Aquatic & Environmental Applications

October 10, 1998

REF: 1004-3Q.98

Mr. Barney Chan
Environmental Health
Alameda County
1131 Harbor Bay Pkwy
Alameda, CA 94502-6577

SUBJECT: QUARTERLY MONITORING REPORT MOTOR PARTNERS, 1234 40TH AVE., OAKLAND, CA

Dear Barney:

I have enclosed a copy of the Quarterly Monitoring report prepared for the Motor Partners site, 1234 40th Ave., Oakland, California. Groundwater sampling results are presented for the third quarterly monitoring event in 1998. The results of sampling indicate that hydrocarbon contamination is present in groundwater samples from all five wells. Concentrations of hydrocarbons are in the same range as those of the previous monitoring period.

Samples were also collected from each of the wells for analysis of dissolved oxygen, redox, nitrate, sulfate, iron, total phosphorus, and ammonia. At the completion of the sampling event, AEA installed Oxygen Release Compound filter socks in three of the wells. The ORC® was selected to enhance natural bioremediation processes at the site.

If you have any questions or comments regarding the report, please give me a call.

Sincerely,

Gary Rogers

Gary Rogers, Ph.D.

cc: Bill Owens

38053 Davy Ct. ❖ Fremont, CA 94536 ❖ 510-791-7157 ❖ E-mail: rogers1@ix.netcom.com

QUARTERLY MONITORING REPORT
3rd Quarter, 1998

PROJECT SITE:

MOTOR PARTNERS
1234 40TH AVE., OAKLAND, CALIFORNIA
StID #3682

PREPARED FOR:

Mr. Bill Owens
2221 Olympic Blvd.
Walnut Creek, CA 94595
510-935-3840

SUBMITTED TO:

Mr. Barney Chan
Environmental Health
Alameda County
1131 Harbor Bay Pkwy
Alameda, CA 94502-6577

PREPARED BY:

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Aquatic & Environmental Applications
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PROJECT NO. 1004.95

October 10, 1998

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

PROJECT DESCRIPTION

This report discusses the results of quarterly sampling for the third quarter in 1998 at the Motor Partners site, 1234 40th Ave., Oakland, California.

SITE LOCATION AND DESCRIPTION

The project site is known as Motor Partners, 1234 40th Avenue, Oakland, California (Figure 1), located in a commercial/light industrial area. The elevation of the site is approximately 30 feet above mean sea level.

Motor Partners is located at 1234 40th Avenue near Nimitz Highway (880) in the Fruitvale District of Oakland, California (Figure 1). The BART rail tracks are about 500 feet west of the site and San Leandro Bay is less than one mile to the southwest.

Motor Partners utilized the site for auto repair shops. Two underground storage tanks were maintained outside the 1234 40th Avenue building. A 1,000-gallon underground gasoline tank and a 500-gallon underground waste oil tank were located below the sidewalk (Figure 2). No reliable records exist to determine if inventory was lost.

Previous Subsurface Investigations

On Oct. 12, 1990, Semco, Inc. of Modesto, California removed both the 1,000-gallon gasoline tank and the 500-gallon waste oil tank. The concentration of total petroleum hydrocarbons in the gasoline range (TPH-G) below the 1,000-gallon tank was 1,600 mg/Kg. The TPH-G and TPH-D concentrations below the 500-gallon tank were 570 mg/Kg and 650 mg/Kg, respectively. There was no record of groundwater in the excavations. The excavations were backfilled to grade with original spoils.

In January, 1994, SEMCO re-excavated the area to remove contaminated soil, and dispose of the contaminated backfill. During the course of over excavation, it was noted that contamination extended beneath the building and into the street. Utilities prevented further excavation. The over excavation was halted and samples taken from the sidewalls of each excavation. An extraction well casing was installed in each excavation. Clean imported soil was used to backfill the two areas and the sidewalk was resurfaced with Christy boxes housing the two extraction casings.

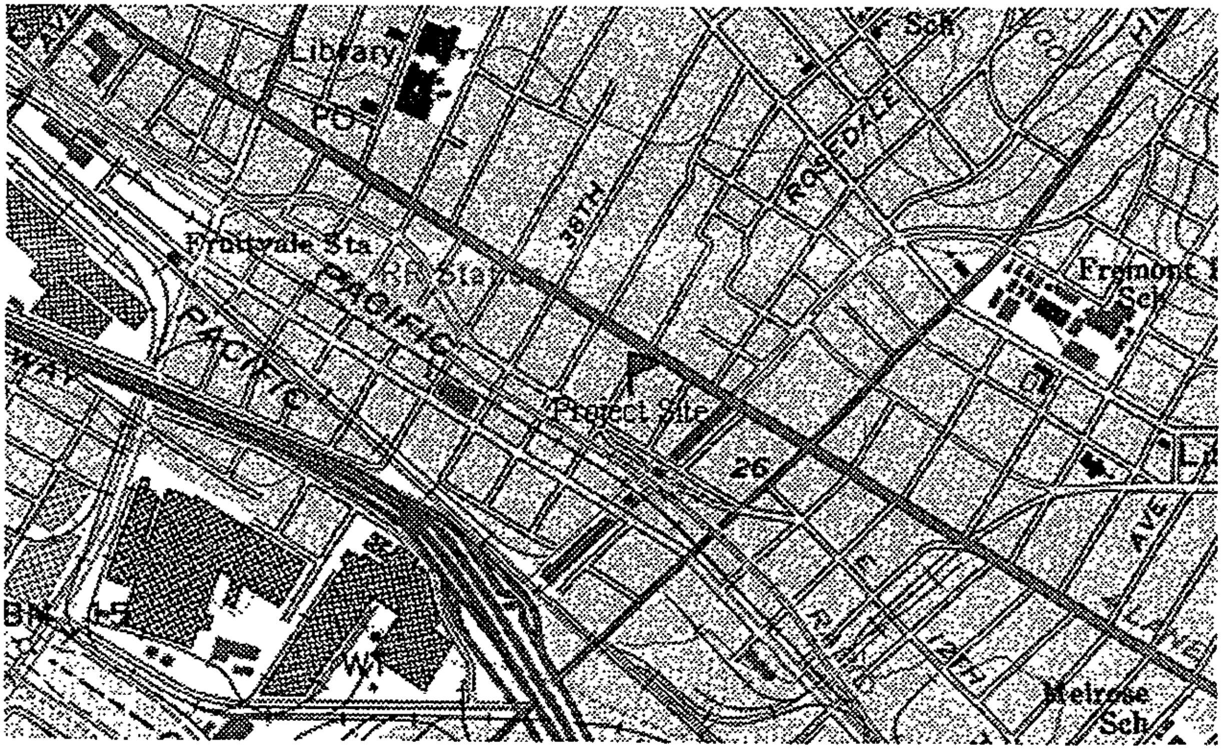
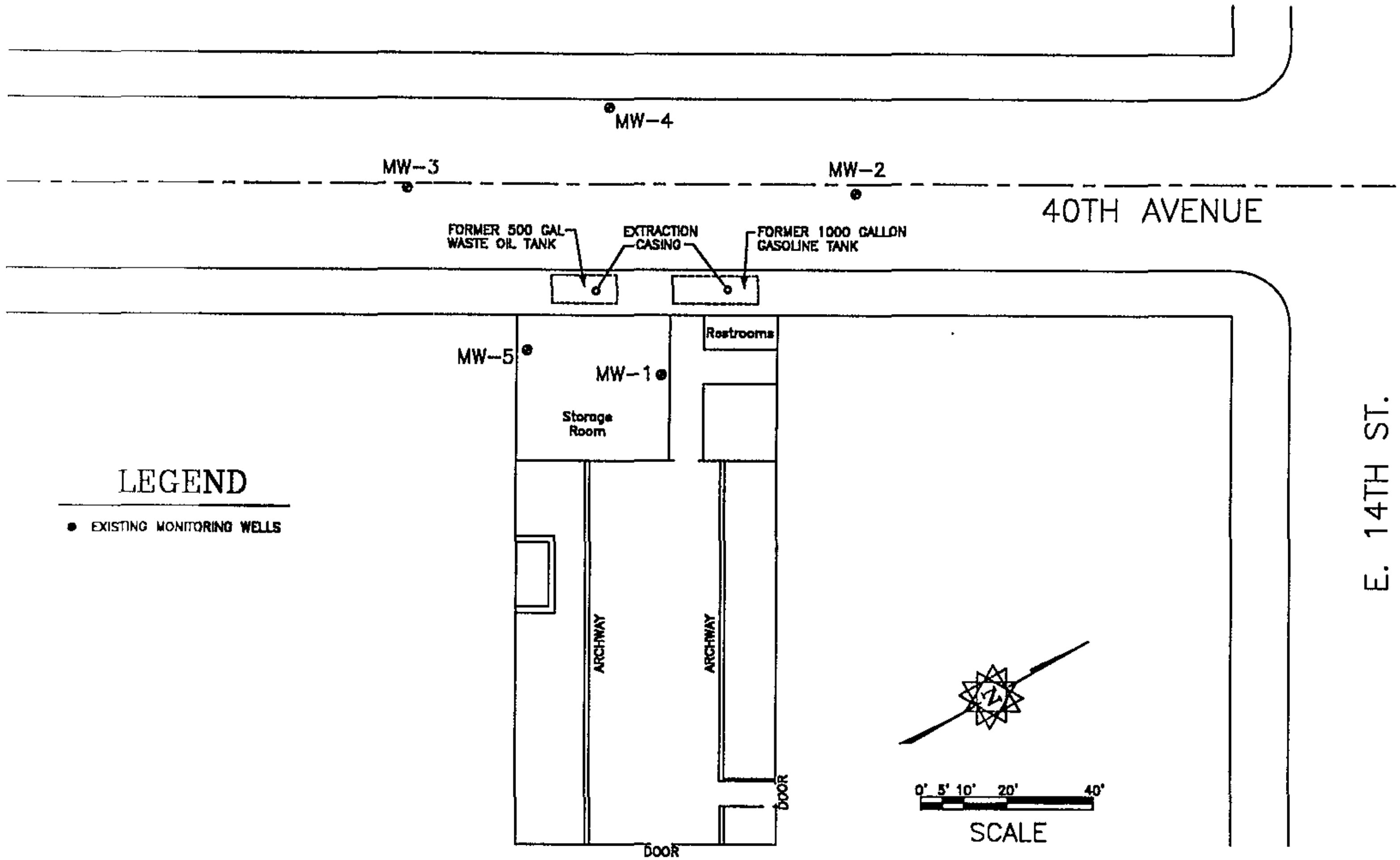


Figure 1. Site Location Map



AQUATIC & ENVIRONMENTAL APPLICATIONS 38053 DAVY CT. FREMONT, CA 94536 (510) 791-7157	DRAWN BY GLR	PROJECT NUMBER 1004	DESCRIPTION Site Layout	FIGURE 2
	DRAWING DATE 10/3/98	FILE NAME 1004-398.DWG		
	REVISION BY	PROJECT MANAGER GLR	PROJECT/LOCATION Motor Partners 1234 40th Ave., Oakland	
	REVISION BY	CHECKED BY		

Sampling conducted on January 11, 1994 indicated levels of TPH-gasoline for the former waste oil tank area between 100 and 700 ppm. Levels of TPH-gasoline for the former gasoline tank area ranged from 150 to 1,200 ppm.

