NA	Conc (ppm):	NA	
	Calibration Date: 5/5/98									
	MnO4- Data									pH Data
Reactor	KMnO4	Initial	Aliquot	Final	Final	mg MnO4-	Cum.	Cum	mg MnO4-	
No.	Added	MnO4-	MnO4-	Spec	MnO4-	Consumed	mg MnO4-	mg MnO4-	in Aliquot	pH
	(mg)	(mg/L)	(mg/L)	DF	(mg/L)	in Interval	Consumed	per gram		
3	0	0	NA	NA	10224.5	0	0	0	0	6.47
3	4860	10225	8.7	401	3488.7	2411	2411	26	34.9	6.79
3	4860	3489	5.7	401	2265.7	426	2837	31	45.3	6.95
3	4860	2266	9.6	201	1935.6	108	2945	32	19.4	7.03
3	4860	1936	15.4	101	1555.4	121	3066	33	15.6	7.11
3	4860	1555	0.7	1	0.7	479	3545	39	0.0	7.18
3	4860	1	0.1	1	0.1	0	3545	39	0.0	7.2
4	0	0	NA	NA	10223.0	0	0	0	0	6.46
4	4900	10223	6.9	401	2758.9	2695	2695	29	27.6	6.75
4	4900	2759	6.1	401	2462.1	104	2799	30	24.6	6.92
4	4900	2462	10.9	201	2190.9	92	2891	31	43.8	6.99
4	4900	2191	19.9	101	2009.9	58	2949	32	20.1	7
4	4900	2010	21.2	41	869.2	355	3304	36	8.7	7.13
4	4900	869	15.5	41	635.5	70	3374	36	6.4	7.27

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4b-R12	For additional comments, RMAL Labortory Research Book												

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Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R12	For additional comments, RMAL Laboratory Research Book								
MnO4- Calb. Slope:		0.046	STOCK SOLN ABS:	NA	DF:	NA		Conc (ppm):	NA	
Calibration Date:	5/5/98									
MnO4- Data										pH Data
Reactor No.	KMnO4 Added (mg)	Initial MnO4- (mg/L)	Aliquot MnO4- (mg/L)	Final Spec DF	Final MnO4- (mg/L)	mg MnO4- Consumed in Interval	Cum. mg MnO4- Consumed	Cum mg MnO4- per gram	mg MnO4- in Aliquot	pH
5	0	0	NA	NA	30986.7	0	0	0	0	6.41
5	14770	30987	21.4	801	17141.4	4970	4970	54	171.4	6.85
5	14770	17141	17.1	801	13697.1	1202	6173	67	137.0	7.01
5	14770	13697	36.8	401	14756.8	-359	5813	63	147.6	7.12
5	14770	14757	35.1	401	14075.1	224	6038	65	281.5	7.18
5	14770	14075	31.2	401	12511.2	483	6521	71	125.1	7.32
5	14770	12511	28.5	401	11428.5	324	6845	74	114.3	7.49
6	0	0	NA	NA	30938.0	0	0	0	0	6.43
6	14870	30938	17.8	801	14257.8	6038	6038	66	142.6	6.75
6	14870	14258	17.9	801	14337.9	-28	6010	65	143.4	6.92
6	14870	14338	34.6	401	13874.6	158	6168	67	138.7	7
6	14870	13875	33.1	401	13273.1	200	6368	69	132.7	7.06
6	14870	13273	33.4	401	13393.4	-39	6329	69	267.9	7.2
6	14870	13393	33.4	401	13393.4	0	6329	69	133.9	7.35

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R12	For additional comments, RMAL Laboratory Research Book															
Reactor No.	ORNL GC #	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)	Flag	Aq. C/Co	mg TCE Oxidized in Interval	Cum. mg TCE Oxidized	% of Init A TCE Oxidi In Interval	% of Total TCE Oxidi In Interval	Cum % Total TCE Oxidized	mg TCE in Aliquot			
5	836R	63,111		3.08	4.06	47,873		1.00	0.0	0.0	0.0%	0.0%	0.0%	0.48			
5	843	244		3.09	3.96	190		0.00	17.1	17.1	96.9%	57.6%	57.6%	0.00			
5	850	353		3.08	4.02	270		0.01	0.0	17.1	-0.2%	-0.1%	57.5%	0.00			
5	857	283		3.07	3.96	219			0.0	17.1	0.1%	0.1%	57.5%	0.00			
5	864	110	U	3.07	2.90	116	U		0.0	17.1	0.2%	0.1%	57.7%	0.00			
5	871	168		3.10	4.34	120			0.0	17.1	0.0%	0.0%	57.7%	0.00			
5	878	96	U	3.14	3.50	87	U		0.0	17.2	0.1%	0.0%	57.7%	0.00			
6	837R	64,633		3.09	3.89	51,301		1.00	0.0	0.0	0.0%	0.0%	0.0%	0.51			
6	844	264		3.10	3.92	209		0.00	18.5	18.5	96.9%	61.7%	61.7%	0.00			
6	851	242		3.06	4.10	181		0.00	0.0	18.5	0.1%	0.0%	61.7%	0.00			
6	858	272		3.07	3.88	215		0.00	0.0	18.5	-0.1%	0.0%	61.7%	0.00			
6	865	106	U	3.05	4.49	72	U	0.00	0.0	18.5	0.2%	0.2%	61.9%	0.00			
6	872	117	U	3.09	4.32	83	U	0.00	0.0	18.5	0.0%	0.0%	61.9%	0.00			
6	879	116	U	3.13	3.61	101	U	0.00	0.0	18.5	0.0%	0.0%	61.8%	0.00			

Steven Robert Cline:
Attempted to redilute unsecessfully

C-237

Prepared by: S.R. Cline

LastUpdated: 11/3/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Experiment: 4b-R13

For additional comments, RMAL Laboratory Research Book

Solid Media	Initial TCE (ppb)	Co-Contaminant?	MnO4- Concs. (%)
Sludge	**DNAPL	NO	.01&.1

Experiment Start Date: 7/14/98

Comments:

Per Procedure: Pure TCE added directly into each Reactor/Flask, A Single Spike Solution Could Not Be Prepared

SPIKE SOLUTION PREPARATION

NA, See Above

Predicted Spike Concentrations

Resulting

Reactor No.	TCE Added (mg)	GW Added (mL)	Aq. Conc (ppb)
1	750.6	360	2,085,000
2	726.6	362	2,007,182
3	736.4	367	2,006,540
4	721.3	362	1,992,541
5	727.6	368	1,977,174
6	725.3	360	2,014,722

NOTE: Aqueous Solubility of TCE is only approx. 1,100 mg/L (1,100,000 ppb)
Thus, some TCE is present in each react as DNAPL

Prepared by: S.R. Cline

Last Updated: 10/22/98

C-239

Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R13	For additional comments, RMAL Labortory Research Book								
MnO4- Calb. Slope:		0.046	STOCK Conc.(ppm):	49.8	DF:		800	Conc (ppm):	39840	
Calibration Date: 5/5/98										
MnO4- Data										pH Data
Reactor No.	Volume Added (mL)	Initial MnO4- (mg/L)	Aliquot MnO4- (mg/L)	Final Spec DF	Final MnO4- (mg/L)	mg MnO4- Consumed in Interval	Cum. mg MnO4- Consumed	Cum mg MnO4- per gram	mg MnO4- in Aliquot	pH
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.25
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.1
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.01
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.12
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.03
1	0	0	NA	NA	NA	NA	NA	NA	NA	8
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.14
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.27
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.26
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.16
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.13
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.14
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.13
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.15
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.29

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R13	For additional comments, RMAL Labortory Research Book												
						57,217								
Reactor No.	ORNL GC #	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)	Flag	Aq. C/Co	mg TCE Oxidized in Interval	Cum. mg TCE Oxidized	% of Init A TCE Oxidi In Interval	% of Total TCE Oxidi In Interval	Cum % Total TCE Oxidized	mg TCE in Aliquot
1	1105	1564799		3.08	3.61	1,334,621		NA	NA	NA	NA	NA	NA	26.69
1	1119	1393518		3.07	3.34	1,280,244		NA	NA	NA	NA	NA	NA	12.80
1	1133	1254883		3.07	3.04	1,267,975		NA	NA	NA	NA	NA	NA	12.68
1	1147	1285923		3.12	3.10	1,295,554		NA	NA	NA	NA	NA	NA	12.96
1	1161	1162801		3.11	3.08	1,173,213		NA	NA	NA	NA	NA	NA	11.73
1	1175	1391448		3.10	3.55	1,214,907		NA	NA	NA	NA	NA	NA	12.15
1	1189	1377764		3.09	3.22	1,320,584		NA	NA	NA	NA	NA	NA	26.41
1	1203	1274431		3.08	3.29	1,193,341		NA	NA	NA	NA	NA	NA	11.93
2	1106	1599413		3.07	3.81	1,289,274		NA	NA	NA	NA	NA	NA	12.89
2	1120	1349734		3.07	3.16	1,313,104		NA	NA	NA	NA	NA	NA	26.26
2	1134	1343460		3.07	3.21	1,285,942		NA	NA	NA	NA	NA	NA	12.86
2	1148	1169203		3.12	3.06	1,192,213		NA	NA	NA	NA	NA	NA	11.92
2	1162	1081026		3.13	2.96	1,145,103		NA	NA	NA	NA	NA	NA	11.45
2	1176	1199899		3.11	3.07	1,214,189		NA	NA	NA	NA	NA	NA	12.14
2	1190	1271064		3.08	3.20	1,225,489		NA	NA	NA	NA	NA	NA	12.25
2	1204	1161823		3.10	2.93	1,232,718		NA	NA	NA	NA	NA	NA	24.65