GROWTH Environmental completed soil borings at the property between May and June of 1994. Eleven borings were drilled and three monitoring wells were installed. Both soil and groundwater samples were collected from the borings. Soil and groundwater contamination was found in nearly every boring. Levels of TPH-D up to 2,700 ppm were observed on the west side of the building. A sample from inside the building had a TPH-D level of 520 ppm.

Groundwater samples had highest concentrations near the former tank excavations. The highest level of TPH-G was 64,000 ppb. BTEX compounds were found in groundwater samples from all the borings.

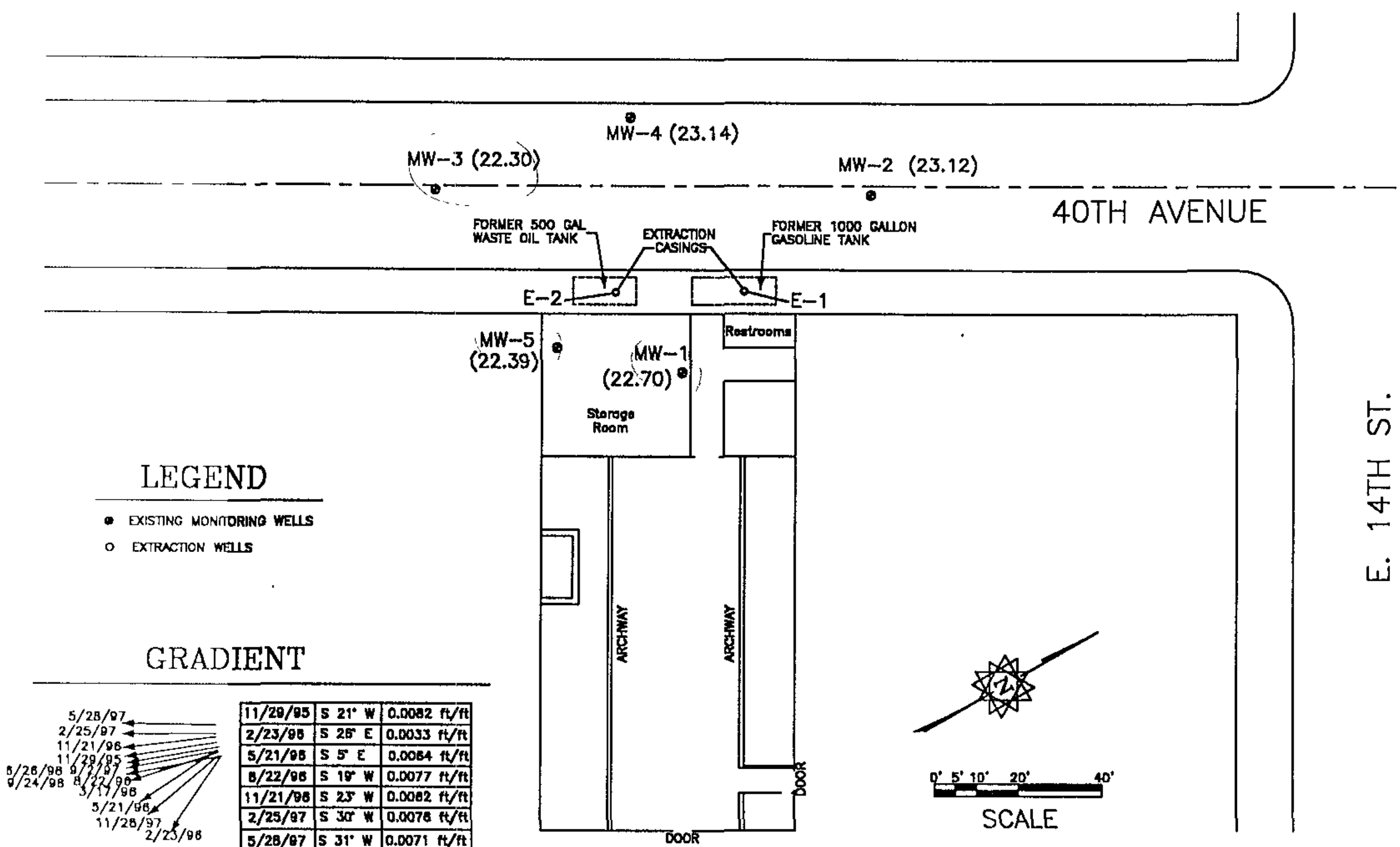
The monitoring wells were sampled on June 17, 1994 and December 7, 1994. Contamination was reported in all three wells. Levels of TPH-G were up to 17,000 ppb and Benzene levels were up to 1,200 ppb in MW-1.

A quarterly monitoring sampling event was completed on November 29, 1995. All of the wells showed increased TPH-G and BTEX levels when compared to the previous sampling event. TPH-G levels were up to 67,000 ppb in MW-1. The groundwater gradient was calculated to be in a southwesterly direction.

Additional geoprobe borings were completed along 40th Avenue between November, 1995 and February, 1996 to determine the extent of contamination.

On February 1, 1996, Bay Area Exploration drilled a soil boring across the street from the former underground storage tank excavations at the Motor Partners site (location shown in Figure 3). A two-inch groundwater monitoring well (MW-4) was installed in the boring. The monitoring well was installed according to State of California Water Resource Control Board standards to a depth of 25 feet below grade surface (bgs) and screened from 5 to 25 feet bgs.

On February 11, 1998, HK2, Inc./SEMCO drilled a soil boring inside the building and down gradient from the former underground storage tank excavations (location shown in Figure 3). A two-inch groundwater monitoring well (MW-5) was installed in the boring. The monitoring well was installed to a depth of 21 feet below grade surface (bgs) and screened from 6 to 21 feet bgs.



GRADIENT

11/29/95	S 21° W	0.0082 ft/ft
2/23/96	S 26° E	0.0033 ft/ft
5/21/96	S 5° E	0.0064 ft/ft
8/22/96	S 19° W	0.0077 ft/ft
11/21/96	S 23° W	0.0082 ft/ft
2/25/97	S 30° W	0.0076 ft/ft
5/28/97	S 31° W	0.0071 ft/ft
9/2/97	S 20° W	0.0086 ft/ft
11/26/97	S 11° E	0.0057 ft/ft
3/17/98	S 11° W	0.0029 ft/ft
6/26/98	S 20° W	0.0089 ft/ft
9/24/98	S 19° W	0.0076 ft/ft

AQUATIC & ENVIRONMENTAL APPLICATIONS 38053 DAVY CT. FREMONT, CA 94536 (510) 791-7157	DRAWN BY GLR	PROJECT NUMBER 1004	DESCRIPTION Ground Water Gradient	FIGURE 3
	DRAWING DATE 10/3/98	FILE NAME 1004-398.DWG		
	REVISION BY	PROJECT MANAGER GLR	PROJECT/LOCATION Motor Partners 1234 40th Ave., Oakland	
	REVISION BY	CHECKED BY		

GEOLOGY AND HYDROGEOLOGY

Regional Geology.

The site is located on the East Bay Plain about 1.0 mile west of the Oakland Hills, about 1.0 mile east of the San Francisco Bay, and about 0.5 miles north of San Leandro Bay. The nearest cross street is 14th Street.

The site rests on Quaternary Deposits of various physical and compositional properties. The predominant formation is the Temescal Formation consisting of contemporaneous alluvial units of different origin, lithology, and physical properties. The material ranges from irregularly bedded clay, silt, sand and gravel to lenses of clay, silt, sand, and gravel with Claremont Chert.

The Hayward Fault is approximately 1.5 miles East of the site and is an active historic Fault. The Hayward Fault is the only active fault in the Oakland East Quadrangle.

Regional Hydrogeology.

The site is located within the East Bay Plain which makes up the ground water reservoir in the area. The water bearing capacity varies within the area due to the juxtaposed positions of the various types of soils and strata encountered underneath the East Bay Plain.

In General the water bearing capacities of the Younger Alluvium range from moderately permeable to low permeable soils. Below the Younger Alluvium at a depth of approximately 70 feet lies the Older Alluvium, which yields large to small quantities of well water.

Site Geology. The site soils were characterized using the United Soil Classification System (USCS). During on-site subsurface drilling, CEC (GROWTH) encountered up to two feet of baserock (fill) followed by a 4 to 5 foot layer of dark sandy clay (CL). Below the dark clay to a depth between 7 and 15 feet, a grey sandy gravel was found. Below the sandy gravel the soil varied between a clayey sand to a sandy silty clay (SC). The gravels are poorly sorted, angular to rounded clasts ranging in size from 0.2 cm to 3.0 cm.

Site Hydrogeology. The depth of first water ranged from 8 to 10 feet below the ground surface (bgs) in the borings. Groundwater was encountered within the grey clayey sandy gravel layers.

Table 1
Monitoring Well Construction Data for Motor Partners Site
1234 40th Ave., Oakland, California

	MW-1	MW-2	MW-3	MW-4	MW-5
Date Drilled	6/15/94	6/14/94	6/14/94	2/1/96	2/11/98
Total Depth	22.5 ft.	22.0 ft.	23.0 ft.	23.0 ft.	21.0 ft.
Bore Diameter	10 inches	10 inches	10 inches	10 inches	6 inches
Casing Diameter	2 inch	2 inch	2 inch	2 inch	2 inch
Well Seal Type	Bentonite Pellets	Bentonite Pellets	Bentonite Pellets	Bentonite Pellets	Bentonite Pellets
Well Seal Interval	5.0 - 6.0 bgs	5.0 - 6.0 bgs	5.0 - 6.0 bgs	3.0 - 4.0 bgs	4.0 - 5.0 bgs
Filter Pack Material	2/14 Lonestar Sand	2/14 Lonestar Sand	2/14 Lonestar Sand	2/14 Lonestar Sand	2/14 Lonestar Sand
Filter Pack Interval	6.0 - 17.0 bgs	9.0 - 20.0 bgs	6.5 - 20.0 bgs	4.0 - 25.0 bgs	5.0 - 21.0 bgs
Screen Slot Size	0.020 in.	0.020 in.	0.020 in.	0.010 in.	0.020 in.
Screened Interval	7.0 - 17.0 bgs	10.0 - 20.0 bgs	7.0 - 20.0 bgs	5.0 - 25.0 bgs	6.0 - 21.0 bgs
Well Elevation[1]	31.44 ft.	31.06 ft.	31.43 ft.	31.37 ft.	31.15 ft.

[1]TOC -Top of Casing Elevations for MW-1, MW-2, MW-3, and MW-4 were surveyed on 8/22/96 by Kier & Wright Civil Engineers & Surveyors, Inc. TOC. Elevation for MW-5 surveyed on 3/20/98 by AEA.

GROUNDWATER MONITORING

GROUNDWATER ELEVATION MEASUREMENTS

The static water level was measured in all five monitoring wells (MW-1, MW-2, MW-3, MW-4 and MW-5) on September 24, 1998 and the depths were recorded to the nearest 0.01 foot using an electronic water level sounder. All of the results were recorded on Quarterly Monitoring Data Sheets presented in Appendix B.

MONITORING WELL SAMPLING

The monitoring wells were purged by withdrawing a minimum of three casing volumes from each well using a 2" submersible pump. The purging continued until the turbidity was less than 100 NTU and the temperature, electric conductivity, and pH were relatively stable. Samples were collected when the water levels recovered to at least 80% of the original static level.

A groundwater sample was collected with a disposable Teflon bailer and placed in two 40-ml VOA's and one one-liter amber bottle. The samples were labeled and stored on ice until delivered under a chain of custody to the state certified laboratory. Samples from all five wells (MW-1, MW-2, MW-3, MW-4, and MW-5) were analyzed for total petroleum hydrocarbons as diesel (TPH-D), using EPA methods modified 8015; as gasoline (TPH-G) using EPA methods 8015/5030; benzene, toluene, ethylbenzene, and xylenes (BTEX) using EPA methods 8020; and methyl t-butyl ether (MTBE) using EPA method 8020.

In addition to the petroleum hydrocarbon parameters, samples from the five wells were analyzed on-site for dissolved oxygen and redox potential. Groundwater samples from each of the wells were also submitted to a state certified laboratory for analysis of nitrate, sulfate, iron, total phosphorus, and ammonia.

ANALYTICAL RESULTS

GROUNDWATER HYDRAULIC CONDITIONS

Groundwater Elevation. The groundwater elevation data for the monitoring wells is presented in Table 2. Based on groundwater level measurements collected on September 24, 1998, the depth to groundwater in the wells ranged from 7.2 to 8.8 feet below the top of the casing. The groundwater elevations for the wells were as follows; MW-1 was 22.70 feet above mean sea level (msl), MW-2 was 23.12 feet above msl, MW-3 was 22.30 feet above msl, MW-4 was 23.14 feet above msl, and MW-5 was 22.39 feet above msl.

Groundwater Flow Direction and Gradient. Groundwater flow direction was calculated using three wells (MW-1, MW-2, and MW-3). Groundwater flow direction trended to the southwest (S 19°W) at a gradient of 0.0076 ft/ft. The flow direction and gradient are shown in Figure 3.

LABORATORY DATA

A summary of the hydrocarbon analytical results for the quarterly sampling is presented in Table 3. Table 4 presents the results of on-site sampling for dissolved oxygen and redox potential. A summary of the other bio-parameters is presented in Table 5. The additional bio-parameters included the following; nitrate, sulfate, iron, total phosphorus, and ammonia. Copies of all the analytical data sheets from McCampbell Analytical Lab are presented in Appendix A.

In addition, microbiological analyses were completed in conjunction with enhanced natural attenuation activities for the site. Total aerobic hydrocarbon degraders and total anaerobic degraders were enunmerated in groundwater samples collected from each of the 5 monitoring wells. The results are summarized in Table 6. Copies of the analytical data sheets from CytoCulture are presented in Appendix A.

Table 2
Groundwater Elevation Results at Motor Partners Site
1234 40th Ave., Oakland, California

	DATE	MW-1	MW-2	MW-3	MW-4	GRADIENT
TOC		31.44 ft	31.06 ft	30.43 ft.	30. 37 ft.	
SWL	11/29/95	10.13	9.31	9.53		S 21° W
GSE		21.31	21.75	20.90		0.0082 ft/ft
SWL	2/23/96	4.59	3.77	3.56	3.17	S 26° E
GSE		26.85	27.29	26.87	27.20	0.0033 ft/ft
SWL	5/21/96	6.04	5.24	5.29	4.68	S 5° E
GSE		25.40	25.82	25.14	25.69	0.0064 ft/ft
SWL	8/22/96	8.46	7.66	7.88	7.10	S 19° W
GSE		22.98	23.40	22.55	23.27	0.0077 ft/ft
SWL	11/21/96	8.44	7.73	7.76	7.31	S 23° W
GSE		23.00	23.33	22.67	23.06	0.0062 ft/ft
SWL	2/25/97	6.53	5.78	5.97	5.06	S 30° W
GSE		24.91	25.28	24.46	25.31	0.0076 ft/ft
SWL	5/28/97	8.08	7.38	7.53	6.94	S 31° W
GSE		23.36	23.68	22.90	23.43	0.0071 ft/ft
SWL	9/2/97	9.08	8.24	9.26	7.84	S 20° W
GSE		22.36	22.82	21.17	22.53	0.0086 ft/ft
SWL	11/26/97	7.98	7.24	7.06	6.64	S 11° E
GSE		23.46	23.82	23.37	23.73	0.0057 ft/ft

TOC - Top of Casing Elevations for MW-1, MW-2, MW-3, and MW-4 were surveyed on 8/22/96 by Kier & Wright Civil Engineers & Surveyors, Inc.
SWL - Static Water Level (ft)
GSE - Groundwater Surface Elevation (feet relative to mean sea level)

Table 2 (Continued)
Groundwater Elevation Results at Motor Partners Site
1234 40th Ave., Oakland, California

	DATE	MW-1	MW-2	MW-3	MW-4	MW-5	GRADIENT
TOC		31.44 ft	31.06 ft	30.43 ft.	30. 37 ft.	31.15 ft.	
SWL	3/17/98	5.84	5.05	5.11	4.52	5.80	S 11° W
GSE		25.60	26.01	25.32	25.85	25.35	0.0029 ft/ft
SWL	6/26/98	7.09	6.24	6.52	5.52	7.07	S 20° W
GSE		24.35	24.82	23.91	24.85	24.08	0.0089 ft/ft
SWL	9/24/98	8.74	7.94	8.13	7.23	8.76	S 19° W
GSE		22.70	23.12	22.30	23.14	22.39	0.0076 ft/ft
SWL							
GSE							
SWL							
GSE							
SWL							
GSE							
SWL							
GSE							
SWL							
GSE							
SWL							
GSE							

TOC - Top of Casing Elevations for MW-1, MW-2, MW-3, and MW-4 were surveyed on 8/22/96 by Kier & Wright Civil Engineers & Surveyors, Inc. Elevation for MW-5 surveyed on 3/20/98 by AEA.
SWL - Static Water Level (ft)
GSE - Groundwater Surface Elevation (feet relative to mean sea level)

Table 3
Quarterly Groundwater Sampling Results at Motor Partners
1234 40th Ave., Oakland, California

Sample I.D. Number	Date Collected	TPH-D (μg/L)	TPH-G (μg/L)	MTBE (μg/L)	Benzene (μg/L)	Toluene (μg/L)	Ethyl Benzene (μg/L)	Total Xylenes (μg/L)
MW-1	6/17/94	2,400	17,000		1,200	220	1,000	2,600
	11/29/95	53,000	67,000		860	180	1,300	3,100
	2/23/96	25,000	16,000		360	ND	370	740
	5/21/96	650	11,000		290	37	600	1,300
	8/22/96	ND	13,000		270	51	540	1,400
	11/21/96	5,500	15,000		810	79	680	1,700
	2/25/97	3,900	15,000		430	36	760	1,200
	5/28/97	3,700	7,600		110	15	370	870
	9/2/97	8,200	18,000	ND	1,300	81	1,300	2,800
	11/26/97	14,000	24,000	81	760	75	660	2,100
	3/17/98	5,000	14,000	150	360	120	650	1,200
	6/26/98	1,200	2,500	ND	60	5.6	76	110
	9/24/98	2,200	5,100	310	220	27	300	590
California Drinking Water MCL		None Listed	None Listed	None Listed	1.0	1,000	680	1,750
Reporting Limit		50	50	5	0.5	0.5	0.5	1.0

Notes: All results in μg/l (ppb)
ND = Not Detected
NA = Not Analyzed

Table 3 Continued
Quarterly Groundwater Sampling Results at Motor Partners
1234 40th Ave., Oakland, California