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Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R13	For additional comments, RMAL Laboratory Research Book							
MnO4- Calb. Slope:		0.046	STOCK Conc.(ppm):		49.8	DF:		800	Conc (ppm):
Calibration Date: 5/5/98									
Reactor No.	Volume	Initial MnO4- (mg/L)	Aliquot MnO4- (mg/L)	Final Spec DF	Final MnO4- (mg/L)	mg MnO4- Consumed in Interval	Cum. mg MnO4- Consumed per gram	mg MnO4- in Aliquot	pH
3	0	0	NA	NA	102.2	0.0	0.0	0.0	6.58
3	0.918	102.2	1.90	1	1.9	35.9	35.9	0.4	6.53
3	0.918	1.9	2.10	1	2.1	-0.1	35.8	0.4	6.51
3	0.918	2.1	2.27	1	2.3	-0.1	35.8	0.4	6.47
3	0.918	2.3	2.41	1	2.4	0.0	35.7	0.4	6.61
3	0.918	2.4	2.72	1	2.7	-0.1	35.6	0.4	6.81
3	0.918	2.7	2.74	1	2.7	0.0	35.6	0.4	6.81
3	0.918	2.7	4.92	1	4.9	-0.6	35.0	0.4	6.93
4	0	0	NA	NA	102.2	0.0	0.0	0.0	6.62
4	0.905	102.2	1.70	1	1.7	35.5	35.5	0.4	6.66
4	0.905	1.7	1.88	1	1.9	-0.1	35.4	0.4	6.64
4	0.905	1.9	2.00	1	2.0	0.0	35.4	0.4	6.65
4	0.905	2.0	2.19	1	2.2	-0.1	35.3	0.4	6.73
4	0.905	2.2	2.50	1	2.5	-0.1	35.2	0.4	6.8
4	0.905	2.5	2.43	1	2.4	0.0	35.2	0.4	6.77
4	0.905	2.4	3.89	1	3.9	-0.4	34.8	0.4	7.13

Prepared by: S.R. Cline

Last Updated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R13	For additional comments, RMAL Labortory Research Book													
							57,217								
	ORNL	Extract	Flag	Hexane	Aqueous	Aqueous	Flag	Aq.	mg TCE	Cum.	% of Init A	% of Total	Cum %	mg TCE	
Reactor	GC #	Conc.		Volume	Volume	Conc.		C/Co	Oxidized	mg TCE	TCE Oxidi	TCE Oxidi	Total TCE	in Aliquot	
No.		(ppb)		(mL)	(mL)	(ppb)			in Interval	Oxidized	In Interval	In Interval	Oxidized		
3	1107	806012		3.08	3.56	697,355		1.00	0.0	0.0	0.0%	0.0%	0.0%	6.97	
3	1121	709234		3.07	3.10	701,608		1.01	-1.5	-1.5	-0.6%	-0.2%	-0.2%	7.02	
3	1135	722145		3.09	2.97	749,934		1.08	-16.8	-18.3	-6.6%	-2.3%	-2.5%	15.00	
3	1149	876862		3.12	3.64	751,840		1.08	-0.6	-19.0	-0.2%	-0.1%	-2.6%	7.52	
3	1163	844639		3.13	3.38	782,642		1.12	-9.8	-28.8	-3.8%	-1.3%	-3.9%	7.83	
3	1177	937410		3.10	3.39	856,547		1.23	-22.8	-51.5	-8.9%	-3.1%	-7.0%	8.57	
3	1191	1385474		3.09	3.04	1,405,217		2.02	-163.5	-215.0	-63.9%	-22.2%	-29.2%	14.05	
3	1205	1608422		3.07	3.41	1,446,770		2.07	-11.9	-226.9	-4.7%	-1.6%	-30.8%	14.47	
4	1108	848822		3.08	3.55	734,600		1.00	0.0	0.0	0.0%	0.0%	0.0%	7.35	
4	1122	708856		3.06	3.05	711,435		0.97	8.2	8.2	3.1%	1.1%	1.1%	7.11	
4	1136	810402		3.07	3.43	727,050		0.99	-5.4	2.8	-2.0%	-0.7%	0.4%	7.27	
4	1150	643995		3.12	2.85	704,974		0.96	7.3	10.2	2.8%	1.0%	1.4%	14.10	
4	1164	900853		3.10	3.27	853,081		1.16	-46.3	-36.2	-17.4%	-6.4%	-5.0%	8.53	
4	1178	1003837		3.10	3.40	914,009		1.24	-18.5	-54.6	-6.9%	-2.6%	-7.6%	9.14	
4	1192	1270231		3.08	3.04	1,288,546		1.75	-109.7	-164.3	-41.3%	-15.2%	-22.8%	12.89	
4	1206	1646610		3.09	3.26	1,557,951		2.12	-76.0	-240.3	-28.6%	-10.5%	-33.3%	15.58	

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Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R13	For additional comments, RMAL Laboratory Research Book								
MnO4- Calb. Slope:		0.046	STOCK Conc.(ppm):	49.8	DF:		800	Conc (ppm):	39840	
Calibration Date: 5/5/98										
MnO4- Data										pH Data
Reactor	Volume	Initial	Aliquot	Final	Final	mg MnO4	Cum.	Cum	mg MnO4	
No.	Stock MnO4- Added (mL)	MnO4- (mg/L)	MnO4- (mg/L)	Spec DF	MnO4- (mg/L)	Consumed in Interval	mg MnO4 Consumed	mg MnO4 per gram	in Aliquot	pH
5	0	0	NA	NA	998.2	0.0	0.0	0.0	0.0	6.51
5	9.2	998.2	1.0	1	1.0	366.2	366.2	4.0	0.0	6.44
5	9.2	1.0	1.4	1	1.4	-0.2	366.0	4.0	0.0	6.51
5	9.2	1.4	1.6	1	1.6	0.0	366.0	4.0	0.0	6.51
5	9.2	1.6	1.7	1	1.7	0.0	365.9	4.0	0.0	6.66
5	9.2	1.7	2.1	1	2.1	-0.1	365.8	4.0	0.0	6.8
5	9.2	2.1	2.0	1	2.0	0.0	365.8	4.0	0.0	6.72
5	9.2	2.0	4.8	1	4.8	-0.8	365.0	4.0	0.0	7.08
6	0	0	NA	NA	998.8	0.0	0.0	0.0	0.0	7.35
6	9	998.8	0.6	1	0.6	358.4	358.4	4.0	0.0	6.48
6	9	0.6	0.6	1	0.6	0.0	358.4	4.0	0.0	6.8
6	9	0.6	0.5	1	0.5	0.0	358.4	4.0	0.0	6.86
6	9	0.5	0.5	1	0.5	0.0	358.4	4.0	0.0	7.01
6	9	0.5	0.7	1	0.7	-0.1	358.3	4.0	0.0	7.17
6	9	0.7	0.6	1	0.6	0.0	358.3	4.0	0.0	7.13
6	9	0.6	1.1	1	1.1	-0.1	358.2	4.0	0.0	7.68

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Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R13	For additional comments, RMAL Laboratory Research Book												
						57,217								
Reactor No.	ORNL GC #	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)	Flag	Aq. C/Co	mg TCE Oxidized in Interval	Cum. mg TCE Oxidized	% of Init A TCE Oxidi In Interval	% of Total TCE Oxidi In Interval	Cum % Total TCE Oxidized	mg TCE in Aliquot
5	1109	723485		3.07	3.63	611,714		1.00	0.0	0.0	0.0%	0.0%	0.0%	6.12
5	1123	461589		3.07	3.07	461,926		0.76	55.0	55.0	24.4%	7.6%	7.6%	4.62
5	1137	494215		3.08	2.81	542,095		0.89	-28.6	26.4	-12.7%	-3.9%	3.6%	5.42
5	1151	468831		3.13	3.73	393,665		0.64	51.5	77.9	22.9%	7.1%	10.7%	3.94
5	1165	598585		3.13	2.98	629,833		1.03	-79.6	-1.7	-35.4%	-10.9%	-0.2%	12.60
5	1179	661657		3.10	3.12	656,673		1.07	-8.5	-10.2	-3.8%	-1.2%	-1.4%	6.57
5	1193	779813		3.09	3.03	796,150		1.30	-42.8	-53.1	-19.0%	-5.9%	-7.3%	7.96
5	1207	1349138		3.10	3.58	1,167,351		1.91	-106.9	-160.0	-47.5%	-14.7%	-22.0%	11.67
6	1110	754116		3.09	3.79	614,249		1.00	0.0	0.0	0.0%	0.0%	0.0%	6.14
6	1124	356152		3.09	3.14	350,807		0.57	94.6	94.6	42.8%	13.0%	13.0%	3.51
6	1138	482759		3.07	3.36	440,700		0.72	-31.4	63.2	-14.2%	-4.3%	8.7%	4.41
6	1152	521458		3.13	3.65	447,399		0.73	-2.3	60.9	-1.0%	-0.3%	8.4%	4.47
6	1166	542263		3.12	3.43	492,918		0.80	-15.0	46.0	-6.8%	-2.1%	6.3%	4.93
6	1180	629866		3.10	3.37	579,007		0.94	-27.5	18.5	-12.4%	-3.8%	2.5%	11.58
6	1194	610815		3.10	3.32	570,921		0.93	2.4	20.9	1.1%	0.3%	2.9%	5.71
6	1208	1344166		3.09	3.26	1,274,446		2.07	-197.0	-176.1	-89.1%	-27.2%	-24.3%	12.74

[illegible]

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Experiment: 4B-R14

For additional comments, RMAL Laboratory Research Book

Solid Media	Initial TCE (ppb)	Co-Contaminant?	MnO4- Concs. (%)
Sludge	**DNAPL	NO	1 & 3

Experiment Start Date: 7/14/98

Comments:

Per Procedure: Pure TCE added directly into each Reactor/Flask, A Single Spike Solution Could Not Be Prepared