Sample I.D. Number	Date Collected	TPH-D (μg/L)	TPH-G (μg/L)	MTBE (μg/L)	Benzene (μg/L)	Toluene (μg/L)	Ethyl Benzene (μg/L)	Total Xylenes (μg/L)
MW-2	6/17/94	370	990		ND	1.3	2.3	4.4
	12/07/94	ND	170		2.1	0.70	0.60	1.7
	11/29/95	200	400		ND	ND	ND	3
	2/23/96	ND	500		ND	ND	ND	ND
	5/21/96	ND	62		ND	ND	ND	1
	8/22/96	ND	120		0.58	0.62	ND	0.62
	11/21/96	89	89		0.60	0.78	ND	ND
	2/25/97	ND	250		1.2	1.0	ND	ND
	5/28/97	ND	ND		ND	ND	ND	ND
	9/2/97	ND	220	ND	ND	1.2	0.80	1.7
	11/26/97	ND	ND	ND	ND	ND	ND	ND
	3/17/98	ND	ND	ND	ND	ND	ND	ND
	6/26/98	170	260	ND	ND	0.86	ND	0.63
	9/24/98	130	240	ND	0.73	1.2	0.8	0.61
California Drinking Water MCL		None Listed	None Listed	None Listed	1.0	1,000	680	1,750
Reporting Limit		50	50	5	0.5	0.5	0.5	1.0

Notes: All results in μg/l (ppb)
ND = Not Detected
NA = Not Analyzed

Table 3 Continued
Quarterly Groundwater Sampling Results at Motor Partners
1234 40th Ave., Oakland, California

Sample I.D. Number	Date Collected	TPH-D (μg/L)	TPH-G (μg/L)	MTBE (μg/L)	Benzene (μg/L)	Toluene (μg/L)	Ethyl Benzene (μg/L)	Total Xylenes (μg/L)
MW-3	6/17/95	2,200	9,500		330	40	100	74
	12/07/94	1,700	7,500		380	42	130	72
	11/29/95	14,000	9,000		300	49	300	16
	2/23/96	14,000	13,000		270	83	260	67
	5/21/96	350	6,600		220	48	160	66
	8/22/96	ND	4,800		120	34	44	44
	11/21/96	3,300	8,700		220	51	150	68
	2/25/97	ND	8,200		260	57	200	72
	5/28/97	1,800	7,000		140	22	44	31
	9/2/97	ND	8,100	65	240	50	170	72
	11/26/97	4,100	5,600	44	140	22	9.6	31
	3/17/98	2,100	10,000	330	270	67	260	96
	6/26/98	2,400	7,600	ND	280	56	160	73
	9/24/98	2,800	6,300	ND	260	65	130	80
California Drinking Water MCL		None Listed	None Listed	None Listed	1.0	1,000	680	1,750
Reporting Limit		50	50	5	0.5	0.5	0.5	1.0

Notes: All results in μg/l (ppb)
ND = Not Detected
NA = Not Analyzed

Table 3 Continued
Quarterly Groundwater Sampling Results at Motor Partners
1234 40th Ave., Oakland, California

Sample I.D. Number	Date Collected	TPH-D (µg/L)	TPH-G (µg/L)	MTBE (µg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethyl Benzene (µg/L)	Total Xylenes (µg/L)
MW-4	2/23/96	3,000	6,000		58	36	6	28
	5/21/96	78	1,200		18	2.5	6.2	12
	8/22/96	ND	400		8.6	3.4	1.8	2.6
	11/21/96	87	170		3.6	1.1	1.7	2.3
	2/25/97	ND	120		5.4	0.64	0.93	0.80
	5/28/97	55	150		5.6	0.64	4.4	8.8
	9/2/97	ND	100	ND	3.2	ND	ND	0.7
	11/26/97	ND	240	ND	6.8	ND	1.8	10
	3/17/98	200	300	8.9	4.4	5.1	5.1	20
	6/26/98	66	ND	ND	7.7	0.50	0.84	0.61
	9/24/98	84	66	ND	4.2	0.59	0.63	ND

Sample I.D. Number	Date Collected	TPH-D (µg/L)	TPH-G (µg/L)	MTBE (µg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethyl Benzene (µg/L)	Total Xylenes (µg/L)
MW-5	3/17/98	22,000	58,000	ND	320	590	790	2,300
	6/26/98	7,000	2,300	ND	54	20	14	41
	9/24/98	2,500	1,600	ND	31	10	6.3	22
California Drinking Water MCL		None Listed	None Listed	None Listed	1.0	1,000	680	1,750
Reporting Limit		50	50	5	0 5	0 5	0 5	1 0

Notes: All results in µg/l (ppb)
ND = Not Detected
NA = Not Analyzed

Table 4. Dissolved Oxygen and Redox Results
Motor Partners, 1234 40th Ave., Oakland, California

Sample I.D. Number	Date Collected	Dissolved Oxygen (mg/L)	Redox Potential (mv)
MW-1	11/26/97	1.5	56
	3/17/98	0.9	-2.0
	6/26/98	1	-64
	9/24/98	1.1	-49
MW-2	11/26/97	3	162
	3/17/98	2.7	90
	6/26/98	4.3	144
	9/24/98	4	175
MW-3	11/26/97	2	67
	3/17/98	1.5	18
	6/26/98	1.8	-72
	9/24/98	1.4	-10
MW-4	11/26/97	2.4	114
	3/17/98	1.7	69
	6/26/98	2.8	99
	9/24/98	2.9	78
MW-5	3/17/98	1.5	40
	6/26/98	0.9	-33
	9/24/98	1.3	-9

Table 5. Results of Additional Bioremediation Parameters
Motor Partners, 1234 40th Ave., Oakland, California

Sample I.D. Number	Date Collected	Ferrous Iron (mg/L)	Ammonia-N (mg/L)	Nitrate-N (mg/L)	Sulfate (mg/L)	Total Phosphorus (mg/L)
MW-1	11/26/97	1.2	<0.05	<0.05	4200	0.06
	3/17/98	2.0	0.22	<0.05	97	0.14
	6/26/98	3.0	ND	ND	2000	ND
	9/24/98	0.25	ND	2	7	0.16
MW-2	11/26/97	ND	<0.05	1.1	3100	0.08
	3/17/98	0.21	0.08	11	41	0.13
	6/26/98	0.087	ND	7.2	33	ND
	9/24/98	ND	ND	37	38	0.08
MW-3	11/26/97	2.8	<0.05	<0.05	4100	0.45
	3/17/98	0.31	0.06	<0.05	<2.0	0.17
	6/26/98	3.0	ND	ND	ND	ND
	9/24/98	0.11	ND	ND	ND	0.24
MW-4	11/26/97	ND	<0.05	0.66	4900	0.16
	3/17/98	0.17	0.06	7.4	33	0.07
	6/26/98	0.21	ND	7.1	32	ND
	9/24/98	ND	ND	40	37	0.09
MW-5	3/17/98	0.49	0.06	0.83	40	0.13
	6/26/98	0.26	ND	1.7	22	ND
	9/24/98	ND	ND	5	24	0.29

Notes: All results in mg/L (ppm)
ND = Not Detected
NA = Not Analyzed

Table 6. Results of Microbiological Analyses
Motor Partners, 1234 40th Ave., Oakland, California

Sample I.D. Number	Date Collected	Aerobic Hydrocarbon Degraders (cfu/ml)	Anaerobic Hydrocarbon Degraders (cfu/ml)
MW-1	9/24/98	$<1 \times 10^1$	4.6×10^2
MW-2	9/24/98	5.4×10^2	3.4×10^3
MW-3	9/24/98	6.5×10^2	4.3×10^3
MW-4	9/24/98	3.6×10^1	5.1×10^2
MW-5	9/24/98	3.9×10^1	5.1×10^3

IMPLEMENTATION OF ENHANCED NATURAL ATTENUATION USING ORC®

At the completion of this quarterly monitoring event, AEA installed oxygen release compound (ORC®) filter socks in three of the monitoring wells. The protocol and calculation of amounts of ORC® required for the site are provided in Appendix C.

A total of 21 two inch diameter filter socks containing ORC® were installed in three of the monitoring wells. Seven filter socks were installed in each of monitoring wells MW-1, MW-3, and MW-5.

A program of sampling has been implemented that will evaluate the effectiveness of ORC® treatment. During future quarterly monitoring events, groundwater samples will be collected for microbiological analysis (enumeration of aerobic and anaerobic hydrocarbon degraders) as well as chemical parameters collected previously.

need to discuss sampling method w/ G. Rogers.

S/w G Rogers

11/2/98 Sampling: propose to spl wells into [illegible]

Cyto culture: $10^2 - 10^4$

G Rogers will send a sampling plan prior to next qtrly event

SUMMARY AND RECOMMENDATIONS

The five monitoring wells at Motor Partners were purged and sampled on September 24, 1998 for the third quarter in 1998. The results of the sampling indicate that hydrocarbon contamination is present in groundwater samples from all five wells. Concentrations of hydrocarbons were in the same range as the results from the previous monitoring period.

TPH-Gasoline and Benzene contamination exists in groundwater on the property. The highest concentrations reported from the five wells were from the groundwater samples collected at MW-1, MW-3, and MW-5. Groundwater flow direction for this sampling period was shown to be in a southwesterly direction.

A program of enhanced natural attenuation has been implemented using Oxygen Release Compound (ORC®). Quarterly groundwater sampling for evaluation of microbiological and chemical parameters will continue at the site.

LIMITATIONS

This report has been prepared in accordance with generally accepted environmental, geological and engineering practices. No warranty, either expressed or implied is made as to the professional advice presented herein. The analysis, conclusions, and recommendations contained in this report are based upon site conditions as they existed at the time of the investigation and they are subject to change.

The conclusions presented in this report are professional opinions based solely upon visual observations of the site and vicinity, and interpretation of available information as described in this report. The scope of services performed in execution of this investigation may not be appropriate to satisfy the needs of other users and any use or reuse of this document or its findings, conclusions or recommendations presented herein is at the sole risk of the said user.

Stanley L. Klemetson Ph.D., P.E.
P.E No. 40087

APPENDIX A

Analytical Results

McCAMPBELL ANALYTICAL INC.

110 2nd Ave. South, #D7, Pacheco, CA 94553-5560
Telephone : 925-798-1620 Fax : 925-798-1622
http://www.mccampbell.com E-mail: main@mccampbell.com

Aquatic & Environmental Applications 38053 Davy Court Fremont, CA 94536	Client Project ID: #1004.95; Motor Partners	Date Sampled: 09/24/98 Date Received: 09/24/98
	Client Contact: Gary Rogers	Date Extracted: 09/26-09/27/98
	Client P.O:	Date Analyzed: 09/26-09/27/98

Gasoline Range (C6-C12) Volatile Hydrocarbons as Gasoline*, with Methyl tert-Butyl Ether* & BTEX*

EPA methods 5030, modified 8015, and 8020 or 602; California RWQCB (SF Bay Region) method GCFID(5030)

Lab ID	Client ID	Matrix	TPH(g)[+]	MTBE	Benzene	Toluene	Ethylbenzene	Xylenes	% Recovery Surrogate
95760	MW-2	W	240,j	ND	0.73	1.2	0.80	0.61	---#
95761	MW-3	W	6300,a	ND<25	260	65	130	80	---#
95762	MW-5	W	1600,a	ND	31	10	6.3	22	---#
95763	MW-1	W	5100,a	310	220	27	300	590	---#
95764	MW-4	W	66,a	ND	4.2	0.59	0.63	ND	---#
Reporting Limit unless otherwise stated; ND means not detected above the reporting limit		W	50 ug/L	5.0	0.5	0.5	0.5	0.5	
		S	1.0 mg/kg	0.05	0.005	0.005	0.005	0.005	

* water and vapor samples are reported in ug/L, wipe samples in ug/wipe, soil and sludge samples in mg/kg, and all TCLP and SPLP extracts in ug/L

cluttered chromatogram, sample peak coelutes with surrogate peak

+The following descriptions of the TPH chromatogram are cursory in nature and McCampbell Analytical is not responsible for their interpretation a) unmodified or weakly modified gasoline is significant, b) heavier gasoline range compounds are significant(aged gasoline?), c) lighter gasoline range compounds (the most mobile fraction) are significant, d) gasoline range compounds having broad chromatographic peaks are significant, biologically altered gasoline?, e) TPH pattern that does not appear to be derived from gasoline (?), f) one to a few isolated peaks present, g) strongly aged gasoline or diesel range compounds are significant, h) lighter than water immiscible sheen is present, i) liquid sample that contains greater than ~5 vol % sediment, j) no recognizable pattern

DHS Certification No. 1644

Edward Hamilton, Lab Director

McCAMPBELL ANALYTICAL INC.

110 2nd Ave. South, #D7, Pacheco, CA 94553-5560
Telephone : 925-798-1620 Fax : 925-798-1622
http://www.mccampbell.com E-mail: main@mccampbell.com

Aquatic & Environmental Applications 38053 Davy Court Fremont, CA 94536	Client Project ID: #1004.95; Motor Partners	Date Sampled: 09/24/98
		Date Received: 09/24/98
	Client Contact: Gary Rogers	Date Extracted: 09/25-09/29/98
	Client P.O:	Date Analyzed: 09/25-09/29/98

Diesel Range (C10-C23) Extractable Hydrocarbons as Diesel *

EPA methods modified 8015, and 3550 or 3510; California RWQCB (SF Bay Region) method GCFID(3550) or GCFID(3510)

Lab ID	Client ID	Matrix	TPH(d)+	% Recovery Surrogate
95760	MW-2	W	130,d	98
95761	MW-3	W	2800,d	99
95762	MW-5	W	2500,g,d	98
95763	MW-1	W	2200,d	96
95764	MW-4	W	84,b	100
Reporting Limit unless otherwise stated; ND means not detected above the reporting limit		W	50 ug/L	
		S	1.0 mg/kg	

* water and vapor samples are reported in ug/L, wipe samples in ug/wipe, soil and sludge samples in mg/kg, and all TCLP / STLC / SPLP extracts in ug/L

\# cluttered chromatogram resulting in coeluted surrogate and sample peaks, or, surrogate peak is on elevated baseline, or, surrogate has been diminished by dilution of original extract

+The following descriptions of the TPH chromatogram are cursory in nature and McCampbell Analytical is not responsible for their interpretation a) unmodified or weakly modified diesel is significant, b) diesel range compounds are significant, no recognizable pattern, c) aged diesel? is significant), d) gasoline range compounds are significant, e) medium boiling point pattern that does not match diesel (?), f) one to a few isolated peaks present, g) oil range compounds are significant, h) lighter than water immiscible sheen is present, i) liquid sample that contains greater than ~5 vol % sediment

DHS Certification No 1644

Edward Hamilton, Lab Director

McCAMPBELL ANALYTICAL INC.

110 2nd Ave. South, #D7, Pacheco, CA 94553-5560
Telephone : 925-798-1620 Fax : 925-798-1622
http://www.mccampbell.com E-mail: main@mccampbell.com

Aquatic & Environmental Applications 38053 Davy Court Fremont, CA 94536	Client Project ID: #1004.95; Motor Partners	Date Sampled: 09/24/98 Date Received: 09/24/98
	Client Contact: Gary Rogers	Date Extracted: 09/25/98
	Client P.O:	Date Analyzed: 09/25/98

Ferrous Iron

SM 3500-Fe D4c

Lab ID	Client ID	Matrix	Fe^{+2} *
95760	MW-2	W	ND
95761	MW-3	W	0.11
95762	MW-5	W	ND
95763	MW-1	W	0.25
95764	MW-4	W	ND
Reporting Limit unless otherwise stated, ND means not detected above the reporting limit		W	0.08 mg/L
		S	5 0 mg/kg

* water samples are reported in mg/L, soil and sludge samples in mg/kg and wipes in mg/wipe

DHS Certification No. 1644

Edward Hamilton, Lab Director

McCAMPBELL ANALYTICAL INC.
110 2nd Avenue South, #D7, Pacheco, CA 94553
Tele: 510-798-1620 Fax: 510-798-1622

QC REPORT FOR HYDROCARBON ANALYSES

Date: 09/25/98 Matrix: WATER

Analyte	Concentration (mg/L) Sample (#95795)	MS	MSD	Amount Spiked	% Recovery MS	MSD	RPD
TPH (gas)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzene	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Toluene	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ethyl Benzene	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Xylenes	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TPH(diesel)	0.0	176	179	150	118	119	1.6
TRPH (oil & grease)	N/A	N/A	N/A	N/A	N/A	N/A	N/A

% Rec. = (MS - Sample) / amount spiked x 100

RPD = (MS - MSD) / (MS + MSD) x 2 x 100

McCAMPBELL ANALYTICAL INC.
110 2nd Avenue South, #D7, Pacheco, CA 94553
Tele: 510-798-1620 Fax: 510-798-1622

QC REPORT FOR HYDROCARBON ANALYSES

Date: 09/26/98-09/27/98 Matrix: WATER

Analyte	Concentration (mg/L) Sample (#95795)	MS	MSD	Amount Spiked	% Recovery MS	MSD	RPD
TPH (gas)	0.0	95.0	91.3	100.0	95.0	91.3	4.0
Benzene	0.0	10.8	10.9	10.0	108.0	109.0	0.9
Toluene	0.0	11.0	11.1	10.0	110.0	111.0	0.9
Ethyl Benzene	0.0	11.1	11.1	10.0	111.0	111.0	0.0
Xylenes	0.0	33.3	33.5	30.0	111.0	111.7	0.6
TPH(diesel)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TRPH (oil & grease)	N/A	N/A	N/A	N/A	N/A	N/A	N/A

% Rec. = (MS - Sample) / amount spiked x 100

RPD = (MS - MSD) / (MS + MSD) x 2 x 100

McCAMPBELL ANALYTICAL INC.

110 2nd Avenue South, #D7, Pacheco, CA 94553
Tele: 510-798-1620 Fax: 510-798-1622

QC REPORT FOR HYDROCARBON ANALYSES

Date: 09/25/98 Matrix: WATER

Analyte	Concentration (mg/L) Sample (#95514)	MS	MSD	Amount Spiked	% Recovery MS	MSD	RPD
TPH (gas)	0.0	94.5	90.3	100.0	94.5	90.3	4.6
Benzene	0.0	10.5	9.9	10.0	105.0	99.0	5.9
Toluene	0.0	10.7	10.0	10.0	107.0	100.0	6.8
Ethyl Benzene	0.0	10.7	10.2	10.0	107.0	102.0	4.8
Xylenes	0.0	32.7	30.8	30.0	109.0	102.7	6.0
TPH(diesel)	0.0	176	179	150	118	119	1.6
TRPH (oil & grease)	N/A	N/A	N/A	N/A	N/A	N/A	N/A

% Rec. = (MS - Sample) / amount spiked x 100

RPD = (MS - MSD) / (MS + MSD) x 2 x 100

GeoAnalytical Laboratories, Inc.

1405 Kansas Avenue
Modesto, CA 95351

Phone (209) 572-0900
FAX (209) 572-0916

CERTIFICATE OF ANALYSIS

Report # J268-03
McCampbell Analytical
110 2nd Avenue #D7
Pacheco CA 94553-5560

Date of Report: 09/30/98
Date Received: 09/25/98
Date Started: 09/25/98
Date Completed: 09/30/98

Project Name: A.E.- Motor P.