SPIKE SOLUTION PREPARATION

NA, See Above

Predicted Spike Concentrations

Resulting

Reactor No.	TCE Added (mg)	GW Added (mL)	Aq. Conc (ppb)
1	734.1	360	2,039,167
2	791	360	2,197,222
3	735.8	363	2,026,997
4	717.8	367	1,955,858
5	719.6	366	1,966,120
6	734	365	2,010,959

NOTE: Aqueous Solubility of TCE is only approx. 1,100 mg/L (1,100,000 ppb)
Thus, some TCE is present in each react as DNAPL

C-249

C-250

Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4B-R14	For additional comments, RMAL Labortory Research Book								
	MnO4- Calb. Slope:		0.046	STOCK SOLN ABS:	NA	DF:	NA	Conc (ppm):	NA		
	Calibration Date: 5/5/98										
	MnO4- Data										pH Dat
	KMnO4	Initial	Aliquot	Final	Final	mg MnO4	Cum.	Cum	mg MnO4-		
Reactor	Added	MnO4-	MnO4-	Spec	MnO4-	Consumed	mg MnO4	mg MnO4	in Aliquot	pH	
No.	(mg)	(mg/L)	(mg/L)	DF	(mg/L)	in Interval	Consumed	per gram			
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.05	
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.2	
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.14	
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.01	
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.21	
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.13	
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.06	
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.08	
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.21	
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.21	
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.15	
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.07	
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.18	
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.17	
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.12	
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.23	

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4B-R14	For additional comments, RMAL Laboratory Research Book												

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Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4B-R14	For additional comments, RMAL Laboratory Research Book												
</															

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Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4B-R14	For additional comments, RMAL Laboratory Research Book							
	MnO4- Calb. Slope:		0.046	STOCK SOLN ABS:	NA	DF:	NA	Conc (ppm):	NA	
	Calibration Date: 5/5/98									
	MnO4- Data									pH Data
Reactor	KMnO4	Initial	Aliquot	Final	Final	mg MnO4	Cum.	Cum	mg MnO4-	
No.	Added	MnO4-	MnO4-	Spec	MnO4-	Consumed	mg MnO4	mg MnO4	in Aliquot	pH
	(mg)	(mg/L)	(mg/L)	DF	(mg/L)	in Interval	Consumed	per gram		
5	0	0	NA	NA	30976	0	0	0	0	6.73
5	14641.6	30976	17	801	13697	6151	6151	67	137.0	6.24
5	14641.6	13697	36	401	14356	-228	5923	65	143.6	6.4
5	14641.6	14356	35	401	14035	108	6031	66	140.4	6.46
5	14641.6	14035	39	401	15519	-484	5548	61	310.4	6.74
5	14641.6	15519	32	401	12792	834	6382	70	127.9	6.82
5	14641.6	12792	31	401	12471	95	6477	71	124.7	6.83
5	14641.6	12471	43	161	6987	1568	8045	88	69.9	7.14
6	0	0	NA	NA	30979	0	0	0	0	6.63
6	14602	30979	29	801	23549	2638	2638	29	235.5	6.29
6	14602	23549	53	401	21373	751	3388	37	213.7	6.47
6	14602	21373	49	401	19609	591	3980	44	196.1	6.53
6	14602	19609	41	401	16281	1082	5061	55	162.8	6.72
6	14602	16281	29	401	11509	1503	6564	72	230.2	6.83
6	14602	11509	26	401	10266	367	6931	76	102.7	6.84
6	14602	10266	18	161	2946	2086	9017	99	29.5	7.15

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4B-R14	For additional comments, RMAL Laboratory Research Book												
	ORNL	Extract	Flag	Hexane	Aqueous	Aqueous	Flag	Aq.	mg TCE	Cum.	% of Init A	% of Total	Cum %	mg TCE	
Reactor	GC #	Conc.		Volume	Volume	Conc.		C/Co	Oxidized	mg TCE	TCE Oxidi	TCE Oxidi	Total TCE	in Aliquot	
No.		(ppb)		(mL)	(mL)	(ppb)			in Interval	Oxidized	In Interval	In Interval	Oxidized		
5	1102	904,795		3.08	3.76	741,037		1.00	0.0	0.0	0.0%	0.0%	0.0%	7.41	
5	1116R	500	U	3.07	2.88	532	U	0.00	263.6	263.6	97.2%	36.6%	36.6%	0.01	
5	1130R	500	U	3.06	3.34	458	U	0.00	0.0	263.6	0.0%	0.0%	36.6%	0.00	
5	1144R	500	U	3.10	3.61	429	U	0.00	0.0	263.7	0.0%	0.0%	36.6%	0.00	
5	1158R	500	U	3.11	3.27	476	U	0.00	0.0	263.6	0.0%	0.0%	36.6%	0.01	
5	1172R	500	U	3.09	3.32	466	U	0.00	0.0	263.6	0.0%	0.0%	36.6%	0.00	
5	1186R	500	U	3.08	3.01	511	U	0.00	0.0	263.6	0.0%	0.0%	36.6%	0.01	
5	1200	0	U	3.06	4.34	1	U	0.00	0.1	263.8	0.1%	0.0%	36.7%	0.00	
6	1103	886,009		3.07	3.56	765,114		1.00	0.0	0.0	0.0%	0.0%	0.0%	7.65	
6	1117	10,434	U	3.06	3.42	9,326	U	0.01	268.3	268.3	96.1%	36.6%	36.6%	0.09	
6	1131R	500	U	3.05	3.66	417	U	0.00	3.1	271.4	1.1%	0.4%	37.0%	0.00	
6	1145R	500	U	3.10	3.76	412	U		0	271.4	0.0%	0.0%	37.0%	0.00	
6	1159R	500	U	3.13	3.28	478	U		0	271.4	0.0%	0.0%	37.0%	0.00	
6	1173R	500	U	3.10	3.59	432	U		0	271.4	0.0%	0.0%	37.0%	0.01	
6	1187R	500	U	3.09	3.34	464	U	0.00	0.0	271.4	0.0%	0.0%	37.0%	0.00	
6	1201	0	U	3.08	4.55	1	U	0.00	0.1	271.5	0.0%	0.0%	37.0%	0.00	

Steven Robert Cline:
ND, BUT ENTERED AS 1 PPB
FOR PLOTTING LOG SCALE

LastUpdated: 11/1/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Experiment: 4b-R15

For additional comments, RMAL Laboratory Research Book

Solid Media	Initial TCE (ppb)	Co-Contaminant?	MnO4- Concs. (%)
Sludge	10,000	NO	1 & 3

Experiment Start Date: 6/22/98

Comments:

Immediately prior to T=0:

Due to crack in reaction vessel 4b-R15-4, sample transferred to new reaction vessel without stopcock assembly. (stopper only)

SPIKE SOLUTION PREPARATION

6/22/98

Prepared a 10 ppm TCE spiking solution in Tedlar bag using 2460.0 gm of sparged groundwater and and 40.0 mL of saturated TCE spiking solution.

GC Analysis of Spike Solution

ORNL GC #	Sample Name	Sample Time	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)
897	4B-R15-TB-A	6/23/98 7:30	8,816		5.13	4.89	9,245
898	4B-R15-TB-B	6/23/98 7:30	8,763		5.10	4.91	9,114

Prepared by: S.R. Cline

Last Updated: 10/22/98

C-261

Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.		4b-R15	For additional comments, RMAL Laboratory Research Book								
MnO4- Calb. Slope:		0.046	STOCK SOLN ABS:		NA	DF:	NA	Conc (ppm):		NA	
Calibration Date: 5/5/98										pH Data	
MnO4- Data											
Reactor No.	KMnO4 Added (mg)	Initial MnO4- (mg/L)	Aliquot MnO4- (mg/L)	Final Spec DF	Final MnO4- (mg/L)	mg MnO4 Consumed in Interval	Cum. mg MnO4 Consumed	Cum mg MnO4 per gram	mg MnO4- in Aliquot	pH	
1	0	0	NA	NA	NA	NA	NA	NA	NA	7.97	
1	0	0	NA	NA	NA	NA	NA	NA	NA	7.93	
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.05	
1	0	0	NA	NA	NA	NA	NA	NA	NA	7.98	
1	0	0	NA	NA	NA	NA	NA	NA	NA	7.95	
1	0	0	NA	NA	NA	NA	NA	NA	NA	7.96	
1	0	0	NA	NA	NA	NA	NA	NA	NA	7.93	
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.07	
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.07	
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.06	
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.06	
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.02	
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.01	
2	0	0	NA	NA	NA	NA	NA	NA	NA	8	

C-262

Prepared by: S.R. Cline

LastUpdated: 10/23/98

C-263

Prepared by: S.R. Cline

LastUpdated: 10/23/98

C-264

Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R15	For additional comments, RMAL Laboratory Research Book								
MnO4- Calb. Slope:		0.046	STOCK SOLN ABS:	NA	DF:	NA	Conc (ppm):	NA		
Calibration Date: 5/5/98										
MnO4- Data										pH Data
Reactor	KMnO4	Initial	Aliquot	Final	Final	mg MnO4	Cum.	Cum	mg MnO4-	
No.	Added	MnO4-	MnO4-	Spec	MnO4-	Consumed	mg MnO4	mg MnO4	in Aliquot	pH
	(mg)	(mg/L)	(mg/L)	DF	(mg/L)	in Interval	Consumed	per gram		
3	0	0	NA	NA	10219	0	0	0	0	6.6
3	4890	10219	17.9	401	7178	1096	1096	12	71.8	6.84
3	4890	7178	22.3	201	4482	945	2041	22	89.6	7.06
3	4890	4482	15.9	201	3196	425	2466	27	32.0	7.12
3	4890	3196	23.3	101	2353	270	2736	30	23.5	7.14
3	4890	2353	35.2	9	317	632	3368	37	3.2	7.24
3	4890	317	48.1	4	192	37	3405	37	1.9	7.4
4	0	0	NA	NA	10220	0	0	0	0	6.67
4	4820	10220	7.0	401	2807	2633	2633	29	28.1	6.94
4	4820	2807	15.8	201	3176	-127	2506	27	31.8	7.13
4	4820	3176	13.5	201	2714	155	2661	29	54.3	7.21
4	4820	2714	27.4	101	2767	-17	2644	29	27.7	7.24
4	4820	2767	13.0	81	1053	523	3167	35	10.5	7.3
4	4820	1053	22.6	41	927	37	3204	35	9.3	7.39