Project# 12450

Sample ID	Lab ID	Detection Limit	Method	Analyte	Results	Units mg/L
MW-2	J34919	0.01	365.2	Total Phosphate	0.08	
		1.0	300	Nitrate	37	
		1	300	Sulfate	38	
		0.5	350.1	Ammonia	ND	
MW-3	J34920	0.01	365.2	Total Phosphate	0.24	
		1.0	300	Nitrate	ND	
		1	300	Sulfate	ND	
		0.5	350.1	Ammonia	ND	
MW-5	J34921	0.01	365.2	Total Phosphate	0.29	
		1.0	300	Nitrate	5	
		1	300	Sulfate	24	
		0.5	350.1	Ammonia	ND	
MW-1	J34922	0.01	365.2	Total Phosphate	0.16	
		1.0	300	Nitrate	2	
		1	300	Sulfate	7	
		0.5	350.1	Ammonia	ND	
MW-4	J34923	0.01	365.2	Total Phosphate	0.09	
		1.0	300	Nitrate	40	
		1	300	Sulfate	37	
		0.5	350.1	Ammonia	ND	

Ramiro Salgado
Chemist

Certification # 1157

Donna Keller
Laboratory Director

12450 XAEA4

McCAMPBELL ANALYTICAL INC.
110 2nd AVENUE SOUTH, #D7
PACHECO, CA 94553-5560
Telephone. (925) 798-1620 Fax: (925) 798-1622

CHAIN OF CUSTODY RECORD

TURN AROUND TIME ☐ RUSH ☐ 24 HOUR ☐ 48 HOUR ☒ 5 DAY

Report To: Gary Rogers Bill To:
Company: Aquatic + Environmental Apps.
38053 Davy Ct
Fremont CA 94536
Tele: 510-791-7157 Fax: 510-791-7157
Project #: 1004.95 Project Name: Motor Partners
Project Location: 1234 40th Ave Oakland
Sampler Signature: Gary Rogers

SAMPLE ID	LOCATION	Sampling Date	Sampling Time	# Containers	Type Containers	Matrix: Water	Soil	Air	Sludge	Other	Method Preserved: Ice	HCl	HNO_3	Other
MW-2		9-24	1:05	7		X								
MW-3		|	1:20	7		X								
MW-5		|	1:30	7		X								
MW-1		|	1:40	7		X								
MW-4		9-24	1:50	7		X								

SAMPLE ID	BTEX & TPH as Gas (602/8020 + 8015)/ MTBE	TPH as Diesel (8015)	Total Petroleum Oil & Grease (5520 E&F/B&F)	Total Petroleum Hydrocarbons (418.1)	EPA 601 / 8010	BTEX ONLY (EPA 602 / 8020)	EPA 608 / 8080	EPA 608 / 8080 PCB's ONLY	EPA 624 / 8240 / 8260	EPA 625 / 8270	PAH's / PNA's by EPA 625 / 8270 / 8310	CAM-17 Metals	LUFT 5 Metals	Lead (7240/7421/239.2/6010)	RCI	Other: Ferrous Iron	Total Phosphorus	NO_3^-, NH_3, SO_4		Comments
MW-2	X	X														X	X	X		95760
MW-3	X	X														X	X	X		95761
MW-5	X	X														X	X	X		95762
MW-1	X	X														X	X	X		95763
MW-4	X	X														X	X	X		95764

Relinquished By	Date	Time	Received By
Gary Rogers	9-24-98	3:45	[signature] MAI

Remarks:

ICE/t° ✓ PRESERVATION ✓ (VOAS | O&G | METALS | OTHER)
GOOD CONDITION ✓ APPROPRIATE
HEAD SPACE ABSENT ✓ CONTAINERS ✓

CytoCulture
ENVIRONMENTAL
BIOTECHNOLOGY

CytoCulture International, Inc. 1986

Reporting Date: October 8, 1998

Gary Rogers
Aquatic & Environmental Applications
38053 Davy Ct.
Fremont, CA 94536

Project Description: Motor Partners
Project #: 1004.95
Fax: (510) 791-7157

SAMPLES: 5 water samples were received on 9/24/1998. The samples were assayed that day, and stored at 4°C for any follow up work.

AEROBIC
Hydrocarbon-Degrading Bacteria Enumeration Assays

ANALYSIS REQUEST: Bacterial enumeration for aerobic petroleum hydrocarbon-degraders (broad range petroleum hydrocarbons: diesel and jet fuel).

CARBON SOURCES: Petroleum hydrocarbons were added as the sole carbon and energy sources for the growth of hydrocarbon-degrading aerobic bacteria on agar plates. Chevron #2 Diesel and JP-4 Jet Fuel were blended into the agar to provide dissolved phase aliphatic and aromatic hydrocarbons in the growth matrix.

PROTOCOLS: *Hydrocarbon Degraders:* Sterile agar plates (100 x 15 mm) were prepared with with 1.0 ml of sample, or a log dilution of the sample, at dilutions of 10^0, 10^{-1}, and 10^{-2}. The hydrocarbon plates were poured on 9/24/98 and counted after 7 days on 10/1/98. The plate count data are reported as colony forming units (cfu) per milliliter (ml) of sample. Each bacteria population value represents a statistical average of the plate count data obtained with inoculations for at least two of the three log dilutions tested.

AEROBIC
Hydrocarbon-Degrading and Heterotrophic Bacteria Enumeration Results

CLIENT SAMPLE NUMBER	SAMPLE DATE	HYDROCARBON DEGRADERS (CFU/ML)	TOTAL HETEROTROPHS (CFU/ML)
MW-2	9/24/98	5.4×10^2	NT
MW-3	9/24/98	6.5×10^2	NT
MW-5	9/24/98	3.9×10^1	NT
MW-1	9/24/98	$<1 \times 10^1$	NT
MW-4	9/24/98	3.6×10^1	NT

1.0×10^1 cfu/ml is the lowest detection level for this assay

ANAEROBIC
Bacterial Plate Count Enumeration Assays

ANALYSIS REQUEST: Anaerobic bacterial plate count enumerations for total petroleum hydrocarbon-degraders (broad range petroleum hydrocarbons: diesel and jet fuel).

PROTOCOLS: ***Anaerobic Hydrocarbon Degraders***

These assays are similar in principle to our aerobic assays, except that they are performed in the absence of oxygen. Alternate electron acceptors such as sulfate, nitrate, and ferric iron are added to the media to meet anaerobic respiration needs. A 1:1 mixture of Chevron No. 2 diesel and jet fuel is added to the media to provide the sole carbon sources. A minimal salts mixture, and trace elements are added to meet growth requirements.

Triplicate plates were inoculated with sample log dilutions of 10^{-0},10^{-1}, 10^{-2}, and 10^{-3} .The plates were poured on 9/24/98 and counted after 14 days on 10/8/98. The plate count data are reported as colony forming units (cfu) per milliliter (ml) of sample. Each microbial population value represents a statistical average of the plate count data obtained with inoculations for two of the three log dilutions tested.

A positive control sample was run concurrently with these samples, and the data obtained from this is reported with your results. The positive control sample used was a composite of anaerobic slurries obtained from hydrocarbon- contaminated San Francisco Bay sediment and a Pt. Richmond, CA soil/ wastewater mixture.

Anaerobic
Hydrocarbon-Degrading and Heterotrophic Bacteria Enumeration Results

CLIENT SAMPLE NUMBER	SAMPLE DATE	HYDROCARBON DEGRADERS (CFU/ML)	TOTAL HETEROTROPHS (CFU/ML)
MW-2	9/24/98	3.4×10^3	NT
MW-3	9/24/98	4.3×10^3	NT
MW-5	9/24/98	5.1×10^3	NT
MW-1	9/24/98	4.6×10^2	NT
MW-4	9/24/98	5.1×10^2	NT
+ Control	NA	7.4×10^7	NT

1.0×10^1 cfu/ml is the lowest detection level for this assay

Bacterial enumerations were performed by Dr. Sean P. Bushart. CytoCulture is available on a consulting basis to assist in the interpretation of these data and their application to field remediation protocols.

Sean P. Bushart, Ph.D.
Environmental Microbiologist
Laboratory Services

Randall von Wedel, Ph.D.
Principal Biochemist and
Director of Research

APPENDIX B

Quarterly Monitoring Data Sheets

Quarterly Monitoring Data Sheet

Date: 9/24/98 Project Location: Motor Partners Site 1234 40th Ave., Oakland Sampler: G. Rogers	Well Diameter: 2 Inches Well ID: MW-1 Well Type: Monitoring Well Total Depth as Built: 19 ft Screened Interval: 7 ft to 17 ft
Water Level Data	**Purge Calculation(Min 3 Casing Volumes)**
Time Depth Sounded: 12:10 PM Measured Depth to Water: 8.74 ft. Measured Total Depth: 17.5 ft.	gal/ft X ft = gal X 3 = gal 0.163 X 8.76 = 1.4 X 3 = 4.3

Purge Data

Time	Flowrate (gpm)	Volume (gal)	Temp (°C)	EC (μs/cm)	pH	Turbidity (NTU)
12:20		0	19.0	746		> 1000
12:22		2	19.1	728		138
12:24		4	19.2	736		139
12:26		6	19.1	739		140

Observations/Comments:

Inside Building

Laboratory Analysis:

Sample at 1:40 PM
Water depth -
Analyze for TPH-D, TPH-G, BTEX, and MTBE; Nitrate, Ammonia, Total Phosphorus, Ferrous Iron, Sulfate, REDOX, and Dissolved Oxygen.

Data for Volume Calculation:

1 cu. ft. = 7.48 gal = 62.4 lbs (approx)
2" well = 0.163 gal/linear ft.
4" well= 0 653 gal/linear ft.

1 gal = 0.134 cu. ft. = 8.34 lbs (approx)
3" well = 0.367 gal/linear ft.
6" well = 1.469 gal/linear ft.