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R15	For additional comments, RMAL Laboratory Research Book															
Reactor No.	ORNL	Extract	Flag	Hexane	Aqueous	Aqueous	Fla	Aq.	mg TCE	Cum.	% of Init A	% of Total	Cum	%	mg TCE		
	GC #	Conc.		Volume	Volume	Conc.		C/Co	Oxidized	mg TCE	TCE Oxidi	TCE Oxidi	Total TCE	%	in Aliquot		
3	901R	5,303		3.03	3.45	4,663		1.00	0.0	0.0	0.0%	0.0%	0.0%	0.0%	0.05		
3	908	16		3.05	3.77	13		0.00	1.7	1.7	97.0%	57.7%	57.7%	0.0%	0.00		
3	915	7		3.06	3.82	5		0.00	0.0	1.7	0.2%	0.1%	57.8%	0.0%	0.00		
3	922	10		3.08	3.39	9		0.00	0.0	1.7	-0.1%	0.0%	57.8%	0.0%	0.00		
3	929	6 U		3.07	3.63	5 U		0.00	0.0	1.7	0.1%	0.0%	57.8%	0.0%	0.00		
3	936	6		3.08	3.87	5		0.00	0.0	1.7	0.0%	0.0%	57.8%	0.0%	0.00		
3	943	9		3.04	3.34	8		0.00	0.0	1.7	-0.1%	0.0%	57.8%	0.0%	0.00		
4	902R	4,752		3.06	3.75	3,880		1.00	0.0	0.0	0.0%	0.0%	0.0%	0.0%	0.04		
4	909	11		3.06	4.16	8		0.00	1.4	1.4	97.1%	48.0%	48.0%	0.0%	0.00		
4	916	0		3.07	3.86	1		0.00	0.0	1.4	0.2%	0.1%	48.1%	0.0%	0.00		
4	923	5 U		3.08	2.87	6 U		0.00	0.0	1.4	-0.1%	-0.1%	48.1%	0.0%	0.00		
4	930	0		3.05	3.87	1		0.00	0.0	1.4	0.1%	0.1%	48.1%	0.0%	0.00		
4	937	0		3.08	3.37	1		0.00	0.0	1.4	0.0%	0.0%	48.1%	0.0%	0.00		
4	944	6 U		3.07	3.71	5 U		0.00	0.0	1.4	-0.1%	0.0%	48.1%	0.0%	0.00		

Steven Robert Cline:
ND, BUT ENTERED AS 1 PPB
FOR PLOTTING LOG SCALE

C-267

Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4b-R15	For additional comments, RMAL Labortory Research Book							
	MnO4- Calb. Slope:		0.046	STOCK SOLN ABS:	NA	DF:	NA	Conc (ppm):	NA	
	Calibration Date: 5/5/98									
	MnO4- Data									pH Data
Reactor No.	KMnO4 Added (mg)	Initial MnO4- (mg/L)	Aliquot MnO4- (mg/L)	Final Spec DF	Final MnO4- (mg/L)	mg MnO4 Consumed in Interval	Cum. mg MnO4 Consumed	Cum mg MnO4 per gram	mg MnO4 in Aliquot	pH
5	0	0	NA	NA	30982	0	0	0	0	6.55
5	14640	30982	19.1	801	15299	5581	5581	61	153.0	7
5	14640	15299	37.0	401	14837	160	5741	63	148.4	7.21
5	14640	14837	33.8	401	13554	431	6172	67	135.5	7.28
5	14640	13554	30.8	401	12351	392	6564	72	247.0	7.33
5	14640	12351	31.7	401	12712	-110	6454	70	127.1	7.49
5	14640	12712	31.2	401	12511	59	6513	71	125.1	7.62
6	0	0	NA	NA	30955	0	0	0	0	6.56
6	14800	30955	19.0	801	15219	5666	5666	62	152.2	7
6	14800	15219	38.9	401	15599	-133	5533	60	156.0	7.22
6	14800	15599	39.3	401	15759	-55	5479	60	157.6	7.22
6	14800	15759	40.0	401	16040	-93	5386	59	160.4	7.27
6	14800	16040	37.3	401	14957	347	5733	62	299.1	7.4
6	14800	14957	37.3	401	14957	0	5733	62	149.6	7.56

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Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4b-R15	For additional comments, RMAL Laboratory Research Book															
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Prepared by: S.R. Cline

LastUpdated: 11/3/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Experiment: 4b-R16

For additional comments, RMAL Laboratory Research Book

Solid Media	Initial TCE (ppb)	Co-Contaminant?	MnO4- Conc. (%)
Sludge	100,000	NO	.01 & .1

Experiment Start Date: 7/6/98

Comments:

SPIKE SOLUTION PREPARATION

7/6/98

Prepared a 100 ppm TCE spiking solution in Tedlar bag using 2100gm of sparged groundwater and 400mL of saturated (1100 ppm) TCE solution. Placed bag in incubator set at 12 C.

Analysis of spiking solution prepared on 7-6-98 found 80ppm TCE. 25uL of pure-phase TCE added to solution.

Placed bag in incubator set at 12 C.

GC Analysis of Spike Solution

ORNL GC #	Sample Name	Sample Time	Extract Conc. (ppb)	Flag	Hexane Volume (mL)	Aqueous Volume (mL)	Aqueous Conc. (ppb)
962	4B-R16-TB-A	7/8/98 7:40	90,127		5.10	5.00	91,984
963	4B-R16-TB-B	7/8/98 7:40	85,604		5.10	4.91	88,981

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Prepared by: S.R. Cline

LastUpdated: 10/22/98

C-272

Prepared by: S.R. Cline

LastUpdated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R16	For additional comments, RMAL Laboratory Research Book								
MnO4- Calb. Slope:		0.046	STOCK	Conc.(ppm):	49.6	DF:	800	Conc (ppm):	39680	
Calibration Date:	5/5/98									
MnO4- Data										pH Data
Reactor No.	Volume Stock MnO4- Added (mL)	Initial MnO4- (mg/L)	Aliquot MnO4- (mg/L)	Final Spec DF	Final MnO4- (mg/L)	mg MnO4- Consumed in Interval	Cum. mg MnO4- Consumed	Cum mg MnO4- per gram	mg MnO4- in Aliquot	pH
1	0	0	NA	NA	NA	NA	NA	NA	NA	8
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.01
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.03
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.07
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.04
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.03
1	0	0	NA	NA	NA	NA	NA	NA	NA	8.04
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.09
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.09
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.1
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.14
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.11
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.12
2	0	0	NA	NA	NA	NA	NA	NA	NA	8.12

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Prepared by: S.R. Cline

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Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R16	For additional comments, RMAL Laboratory Research Book								
MnO4- Calb. Slope:		0.046	STOCK	Conc.(ppm):	49.6	DF:	800	Conc (ppm):	39680	
Calibration Date: 5/5/98										
MnO4- Data										pH Data
Reactor	Volume	Initial	Aliquot	Final	Final	mg MnO4	Cum.	Cum	mg MnO4-	
No.	Stock MnO4- Added (mL)	(mg/L)	MnO4- (mg/L)	Spec	MnO4- (mg/L)	Consumed in Interval	mg MnO4 Consumed	mg MnO4 per gram	in Aliquot	pH
3	0	0	NA	NA	101.8	0.0	0.0	0.0	0	6.56
3	0.913	101.8	1.31	1	1.3	35.8	35.8	0.4	0.0	6.6
3	0.913	1.3	1.52	1	1.5	-0.1	35.7	0.4	0.0	6.61
3	0.913	1.5	1.81	1	1.8	-0.1	35.6	0.4	0.0	6.59
3	0.913	1.8	1.91	1	1.9	0.0	35.6	0.4	0.0	6.6
3	0.913	1.9	2.52	1	2.5	-0.2	35.4	0.4	0.0	6.62
3	0.913	2.5	2.63	1	2.6	0.0	35.3	0.4	0.0	6.63
4	0	0	NA	NA	101.7	0.0	0.0	0.0	0	6.53
4	0.915	101.7	1.80	1	1.8	35.7	35.7	0.4	0.0	6.63
4	0.915	1.8	2.14	1	2.1	-0.1	35.5	0.4	0.0	6.65
4	0.915	2.1	2.20	1	2.2	0.0	35.5	0.4	0.0	6.62
4	0.915	2.2	2.36	1	2.4	-0.1	35.5	0.4	0.0	6.63
4	0.915	2.4	3.06	1	3.1	-0.2	35.3	0.4	0.0	6.63
4	0.915	3.1	3.26	1	3.3	-0.1	35.2	0.4	0.0	6.64

Prepared by: S.R. Cline

Last Updated: 10/23/98

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4b-R16	For additional comments, RMAL Laboratory Research Book											

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Prepared by: S.R. Cline

2.