Quarterly Monitoring Data Sheet

Date: 9/24/98 Project Location: Motor Partners Site 1234 40th Ave., Oakland Sampler: G. Rogers	Well Diameter: 2 Inches Well ID: MW-2 Well Type: Monitoring Well Total Depth as Built: 22 ft Screened Interval: 10 ft to 20 ft
Water Level Data	**Purge Calculation(Min 3 Casing Volumes)**
Time Depth Sounded: 9:20 AM Measured Depth to Water: 7.94 ft. Measured Total Depth: 19.5 ft.	gal/ft X ft = gal X 3 = gal 0.163 X 11.8 = 1.9 X 3 = 5.8

Purge Data

Time	Flowrate (gpm)	Volume (gal)	Temp (°C)	EC (μs/cm)	pH	Turbidity (NTU)
9:35		0	19.1	733	7.54	>1000
11:20		2	20.0	687		>1000
11:25		4	20.3	688		>1000
11:27		6	20.0	690		177

Observations/Comments:

Pump repair between 9:35 and 11:20 AM
Overcast Skies

Laboratory Analysis:

Sample at 1:05 PM
Water depth -
Analyze for TPH-D, TPH-G, BTEX and MTBE; Nitrate, Ammonia, Total Phosphorus, Ferrous Iron, Sulfate, REDOX, and Dissolved Oxygen.

Data for Volume Calculation:

1 cu. ft. = 7.48 gal = 62.4 lbs (approx)
1 gal = 0.134 cu. ft. = 8.34 lbs (approx)
2" well = 0.163 gal/linear ft.
3" well = 0.367 gal/linear ft
4" well = 0.653 gal/linear ft.
6" well = 1.469 gal/linear ft.

Quarterly Monitoring Data Sheet

Date: 9/24/98
Project Location: Motor Partners Site
1234 40th Ave., Oakland
Sampler: G. Rogers

Well Diameter: 2 Inches Well ID: MW-3
Well Type: Monitoring Well
Total Depth as Built: 23 ft
Screened Interval: 7 ft to 20 ft

Water Level Data

Time Depth Sounded: 11:30 AM
Measured Depth to Water: 8.13 ft.
Measured Total Depth: 20.5 ft.

Purge Calculation(Min 3 Casing Volumes)

gal/ft X ft = gal X 3 = gal

0.163 X 12.4 = 2.0 X 3 = 6.0

Purge Data

Time	Flowrate (gpm)	Volume (gal)	Temp (°C)	EC (μs/cm)	pH	Turbidity (NTU)	
11:43		0	20.3	857		201	
11:45		2	20.2	803		202	
11:47		4	20.2	796		174	
11:49		6	20.3	792		195	

Observations/Comments:

Overcast Skies

Laboratory Analysis:

Sample at 1:20 PM
Water depth -
Analyze for TPH-D, TPH-G, BTEX and MTBE; Nitrate, Ammonia, Total Phosphorus, Ferrous Iron, Sulfate, REDOX, and Dissolved Oxygen.

Data for Volume Calculation:

1 cu. ft. = 7.48 gal = 62.4 lbs (approx)
1 gal = 0.134 cu. ft. = 8.34 lbs (approx)
2" well = 0.163 gal/linear ft.
3" well = 0.367 gal/linear ft.
4" well= 0.653 gal/linear ft.
6" well = 1.469 gal/linear ft.

Quarterly Monitoring Data Sheet

Date: 9/24/98 Project Location: Motor Partners Site 1234 40th Ave., Oakland Sampler: G. Rogers	Well Diameter: 2 Inches Well ID: MW-4 Well Type: Monitoring Well Total Depth as Built: 25 ft Screened Interval: 5 ft to 25 ft
Water Level Data	**Purge Calculation(Min 3 Casing Volumes)**
Time Depth Sounded: 12:38 PM Measured Depth to Water: 7.13 ft. Measured Total Depth: 24.2 ft.	gal/ft X ft = gal X 3 = gal 0.163 X 17.1 = 2.8 X 3 = 8.3

Purge Data

Time	Flowrate (gpm)	Volume (gal)	Temp (°C)	EC (μs/cm)	pH	Turbidity (NTU)	
12:42		0	19.7	789		> 1000	
12:44		2	20.5	718		917	
12:46		4	20.0	716		175	
12:48		6	20.0	701		171	
12:50		8	20.0	687		170	

Observations/Comments:

Partly Cloudy Skies

Laboratory Analysis:

Sample at 1:50 PM
Water depth -
Analyze for TPH-D, TPH-G, BTEX and MTBE; Nitrate, Ammonia, Total Phosphorus, Ferrous Iron, Sulfate, REDOX, and Dissolved Oxygen.

Data for Volume Calculation:

1 cu. ft. = 7.48 gal = 62.4 lbs (approx)
1 gal = 0.134 cu. ft. = 8.34 lbs (approx)
2" well = 0.163 gal/linear ft.
3" well = 0.367 gal/linear ft.
4" well = 0.653 gal/linear ft.
6" well = 1.469 gal/linear ft.

Quarterly Monitoring Data Sheet

Date: 9/24/98 Project Location: Motor Partners Site 1234 40th Ave., Oakland Sampler: G. Rogers	Well Diameter: 2 Inches Well ID: MW-5 Well Type: Monitoring Well Total Depth as Built: 21 ft Screened Interval: 6 ft to 21 ft
Water Level Data	**Purge Calculation(Min 3 Casing Volumes)**
Time Depth Sounded: 11:50 AM Measured Depth to Water: 8.76 ft. Measured Total Depth: 19.2 ft.	gal/ft X ft = gal X 3 = gal 0.163 X 10.4 = 1.7 X 3 = 5.1

Purge Data

Time	Flowrate (gpm)	Volume (gal)	Temp (°C)	EC (μs/cm)	pH	Turbidity (NTU)	
11:59		0	20.0	737		890	
12:01		2	19.5	752		>1000	
12:03		4	19.2	754		>1000	
12:05		6	19.2	760		295	

Observations/Comments:

Inside Building

Laboratory Analysis:

Sample at 1:30 PM
Water depth -
Analyze for TPH-D, TPH-G, BTEX and MTBE; Nitrate, Ammonia, Total Phosphorus, Ferrous Iron, Sulfate, REDOX, and Dissolved Oxygen.

Data for Volume Calculation:
1 cu. ft. = 7.48 gal = 62.4 lbs (approx)
1 gal = 0.134 cu. ft. = 8.34 lbs (approx)
2" well = 0.163 gal/linear ft.
3" well = 0.367 gal/linear ft.
4" well= 0.653 gal/linear ft.
6" well = 1.469 gal/linear ft.

APPENDIX C

Enhanced Natural Attenuation Using Oxygen Release Compound (ORC®)

Regenesis Protocol For Use Of ORC® For IN SITU Bioremediation

1.0 INTRODUCTION

The following protocol was developed by Regenesis as a guide for designing *in situ* bioremediation projects specifying the use of Oxygen Release Compound (ORC®). The basic data required to apply natural attenuation is included in this protocol because the combined use of ORC and the RBCA process usually represents an attractive alternative to aggressive site remediation. This protocol will assist in developing remedial designs with inherent monitoring processes to control the application of *in situ* bioremediation technologies.

The protocol is designed to be flexible in respect to the degree of effort expended for each project. The appropriate level of control to match the scale of the project can be determined by selecting the type and amount of data collected. Lists of suggested parameters for data collection are provided below. Not all data is available or appropriate for each site, but the minimum required data is identified in the protocol by an asterisk (*). An emphasis was placed on those parameters that could be monitored with minimal costs using field instrumentation.

2.0 PRE-SCREENING MODEL

Plume delineation is essential to ensure that appropriate remediation steps are taken. The responsible party and/or consultant should determine whether the plume representing the Compounds of Concern (COC) is shrinking, stable in size, or spreading.

The majority of the site specific data required to pre-screen a site for applicability of ORC technology will be available from the assessment efforts. The specific data requirements for investigations can vary substantially from state to state and over time. If historical investigation reports do not contain the all of the required information, some of the qualitative data can be inexpensively collected in the field with monitoring equipment The data groups required to pre-screen a site are:

A. Lithologic/Hydrogeologic/Microbiological Data

<u>Minimum Required Data*</u>

- Aquifer soil texture*
- Groundwater flow direction and velocity*
- Dissolved oxygen (DO)*
- pH*
- Temperature*

<u>Additional Data for Greater Control</u>

- Concentration of alternate terminal electron acceptors (nitrate, iron, manganese, sulfate)
- Soil microbial enumerations of contaminant degrading bacteria
- Biological oxygen demand (BOD)
- Oxidation/Reduction(RedOx) potential or Eh
- percent porosity (*total and effective*)
- Conductivity
- Total minerals

B. Compounds of Concern (COCs) Data.

<u>Minimum Required Data*</u>

- Dissolved concentrations of COCs* (i.e , BTEX, MTBE, TPH-G, TPH-D)

<u>Additional Data for Greater Control</u>

- Adsorbed concentrations of COCs in the capillary fringe or vadose zone soils that will contact groundwater

The soil texture and porosity data are used to calculate the mass of dissolved COCs and the mass of oxygen required to bioremediate the COCs. A significant component of the COC mass consists of COCs adsorbed to the soil. Besides the solubility of the COC the mass of adsorbed material is usually related to the soil type, texture and carbon (organic/inorganic) content. For example, typically a well graded sand with little or no silt or clay will have a smaller adsorbed component than soil types composed primarily of silt and clay. In order to account for unknowns such as the adsorbed COC mass as well as non-target BOD and COD we assign a demand factor. This demand factor ranges from 8x for a sand with little or no silt or clay to 11x for soil types composed primarily of silts and clays.

Groundwater flow and velocity are used to estimate the flux of COCs and potential for dispersion of dissolved oxygen. Typically, the greatest efficiency of DO transport downgradient is achieved via advective flow (greater than 0.3 ft/day). Advective transport of DO through a heterogeneous aquifer material also enhances DO distribution in the aquifer. A low/no velocity site will primarily rely on chemical diffusion rather than advective flow to distribute the dissolved oxygen. Dissolved oxygen data is used to establish baseline conditions for subsequent respirometry events. The pH, temperature, and conductivity data are used to pre-screen for sites that are not conducive to bioremediation technologies. Although adverse conditions related to pH, temperature, and conductivity are rare, it should be noted that fluctuation in groundwater temperature as well as very low or high pH levels can significantly affect the results of an ORC application. A decrease of 10oC in groundwater temperature over a typical ORC release period of six months will likely decrease the biodegradation activity by one-half. In addition, pH levels of less than 5 or greater than 10 can affect the release rate of ORC. Levels of pH less than 5 can cause a release of DO at a moderately accelerated rate while pH levels of greater than 10 will moderately slow the DO release rate.