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Exp.	4b-R16	For additional comments, RMAL Laboratory Research Book								
MnO4- Calb. Slope:		0.046	STOCK Conc.(ppm):		49.6	DF:		800	Conc (ppm):	39680
Calibration Date:	5/5/98									
MnO4- Data										pH Data
Reactor No.	Volume Added (mL)	Initial MnO4- (mg/L)	Aliquot MnO4- (mg/L)	Final Spec DF	Final MnO4- (mg/L)	mg MnO4 Consumed in Interval	Cum. mg MnO4 Consumed	Cum mg MnO4 per gram	mg MnO4 in Aliquot	pH
5	0	0	NA	NA	994.3	0.0	0.0	0.0	0	6.57
5	9.15	994.3	0.3	1	0.3	363.0	363.0	4.0	0.0	6.74
5	9.15	0.3	0.5	1	0.5	-0.1	362.9	4.0	0.0	6.82
5	9.15	0.5	0.6	1	0.6	0.0	362.8	4.0	0.0	6.87
5	9.15	0.6	0.8	1	0.8	-0.1	362.8	4.0	0.0	6.87
5	9.15	0.8	1.7	1	1.7	-0.3	362.5	4.0	0.0	6.9
5	9.15	1.7	2.0	1	2.0	-0.1	362.4	4.0	0.0	6.9
6	0	0	NA	NA	994.76	0.0	0.0	0.0	0	6.53
6	9	994.8	0.6	1	0.6	356.9	356.9	4.0	0.0	6.72
6	9	0.6	1.0	1	1.0	-0.1	356.8	4.0	0.0	6.79
6	9	1.0	1.1	1	1.1	0.0	356.7	4.0	0.0	6.84
6	9	1.1	1.3	1	1.3	-0.1	356.7	4.0	0.0	6.86
6	9	1.3	2.1	1	2.1	-0.3	356.4	4.0	0.0	6.91
6	9	2.1	2.4	1	2.4	-0.1	356.3	4.0	0.0	6.88

Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

	Exp.	4b-R16	For additional comments, RMAL Laboratory Research Book											
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Prepared by: S.R. Cline

LastUpdated: 11/3/98

APPENDIX D: COST AND SCHEDULE SUMMARY

The experiment start dates for those experiments that were both conducted *and* presented in this report are presented in Table D1

Table D1. ORNL Experiment Start Dates.

Task 2 Experiments	
Exp. 2B-1	2/17/98
Exp. 2B-3	4/8/98
Exp. 2A-3B	5/12/98
Task 3 Experiments	
DISSOLVED PLUME OXIDANT DEMAND	
Exp. Repeated 3a-R1	6/10/98
Exp. Repeated 3a-R2	6/22/98
Exp. Repeated 3a-R3	6/25/98
HOT SPOT OXIDANT DEMAND	
Exp. 3b-R1	5/5/98
Exp. 3b-R2	5/7/98
Exp. 3b-R3	5/7/98
Exp. 3b-R4	5/7/98
Task 4 Experiments	
DISSOLVED PLUME DEGRADATION RATE WORK	
Exp. 4a-R1	5/20/98
Exp. 4a-R2	5/28/98
Exp. 4a-R3	6/1/98
Exp. 4a-R5	6/15/98
Exp. 4a-R7	7/7/98
Exp. 4a-R4	7/14/98
Exp. 4a-R6	8/17/98
Exp. 4a-R8	8/24/98
HOT SPOT GROUNDWATER DEGRADATION RATE WORK	
<i>Exp. 4b-R3</i>	7/29/98
Exp. 4b-R4	7/29/98
Exp. 4b-R1	8/10/98
Exp. 4b-R7	8/12/98
Exp. 4b-R8	8/12/98
Exp. 4b-R2	8/13/98
Exp. 4b-R5	8/26/98
Exp. 4b-R6	8/31/98
HOT SPOT SLUDGE DEGRADATION RATE WORK	
Exp. 4b-R11	6/9/98
Exp. 4b-R12	6/16/98
Exp. 4b-R15	6/22/98
Exp. 4b-R16	7/6/98
Exp. 4b-R13	7/14/98
Exp. 4b-R14	7/14/98
Exp. 2B-3B (Matrix Spike Exp)	9/14/98

The period during which each SOW task was performed is presented in Figure D1.

Figure D1. Project Timeline for the Laboratory Evaluation of In Situ Chemical Oxidation (ISCO) to Remediate the INEEL TAN Site.

The final cost summary for the treatability study is presented in Table D2. An additional \$15K of funding was allocated to the project to continue report writing and handling of review comments. (The total budget value in Table D2 reflects this new funding allocation.)

Table D2. Cost Summary for the ISCO Treatability Study.

Project: Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Business Month	ESD-Total Matl	ESD-Total Effort	RMAL-Total Matl	RMAL-Total Effort	Total Material Cost	Total Effort Cost	Total Cost	TOTAL ESD	TOTAL RMAL
Jan-98	\$0	\$7,412	\$0	\$0	\$0	\$7,412	\$7,412	\$7,412	\$0
Feb-98	\$2,105	\$17,675	\$0	\$1,057	\$2,105	\$18,732	\$20,837	\$19,780	\$1,057
Mar-98	\$18,758	\$15,666	\$0	\$901	\$18,758	\$16,567	\$35,325	\$34,424	\$901
Apr-98	\$136	\$11,410	\$0	\$2,265	\$136	\$13,675	\$13,811	\$11,546	\$2,265
May-98	\$382	\$18,081	\$0	\$10,923	\$382	\$29,004	\$29,386	\$18,463	\$10,923
Jun-98	\$2,108	\$14,366	\$0	\$23,310	\$2,108	\$37,676	\$39,784	\$16,474	\$23,310
Jul-98	\$2,473	\$18,532	\$0	\$25,748	\$2,473	\$44,280	\$46,753	\$21,005	\$25,748
Aug-98	\$1,044	\$18,479	\$0	\$0	\$1,044	\$18,479	\$19,523	\$19,523	\$0
Sep-98	\$707	\$21,883	\$17,278	\$0	\$17,985	\$21,883	\$39,868	\$22,590	\$17,278
Oct-98	\$0	\$1,233	-\$1,292	\$0	-\$1,292	\$1,233	-\$59	\$1,233	-\$1,292
Total	\$27,713	\$144,737	\$15,986	\$64,204	\$43,699	\$208,941	\$252,640	\$172,450	\$80,190

GRAND TOTAL (Thru Oct. 98)	\$252,640
TOTAL FUNDS REMAINING	\$13,944

Total Budget:	\$266,584
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APPENDIX E: MONTHLY PROGRESS REPORTS

Monthly Report: January

Project: Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Budget and Cost

Funds were received at ORNL on January 14, 1998. The January cost report is presented in Table E1.1, in which the project costs are broken down in a variety of ways.

Technical Progress

This section describes the progress made in the remaining days of the January business month after receipt of funding (1/14/98). An environmental, safety, health, and quality (ESH&Q) evaluation was submitted for the project and approved. A request to perform the actual EPA Treatability Study with the INEEL media was prepared, submitted to, and approved by the ORNL Office of Environmental Protection. A Project Review Summary (PRS) was prepared and approved for NEPA compliance. The project activities are covered by an existing NEPA categorical exclusion (2017X) for work involving such bench-scale laboratory activities. A draft (>80% complete) test plan for the project was submitted to INEEL for initial review. Completion of this test plan is all that is necessary to fulfill the requirements of Task 1 in the project SOW.

Product research was conducted to select the incubator/shaker for the Tasks 3 and 4 studies. A requisition has been submitted to New Brunswick Scientific for the purchase of two (2) incubators, with an expected delivery date of 2/27/98. Numerous other materials and laboratory supplies (vials, VOC standards, etc.) have been ordered in preparation of the upcoming work.

In the laboratory, several preliminary experiments have been conducted to assist in the selection of an appropriate reactor for the Task 4 TCE degradation work. Of the most significance, an experiment (Exp 2a-2 in the current testplan) was conducted to evaluate the ability of glass reactors sealed with a ground glass stopper to hold TCE solutions (100 mg/L) for a 24 hr period without significant losses due to volatilization. The glass stoppers were equipped with activated carbon tubes, which were vented to the atmosphere. (With this configuration, a reactor cannot be pressurized as a result of the treatment experiments that will be conducted in Task 4.) Duplicate samples of the solution were collected from each reactor at Time =0, 4, and 24 hours. The carbon filters were also extracted with hexane at the end of the 24 hour test period.

Mass balance calculations were performed on each of the four (4) test reactors. The most promising results were obtained when the bottom of the carbon tube was covered with a thin Parafilm covering (which will rupture if a pressurization were to occur). For this reactor, 98.5% of the recovered TCE remained in spike solution following the test. Similar, 1.2% and 0.3% of the recovered TCE was removed from the system via the aliquot samples and carbon filters, respectively. Furthermore, total TCE recovery from the reactor was between 82% and 107% of the initial TCE mass in the reactor. The wide recovery range is unfortunately a result of a large discrepancy between the duplicate TCE samples collected at time=0. However, another test

reactor with <2% difference between duplicate that was evaluated yielded a total TCE recovery between 97% and 99.1%. More details of this experiment will be submitted later.

Technical Problems and Proposed Resolutions

The majority of the effort this month was devoted to administrative issues and material acquisition. Our current G.C. configuration is working very well in regard to overall performance and TCE resolution; however, it is not currently optimized for resolving the cis- and trans-1,2 DCE compounds. Work will continue to refine the configuration (temperature program, columns, flowrates, etc.).

Table E1.1. Cost Report, Through January 1998.

Project: Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Business Month	ESD-Total Matl	ESD-Total Effort	RMAL-Total Matl	RMAL-Total Effort	Total Material Cost	Total Effort Cost	Total Cost	TOTAL ESD	TOTAL RMAL
Jan-98	\$0	\$7,412	\$0	\$0	\$0	\$7,412	\$7,412	\$7,412	\$0
Feb-98									
Mar-98									
Apr-98									
May-98									
Jun-98									
Jul-98									
Aug-98									
Sep-98									
Oct-98									
Total	\$0	\$7,412	\$0	\$0	\$0	\$7,412	\$7,412	\$7,412	\$0

GRAND TOTAL (Thru Oct. 98)	\$7,412
TOTAL FUNDS REMAINING	\$244,172

Total Budget:	\$251,584
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Monthly Report: February

Project: Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Budget and Cost

The February cost report is presented in Table E1.2, in which the project costs are broken down in a variety of ways. The material costs are associated with miscellaneous supplies for the laboratory work and for the purchase of items needed in the development of the reactors to be used for the Task 4 experiments.

Technical Progress

This section describes the progress made during the February business month.

The TSF-05 and TAN-40 groundwater, basalt, and sediment samples were received on 2/11/98, and the eleven coolers used for shipping have been returned to INEEL as requested. The TSF-05 sludge was received at ORNL on 2/27/98. Information regarding the receipt of these materials have been submitted to ORNL Office of Environmental Compliance, as required by the regulations controlling EPA treatability studies. The analytical data for the TSF-05 sludge has not yet been received from INEEL, but ORNL has been notified that the results indicate the material to be less than 50 ppm PCBs.

The laboratory test plan continued to be prepared during the month. Changes and refinements to the test plan for the Task 3 and 4 activities were based on results and observations noted during the technique development work (Task 2) that is underway.

The most significant change to the testplan is a result of the hexane extraction experiment conducted for the reactive zone media at ESD. A summary of this experiment follows:

The extraction experiment was performed to help determine what the most effective extraction period is for each medium being evaluated. The contaminant equilibration (of TAN-40 groundwater spiked at 1 mg/L TCE and soil) period was conducted at 12-15°C. Following equilibration, the hexane extraction was conducted at room temperature. Several aliquot samples were taken with time as the mixture was being extracted. Samples were taken of both the hexane and aqueous phases. The aqueous phase was further evaluated by determining the fraction of TCE present in both the liquid and solid phases at each time interval.

Results obtained for extraction of sediment (Figure E1), crushed basalt, and groundwater alone were similar. Greater than 99.9% of the total TCE extracted after 2 hours is present in the hexane phase, and there is essentially no difference in TCE concentrations between the filtered and unfiltered aqueous samples for any media type evaluated after 2 hours. Extraction efficiency did not appear to increase between the 2 and 24 hr sampling periods, suggesting that a 2 hour extraction time is adequate.

Mass balances were also performed for each test case evaluated. Average TCE recoveries of 89%, 92%, and 92% were obtained for the samples containing sediment, crushed basalt, and groundwater only, respectively. The unrecovered TCE mass is not expected to exist as residual contamination on the solid phase since recoveries obtained for the groundwater only case were comparable. These mass balance computations are greatly controlled by the value obtained for the initial TCE concentration of the spiked groundwater. While duplicate analyses of the initial spike solution were in close agreement (avg= 932 ppb , sd=4 ppb), the potential for VOC losses certainly existed between the time these initial samples were collected and the time the vials were equilibrated (overnight) and finally transferred to the extraction bottles for the start of the extraction test.

Figure E1. Results of Hexane Extraction Experiment for Crushed Basalt.

Notification had been received that refrigerated incubators were shipped from the vendor on 2/27/98, but they have not yet been received by ORNL.

Further development of the test reactors has continued this month. At this point, the required number of reactors needed for the Task 4 experiments have not been ordered. Instead, only a few setups have been acquired for testing to avoid unnecessary spending.

Spreadsheet templates were prepared this month by ESD to have consistency in the approach used to perform the data calculations and present the results of each upcoming experiment. Technical effort this month was also directed toward configuring the GC reports to meet the requirements set forth for the VOC data packages that will ultimately be submitted for the Task 4, TCE degradation studies. The Retention Time Window for TCE compound was determined with the current analytical setup.

Technical Problems and Proposed Resolutions

It was reported last month that our current G.C. configuration is not capable of resolving the vinyl chloride, cis DCE, and trans DCE compounds. This is no longer expected to be a problem. The ORNL staff has access to other instruments that will be able to detect and quantify these compounds when the Task 4 experiments dealing with the co-contaminants are performed. There are currently no major technical problems that must be resolved.

Table E1.2. Cost Report, Through February 1998.

Project: Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Business Month	ESD-Total Matl	ESD-Total Effort	RMAL-Total Matl	RMAL-Total Effort	Total Material Cost	Total Effort Cost	Total Cost	TOTAL ESD	TOTAL RMAL
Jan-98	\$0	\$7,412	\$0	\$0	\$0	\$7,412	\$7,412	\$7,412	\$0
Feb-98	\$2,105	\$17,675	\$0	\$1,057	\$2,105	\$18,732	\$20,837	\$19,780	\$1,057
Total	\$2,105	\$25,087	\$0	\$1,057	\$2,105	\$26,144	\$28,249	\$27,192	\$1,057

GRAND TOTAL (Thru Oct. 98)	\$28,249
TOTAL FUNDS REMAINING	\$223,335

Total Budget:	\$251,584
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Monthly Report: March

Project: Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Budget and Cost

The March cost report is presented in Table E1.3, in which the project costs are broken down in a variety of ways. The material costs this month were significant due to the acquisition of the refrigerated incubators for use in the Task 3 and 4 studies.

Technical Progress

This section describes the progress made during the March business month:

Staff at ORNL/RMAL performed pre-treatment TOC determinations on multiple samples of the TSF-05 sludge. Gross radionuclide activity determinations were also performed by RMAL for the RMAL. The analytical results are still being prepared.

Another test was conducted to assess the gas-tightness of the test reactors to be used in the Task 4 TCE oxidation work. The spike solution was equilibrated 18 hrs at 12 C before initial sampling occurred. A 90% mass balance was achieved. In these developmental experiments, we are conservatively opening up the vessel via collection of duplicate samples at each sampling interval. A better mass balance is anticipated in the Task 4 work: The frequency of duplicate collection during the Task 4 experiments is not as aggressive. Nonetheless, one more iteration of this experiment will be conducted using a slightly different sampling port configuration that has a Teflon stopcock.

Upon the request of INEEL, an additional lab experiment was prepared and setup to determine the oxidant dose needed in the field to reach the 5 ppb MCL limit for TCE. This work was conducted the first week of April, and the test findings have already been submitted to INEEL under separate cover.

The basalt equilibration study was also performed this month. In this test, TCE spiked TAN 40 groundwater was equilibrated with the crushed and aggregate basalt types for various time periods, with the maximum time period being 21 days. Control samples, in which media was not added to the test containers, were also carried through the experiment. Between 20-50% of the initial TCE was lost from the spiked groundwater, however, a larger proportion of the TCE lost appears to be attributed to volatilization losses from the test containers than from sorption by the basalt media. (Due to the long holding times involved, there were significant changes in TCE concentrations in the control samples.). There were also procedural problems as discussed in the next section, thus this experiment will likely be repeated.

Technical Problems and Proposed Resolutions

One of the new refrigerated incubators acquired last month did not function properly, due to a refrigerant leak. The vendor replaced the unit on April 17th, with the damaged unit being

returned at their expense. This problem has caused a slight schedule slip for the work being conducted at ORNL/RMAL on the TSF-05 sludge; however, the ESD portion of the work is still currently the critical path to project completion.

The testplan originally called for the collection of aqueous samples in disposable syringes and subsequent filtering prior to hexane extraction and TCE analysis. This was written into the procedures in order to discern TCE quantities associated with the particulate phase in the samples. Subsequent experimental data has shown that the 0.45 micron filters absorb 10-15% of the TCE that passes through them. Work is currently on-going to modify the testplan to eliminate this step, and work is being conducted to quantify how much solid phase is typically present on a spent filter to determine how much accuracy might be lost if the samples aren't filtered.

Table E1.3. Cost Report, Through March 1998.

Project: Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Business Month	ESD-Total Matl	ESD-Total Effort	RMAL-Total Matl	RMAL-Total Effort	Total Material Cost	Total Effort Cost	Total Cost	TOTAL ESD	TOTAL RMAL
Jan-98	\$0	\$7,412	\$0	\$0	\$0	\$7,412	\$7,412	\$7,412	\$0
Feb-98	\$2,105	\$17,675	\$0	\$1,057	\$2,105	\$18,732	\$20,837	\$19,780	\$1,057
Mar-98	\$18,758	\$15,666	\$0	\$901	\$18,758	\$16,567	\$35,325	\$34,424	\$901
Apr-98									
May-98									
Jun-98									
Jul-98									
Aug-98									
Sep-98									
Oct-98									
Total	\$20,863	\$40,753	\$0	\$1,958	\$20,863	\$42,711	\$63,574	\$61,616	\$1,958

GRAND TOTAL (Thru Oct. 98)	\$63,574
TOTAL FUNDS REMAINING	\$188,010

Total Budget:	\$251,584
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Monthly Report: April

Project: Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Budget and Cost

The April cost report is presented in Table E1.4, in which the project costs are broken down in a variety of ways. Please note that the RMAL portion of the work has begun, costs will be increasing here next month. Also note that the all materials procured for the experimental work are being ordered at ESD to simplify purchasing logistics, but being used by both divisions working on the project.

A review of the current schedule was examined in April and submitted to INEEL for review. As a result, we are requesting that the period of performance be extended to September 30, 1998. Upon review of the costs incurred to date to predict the estimate at completion (EAC), additional budget is not being requested at this time.

Technical Progress

This section describes the progress made during the April business month:

The majority of the Task 3 oxidant consumption experiments were conducted this month. The laboratory data are still being reduced and interpreted. The Task 3a work with the reactive zone material, however, does not indicate a major loss of MnO_4^- as a result of the interaction with either the TAN-40 groundwater, basalt, or sediment matrixes. The greatest losses (<20%) do appear to result from interaction with the finely crushed TAN-37 sediment material. In many circumstances, particularly for the 1% MnO_4^- loading, the error associated with sample dilution for MnO_4^- analyses appears to be greater than any observable losses of the oxidant via its consumption. In contrast, 4:1 L/S slurries of TSF-05 groundwater and sludge consumed all the initial KMnO_4^- in less than 30 minutes for both the 0.01 and 0.10% MnO_4^- loadings. Work with the TSF-05 sludge at higher oxidant loadings is in progress.

At the request of INEEL, a second experiment investigating the kinetics of TCE degradation was performed. In this experiment, three oxidant loadings (15, 65, and 100 mg/L MnO_4^-) were reacted with 40 mL of TAN groundwater spiked with 1000 ppb TCE. The results are presented in Figure 1 (each loading was evaluated in duplicate). The rate of TCE degradation increases with increases in the initial oxidant loading. Twenty-four hours was the maximum reaction period evaluated. At that time, a residual of 20 ppb TCE remained in the samples having the 15 mg/L MnO_4^- loading, and an average residual of 7 ppb was reached for 65 mg/L loading. TCE was not detected in any of the samples with the 100 mg/L MnO_4^- loading after a reaction time of 4 hours. A residual MnO_4^- concentration was still present ($\approx 90\text{wt } \%$ of initial loading) in all samples at 24 hrs. More information regarding this experiment is available if it is needed.

Figure E2. Results of TCE Kinetic Oxidation Study.

Needed supplies to test another configuration for the Task 4 reactors were received this month, and will be assessed during the week of May 11, 1998. The task 4 studies can be initiated after this work is completed.

The basalt equilibration experiment (Exp. 2c-1) was also initiated again this month as a result of the filtering problem encountered during the test last month. These samples are being analyzed via Purge and Trap/FID detector to better detect small changes in TCE concentrations with time that are anticipated.

The hexane extraction experiment on the TSF-05 sludge and groundwater was performed by ORNL/RMAL. As with the reactive zone materials evaluated previously at ORNL/ESD, a 2 hour extraction time is adequate for the sludge material.

Technical Problems and Proposed Resolutions

It was reported last month that one of the new refrigerated incubators did not work upon receipt. A new unit has been received and the other was returned to the vendor at their cost.

It was also reported last month that the 0.45 μ m filters used prior to TCE analyses were adsorbing some quantities of TCE. A test was conducted this month to determine how much solid fraction is present in TAN40 groundwater or slurries of groundwater with basalt or sediment. In the worst case, a 10 mL aliquot of the crushed basalt contained less than 0.2% of the slurry's solid mass. Experiments are planned for May in which a comparison between TCE sampling via glass and plastic, disposable syringes will be performed to determine whether TCE adsorption is a problem here too.

Table E1.4. Cost Report, Through April 1998.

Project: Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Business Month	ESD-Total Matl	ESD-Total Effort	RMAL-Total Matl	RMAL-Total Effort	Total Material Cost	Total Effort Cost	Total Cost	TOTAL ESD	TOTAL RMAL
Jan-98	\$0	\$7,412	\$0	\$0	\$0	\$7,412	\$7,412	\$7,412	\$0
Feb-98	\$2,105	\$17,675	\$0	\$1,057	\$2,105	\$18,732	\$20,837	\$19,780	\$1,057
Mar-98	\$18,758	\$15,666	\$0	\$901	\$18,758	\$16,567	\$35,325	\$34,424	\$901
Apr-98	\$136	\$11,410	\$0	\$2,265	\$136	\$13,675	\$13,811	\$11,546	\$2,265
May-98									
Jun-98									
Jul-98									
Aug-98									
Sep-98									
Oct-98									
Total	\$20,999	\$52,163	\$0	\$4,223	\$20,999	\$56,386	\$77,385	\$73,162	\$4,223

GRAND TOTAL (Thru Oct. 98)	\$77,385
TOTAL FUNDS REMAINING	\$174,199

Total Budget:	\$251,584
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Monthly Report: May

Project: Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Budget and Cost

The May cost report is presented in Table E1.5, in which the project costs are broken down in a variety of ways.

Technical Progress

This section describes the progress made during the May business month:

TASK 3, Oxidant Consumption Work

All originally planned experimental test conditions were completed in May at both the ESD and CASD facilities, for the reactive zone and hot spot media, respectively. The data was recently transmitted to INEEL. While the anticipated results are supported by the data, the results for the reactive zone media were difficult to interpret due to difficulties in executing the test procedure. Thus, the reaction zone experiments (Task 3A) are being repeated using a modified step for oxidant spiking/injection, and the results at this point appear to be more informative and meaningful.

TASK 2, Development Work

The final reactor configuration (TASK 2a-3) was evaluated to assess its ability to maintain gas-tight conditions over time. The reactor, initially spiked at 100 ppb, maintained that TCE concentration when subjected to five (5) aliquot sampling events over a 24 hr period. The final design consists of a 500 mL flask, having a 42/29 standard tapping opening. To both minimize and account for non-oxidative VOC losses that occur during aliquot sampling, the reactors are sealed with an adapter that maintains gas tight conditions during the reaction (Teflon Stopcock). Any VOC mass lost during sampling will be quantified via adsorption onto 6 mm diameter charcoal tubes extracted with hexane and analyzed along with the test samples.

This study also evaluated the effect of sampling via both glass and plastic, disposable syringes. Six aliquots were sampled using both techniques. The average TCE value obtain by sampling with the glass syringe was only 0.1% greater than the value obtained with the disposable syringes. The difference in TCE values between glass and plastic syringe sampling ranged between -4% to +4% for the six aliquots. Based upon this information, the use of the plastic disposable syringes will be continued in the Task 4 studies.

TASK 4, TCE Degradation Work

Significant modifications were made to the test procedure for the Task 4 work this month. These changes were made for numerous reasons: (1) to make the procedure both more thorough and easier to follow (2) to provide specifics regarding the use of the final test reactor (3) to eliminate/modify steps that caused problems in the Task 3 work.

TCE treatment experiments were initiated at both ESD and CASD this month. Six experiments have successfully been conducted to date. The preliminary data indicate both rapid and significant changes in TCE values as a result of oxidant additions. The control reactors appear to be maintaining their initial TCE concentrations well, and little TCE has been observed on the sampling port's charcoal tubes. In fact, there are two charcoal beds placed in series on each reactor, TCE has not yet been detected on the second bed. Formal results of the Task 4 work to date is currently planned to be presented in the June monthly report.

Technical Problems and Proposed Resolutions

TASK 3, Oxidant Consumption Work

As discussed above, ESD experienced problems achieving the desired oxidant concentrations in the test reactors. Often the final, measured oxidant concentration was greater than that computed using the laboratory gravimetric data. To fix this problem, a new calibration curve was prepared, and oxidant is now being added via the use of stock MnO_4^- solutions as opposed to the addition of the solid KMnO_4 crystals. This procedural modification was also written into the most current Task 4 degradation procedures. Calibration standards will also be titrated in the preparation of future MnO_4^- calibration curves to further ensure that the calibration data is correct.

TASK 4, TCE Degradation Work

At the start of the degradation work, CASD staff were experiencing problems achieving the desired initial spike concentrations. After a careful review of their laboratory approach used to execute the test procedure, slight changes have been made that have now resolved this situation. However, two experiments will have to be re-performed.

Table E1.5. Cost Report, Through May 1998.

Project: Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Business Month	ESD-Total Matl	ESD-Total Effort	RMAL-Total Matl	RMAL-Total Effort	Total Material Cost	Total Effort Cost	Total Cost	TOTAL ESD	TOTAL RMAL
Jan-98	\$0	\$7,412	\$0	\$0	\$0	\$7,412	\$7,412	\$7,412	\$0
Feb-98	\$2,105	\$17,675	\$0	\$1,057	\$2,105	\$18,732	\$20,837	\$19,780	\$1,057
Mar-98	\$18,758	\$15,666	\$0	\$901	\$18,758	\$16,567	\$35,325	\$34,424	\$901
Apr-98	\$136	\$11,410	\$0	\$2,265	\$136	\$13,675	\$13,811	\$11,546	\$2,265
May-98	\$382	\$18,081	\$0	\$10,923	\$382	\$29,004	\$29,386	\$18,463	\$10,923
Jun-98									
Jul-98									
Aug-98									
Sep-98									
Oct-98									
Total	\$21,381	\$70,244	\$0	\$15,146	\$21,381	\$85,390	\$106,771	\$91,625	\$15,146

GRAND TOTAL (Thru Oct. 98)	\$106,771
TOTAL FUNDS REMAINING	\$144,813

Total Budget:	\$251,584
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Monthly Report: June

Project: Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Budget and Cost

The June cost report is presented in Table E1.6, in which the project costs are broken down in a variety of ways.

Technical Progress

This section describes the progress made during the June business month:

TASK 3, Oxidant Consumption Work

The consumption experiments using the reactive zone media (Task 3A) were repeated in June and the data has already been sent electronically to INEEL. The experiments were repeated using a modified step for oxidant spiking/injection.

TASK 4, TCE Degradation Work

Reactive Zone Media

Experimental data for one of the reactive zone media experiments are presented in Figures E3 and E4. In this experimental run, TAN40 groundwater only was spiked with TCE. The average TCE concentration of duplicate control reactors during the 6 sampling periods was 1,360 ppb (std dev= 48 ppb over the 24 hr period). Duplicate test reactors were subjected to oxidant loadings of 0.01 and 0.1% MnO_4^- . TCE degradation was rapid and significant. The related oxidant consumption data is presented in Figure E4. It is interesting to note that the "leveling" off of the TCE degradation rate (Figure E3) for the first 0.01% test reactor corresponds to the significantly larger consumption value in Figure E4. Work is on-going to provide both a tabular and additional graphical means to present the vast amount of data points (TCE, pH, MnO_4^-) generated during the course of one of these experiments.

TSF05 Sludge

Similarly, data for one of the TSF05 experiments are presented in Figures E5 and E6. TCE (100,000 ppb) in the TSF05 sludge/groundwater slurry is also quickly oxidized. However, a residual TCE concentration of approximately 100 ppb was still present after 24 hours. Although most of the oxidant was consumed for the 1% MnO_4^- oxidant loading, approximately 40% of the oxidant mass originally added for the 3% MnO_4^- loading is still present at 24 hours. As a result of this observation, some experiments involving the 1 and 3% loadings will be continued for periods greater than 24 hours to determine if TCE oxidation continues, albeit at a much slower rate than observed during the first few hours of reaction.

Figure E3, TAN-40 Groundwater TCE Oxidation

Figure E4, TAN-40 Groundwater, Oxidant Consumption

TSF05 Sludge and Groundwater Degradation

Figure E5, TSF-05 Sludge & Groundwater TCE Oxidation.

TSF05 Sludge Degradation Experiment, Oxidant Consumption

Figure E6, TSF-05 Sludge & Groundwater, Oxidant Consumption.

Technical Problems and Proposed Resolutions

Data from the repeated basalt equilibration study (Task 2c-1) are inconclusive. (The first attempt at this task was erroneous due to the discovery that the 0.45 micron membranes being used to filter the aqueous TCE samples adsorbed TCE.) In the repeated test, aqueous TCE was analyzed via the more sensitive purge and trap GC analysis. At any given time interval, differences among TCE concentrations in samples of TAN40 groundwater only, groundwater with aggregate basalt, and groundwater with crushed basalt were minimal and within one standard deviation. It is believed that instrument performance changed during the course of the 8 day test. A definitive and needed equilibration time for the aggregate basalt was not observed. As a result, ESD is currently planning to use a 24 hr equilibration period (as with the other media) during the Task 4a experiments with aggregate basalt.

Table E1.6. Cost Report, Through June 1998.

Project: Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Business Month	ESD-Total Matl	ESD-Total Effort	RMAL-Total Matl	RMAL-Total Effort	Total Material Cost	Total Effort Cost	Total Cost	TOTAL ESD	TOTAL RMAL
Jan-98	\$0	\$7,412	\$0	\$0	\$0	\$7,412	\$7,412	\$7,412	\$0
Feb-98	\$2,105	\$17,675	\$0	\$1,057	\$2,105	\$18,732	\$20,837	\$19,780	\$1,057
Mar-98	\$18,758	\$15,666	\$0	\$901	\$18,758	\$16,567	\$35,325	\$34,424	\$901
Apr-98	\$136	\$11,410	\$0	\$2,265	\$136	\$13,675	\$13,811	\$11,546	\$2,265
May-98	\$382	\$18,081	\$0	\$10,923	\$382	\$29,004	\$29,386	\$18,463	\$10,923
Jun-98	\$2,108	\$14,366	\$0	\$23,310	\$2,108	\$37,676	\$39,784	\$16,474	\$23,310
Jul-98									
Aug-98									
Sep-98									
Oct-98									
Total	\$23,489	\$84,610	\$0	\$38,456	\$23,489	\$123,066	\$146,555	\$108,099	\$38,456

GRAND TOTAL (Thru Oct 98)	\$146,555
TOTAL FUNDS REMAINING	\$105,029

Total Budget:	\$251,584
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Monthly Report: July

Project: Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Budget and Cost

The July cost report is presented in Table E1.7, in which the project costs are broken down in a variety of ways.

Technical Progress

The conduct of the remaining Task 4 oxidation rate studies continued during the month of July. The hot spot groundwater studies listed in SOW Table 2.6 are being divided up between the ESD and RMAL research teams in order to expedite completion of the lab experiments. ESD will conduct the four (4) 10 mg/L initial TCE experiments listed in Table 2.6 (including the 2 co-contaminant experiments), and RMAL will conduct the 100 mg/L and DNAPL TCE experiments. Summary information regarding the experiments performed in July will be available soon. As observed in the Table 1 cost report, a great deal of the effort was expended in July on this project, with greater than 95% of that effort being dedicated to the actual conduct of the experiments.

Technical Problems and Proposed Resolutions

No additional technical problems were encountered during July.

Table E1.7. Cost Report, Through July 1998.

Project: Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Business Month	ESD-Total Matl	ESD-Total Effort	RMAL-Total Matl	RMAL-Total Effort	Total Material Cost	Total Effort Cost	Total Cost	TOTAL ESD	TOTAL RMAL
Jan-98	\$0	\$7,412	\$0	\$0	\$0	\$7,412	\$7,412	\$7,412	\$0
Feb-98	\$2,105	\$17,675	\$0	\$1,057	\$2,105	\$18,732	\$20,837	\$19,780	\$1,057
Mar-98	\$18,758	\$15,666	\$0	\$901	\$18,758	\$16,567	\$35,325	\$34,424	\$901
Apr-98	\$136	\$11,410	\$0	\$2,265	\$136	\$13,675	\$13,811	\$11,546	\$2,265
May-98	\$382	\$18,081	\$0	\$10,923	\$382	\$29,004	\$29,386	\$18,463	\$10,923
Jun-98	\$2,108	\$14,366	\$0	\$23,310	\$2,108	\$37,676	\$39,784	\$16,474	\$23,310
Jul-98	\$2,473	\$18,532	\$0	\$25,748	\$2,473	\$44,280	\$46,753	\$21,005	\$25,748
Aug-98									
Sep-98									
Oct-98									
Total	\$25,962	\$103,142	\$0	\$64,204	\$25,962	\$167,346	\$193,308	\$129,104	\$64,204

GRAND TOTAL (Thru Oct. 98)	\$193,308
TOTAL FUNDS REMAINING	\$58,276

Total Budget:	\$251,584
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Monthly Report: August

Project: Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Budget and Cost

The August cost report is presented in Table E1.8, in which the project costs are broken down in a variety of ways. Please note that no costs were incurred from the ORNL RMAL research team. This is due to the fact that their operating account was inadvertently closed in July. Their finance organization was not duly notified of the extension to the period of performance. The account has subsequently been re-opened, and the entire remaining balance in the RMAL account (\$12.7 K) will be costed out in the September business month. Likewise, it is also anticipated that all \$\$ resources within the ESD operating account will also be expended during the September in the preparation of the final report.

Technical Progress

During the month of August, all Task 4 oxidation rate experiments were completed, including the co-contaminants experiments in which the TSF-05 groundwater was spiked with TCE, cis-1,2 DCE, trans-1,2 DCE, and 1,1 DCE. A great deal of effort was expended in optimizing instrument operation conditions in order to properly quantify these analytes. It was planned to also spike with vinyl chloride. Unfortunately, quantification of vinyl chloride via GC/ECD could not be accomplished. Vinyl chloride determination via purge & trap of aqueous samples could be accomplished, but was not feasible here due to the large number of VOC samples (70+) that are generated from each experiment. (ORNL/ESD GC instruments used for such purge and trap analyses are not equipped with automated sampling devices.)

Communication with INEEL this month focused upon the final desired format/outline of the ORNL final report. Actual preparation of the final report was initiated in August and will continue throughout the month of September.

At the request of INEEL, additional laboratory work is being conducted in September to perform a matrix spike study for each TAN site material to ascertain the actual % TCE recovery that can be achieved using the final laboratory procedure developed in order to perform the Task 4 oxidation rate studies. These matrix spike experiments are being conducted at 100-500 ppb so that dilutions prior to GC analysis will not be needed, thereby "removing" errors associated with the preparation of such dilutions from the matrix spike study. Results of these experiments will be added to the final report as soon as they are available.

Technical Problems and Proposed Resolutions

All experimental work is essentially complete. The primary task for ORNL is the complete the final report during the September business month.

Table E1.8. Cost Report, Through August 1998.

Project: Laboratory Evaluation of In Situ Chemical Oxidation as a Technology for Groundwater Remediation at the INEEL TAN Site

Business Month	ESD-Total Matl	ESD-Total Effort	RMAL-Total Matl	RMAL-Total Effort	Total Material Cost	Total Effort Cost	Total Cost	TOTAL ESD	TOTAL RMAL
Jan-98	\$0	\$7,412	\$0	\$0	\$0	\$7,412	\$7,412	\$7,412	\$0
Feb-98	\$2,105	\$17,675	\$0	\$1,057	\$2,105	\$18,732	\$20,837	\$19,780	\$1,057
Mar-98	\$18,758	\$15,666	\$0	\$901	\$18,758	\$16,567	\$35,325	\$34,424	\$901
Apr-98	\$136	\$11,410	\$0	\$2,265	\$136	\$13,675	\$13,811	\$11,546	\$2,265
May-98	\$382	\$18,081	\$0	\$10,923	\$382	\$29,004	\$29,386	\$18,463	\$10,923
Jun-98	\$2,108	\$14,366	\$0	\$23,310	\$2,108	\$37,676	\$39,784	\$16,474	\$23,310
Jul-98	\$2,473	\$18,532	\$0	\$25,748	\$2,473	\$44,280	\$46,753	\$21,005	\$25,748
Aug-98	\$1,044	\$18,479	\$0	\$0	\$1,044	\$18,479	\$19,523	\$19,523	\$0
Sep-98									
Oct-98									
Total	\$27,006	\$121,621	\$0	\$64,204	\$27,006	\$185,825	\$212,831	\$148,627	\$64,204

GRAND TOTAL (Thru Oct. 98)	\$212,831
TOTAL FUNDS REMAINING	\$38,753

Total Budget:	\$251,584
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- 1-2. S. R. Cline, 1505, MS-6035
3. Central Research Library
4. ESD Library
5. Laboratory Records, ORNL-RC

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- 6-7. Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831