The concentration of alternate terminal electron acceptors, e.g. NO3, Fe, Mn, SO4, data is used to establish the potential for application of natural attenuation. Microbial enumerations of soil samples by plate count methodology confirms the presence of bacterial populations with the capacity to use the COCs as a carbon and energy source. This data is usually not included in standard investigation reports, but the concentration of DO can be used to infer the presence of adequate bacterial populations when low DO concentrations mirror the extent of high COCs concentrations.

The BOD data is used to estimate any organic-based oxygen demand other than the COCs. Non-target BOD also acts as a DO "sink" because the non-target biodegraders compete with the targeted degraders for the DO. This DO "sink" may compete with the targeted biodegraders to the extent that additional ORC applications will be necessary. Eh data indicates the areas of highly reduced conditions which may require additional ORC applications. Highly reduced conditions exert a significant COD on ORC. This COD competes with the biodegraders for DO. This non-target DO "sink" may compete with the biodegraders to the extent that additional ORC applications will be necessary. Alkalinity measurements were not included due to the complexity of carbonate chemistry in aquifers and the substantial variability between geographic locations for this parameter.

The concentration of dissolved COCs is used to estimate the mass of hydrocarbons to be bioremediated. The adsorbed COCs concentrations are used to estimate the total mass of hydrocarbons that will be remediated over time in the aquifer (see above).

3.0 REGULATORY APPROVAL

The regulatory approval of both the ORC technology and RBCA process should be investigated prior to further design. Currently, ORC and RBCA are approved by most state environmental lead agencies. There is often a substantial variability between individuals in a state or local lead agency regarding any remedial technology and application of risk based closure. For this reason, it is prudent to initiate communications with site case workers regarding the intended use of ORC and RBCA closure at the onset of the project.

4.0 BASELINE PARAMETERS

The following list of parameters should be collected from a series of existing monitoring wells at each site It is recommended that the array of monitoring wells to be used for the baseline analyses are also used for subsequent treatment monitoring. For that reason the number of wells will greatly influence total analytical costs It is recommended that a minimum of three wells in the treated area and one upgradient well be included in the monitoring array.

The following parameters are recommended for baseline assessment:

A. Microbiological/Respirometry Data

<u>Minimum Required Data*</u>

- Biological oxygen demand (BOD)*
- Oxidation/Reduction (RedOx) potential or Eh*
- Dissolved oxygen (DO)*
- pH, temperature and conductivity*
- total minerals*
- concentration of alternate terminal electron acceptors (nitrate, iron, manganese, sulfate)*

<u>Additional Data for Greater Control</u>

- soil microbial enumerations of contaminant degrading bacteria

B. Compounds of Concern (COCs) Data.

- dissolved concentrations of COCs* (i.e., BTEX, MTBE, TPH-G, TPH-D)

5.0 APPLICATION PROTOCOL

The ORC application approach should reflect the remedial goals for the site. In some cases application of ORC is necessary across the entire plume "footprint", while other sites may require only a limited source area application. However, a limited application of ORC should be carefully considered prior to site implementation. Application of ORC at levels below the modeled parameters may lead to under-performance. Under-performance may be the result of numerous factors. Typically it is the result of underestimation of the DO requirements of the COC mass or aquifer COD. A scaled back approach equates to a scaled back result. Typically, multiple applications of ORC are necessary.

The use or application of ORC should reflect specific site objectives. These objectives may range from RBCA clean up levels to MCL's. Prior to implementation, the following list of issues should be addressed:

- Vertical (thickness of the contaminated saturated zone) and lateral extent of the hydrocarbon plume. The vertical extent is critical because ORC releases oxygen which moves laterally from ORC. Where you put ORC is where you will provide the oxygen. DO does not rise through the water column; it remains within the interval in which the ORC is placed.

  - Evaluation and selection of an optimal application approach.
  - REGENESIS application software should be used to estimate the hydrocarbon mass present within the system as well as the amount of DO/ORC necessary to remediate the calculated hydrocarbon mass.
  - It is important to evaluate the DO/ORC requirement based on the mass of the hydrocarbons present as well as the proper distribution of DO in the aquifer. Evaluation of a site based on the hydrocarbon mass alone will not provide a correct answer.
  - Fewer source points containing large dosages of ORC (DO) are less effective in plume reduction than greater numbers of point sources containing smaller dosages of ORC (DO).

ORC applications can be divided into two general categories: 1) mass reduction ("source treatment") and 2) containment ("oxygen barrier treatment").

Mass reduction applications consist of the following:

1 Tank Excavation Backfill Amendment--use as an admixture into excavation backfill material
2. Slurry Injection or Backfill--physical distribution of an ORC slurry directly into the aquifer via a direct push or hollow stem augered hole placement of the ORC array immediately upgradient and/or proximal to the source area will allow aerobic degradation processes to occur within the plume's anaerobic core.

Containment applications consist of the following:

1. Application of ORC filter socks into wells or an ORC slurry into bore holes. The wells or bore holes should be placed along the downgradient property boundary. The ORC source points should be placed perpendicular to groundwater flow and the distance between the points should be appropriately spaced. This application must account for the hydrocarbon concentration as well as groundwater velocity.

6.0 POST APPLICATION–TREATMENT MONITORING

The treatment monitoring process is designed to quantify the degradation of dissolved COCs. Respirometry measurements also provide evidence that bioremediation is the primary mode of destruction of the COCs. The respirometry monitoring is monthly for the first quarter, quarterly for the remainder of the first year, semi-annually for the second year, and annually for any additional years. It should be noted that ORC applications can be designed to reduce concentrations of COCs over a flexible time frame. It is recommended that an economic analysis of ORC applications compared to monitoring costs for long term RBCA activities be conducted to realize maximum remedial efficiency.

The following parameters are recommended to analyze treatment monitoring:

A. Microbiological/Respirometry Data

Minimum Required Data*

- Biological oxygen demand (BOD)*
- Oxidation/Reduction (RedOx) potential or Eh*
- Dissolved oxygen (DO)*
- pH, temperature and conductivity*
- Total minerals*
- Concentration of alternate terminal electron acceptors (nitrate, iron, manganese, sulfate)*

Additional Data for Greater Control

- Soil microbial enumerations of contaminant degrading bacteria

B. Compounds of Concern (COCs) Data.

- Dissolved concentrations of COCs* (i.e., BTEX, MTBE, TPH-G, TPH-D)

7.0 ESTABLISH RATE CONSTANTS FOR ORC APPLICATION AND RBCA PROCESS

The remediation of hydrocarbons using ORC over a wide range of site conditions will provide baseline data to establish relative rate constants. These data should be collected and analyzed during initial ORC applications at various sites, under various hydrogeologic conditions. This will provide a more reliable degradation rate constant for standard applications of ORC, compared to obtaining site specific rate constants. The current ORC applications software uses a first order decay rate constant, and this effort should provide an alternative rate constant for future designs.

CALCULATION OF ORC® REQUIREMENTS FOR THE MOTOR PARTNERS SITE

The REGENESIS application software was used to estimate the hydrocarbon mass present at the site and to calculate the amount of DO/ORC necessary for remediation. The use of filter socks in existing wells was selected as an appropriate method to enhance natural attenuation at the site. The following page presents the results of the software analysis for the Motor Partners site using input data from earlier investigations and quarterly sampling events.

The results suggested that a total of 21 filter socks (seven socks each installed in three of the wells) would be required to remediate the site.

OXYGEN BARRIER - REPLACEABLE SOCK WELLS

Dissolved Hydrocarbon Level (ppm)	3.8
(For gasoline sites use BTEX measurements)	
Plume Width (ft)	70
Plume Velocity (ft/day)	0.25
Thickness of contamination in Saturated Zone (ft)	7
Thickness of ORC Filter Socks in Saturated Zone (ft)	7
Porosity	0.3
(sand = 0.3, silt = 0.35, clay = 0.4)	
Barrier Safety Factor	2
(recommended value is about 2)	
Hydrocarbon Load Per Day (lbs)	0.017
Oxygen Demand per Day (lbs)	0.051
Oxygen Required (lbs)	9.2

Well Diameter (in.) ***enter 4 or 6 ONLY***	4
Number of Wells	3
Well Spacing (ft.)	23
Total Number of Socks	21
Oxygen Available (lbs)	5.775
Unit price per ORC sock	$ 37.50
Total Cost of ORC Socks per Charge	$ 787.50
Percent of O2 Available to O2 Requied	63%

Solute Transport Model

Compliance Point (ft)	50
HC Level at compliance point (ppm)	0.562

APPLICATION COMMENTS

* Barrier Design should potentially handle constant mass flux requirements

Glossary of Terms

Additional Demand Factor
A factor to account for other oxygen sinks, such as BODs, CODs, sorbed material, plus other sorbed volatiles. Regenesis recommends a factor of 8 as standard practice. A factor of 2 should be used for barrier applications due to the fact that barriers are used for containment of a known source, which will have a tendency to desorb over time. The mass that passes through the barrier is a function of desorbtion in the source area.

Effective Porosity
The volume of the void spaces through which water or other fluids can travel in a rock or sediment divided by the total volume of the rock or sediment

Loaded Hydrocarbon Mass
A value equal to the dissolved mass and the additional demand factor representative of an equivalent hydrocarbon mass which will require oxygen on a 3 : 1 mass basis.

Porosity
The ratio of the volume of void spaces in a rock or sediment to the total volume of the rock or sediment

Ratio of O2 provided to O2 required
The ratio of the oxygen provided by ORC application to the theoretical oxygen required to clean up a site. This value is also used to calculate the concentration at a compliance point in the solute transport model.

Safety Factor
A factor used to account for system loses due to variability in hydraulic conductivity, groundwater velocity, and dissolved oxygen spreading downgradient from an oxygen barrier.

Solute Transport Model
The solute transport model calculates the attenuation of hydrocarbons between two points with the influence of ORC in the system. The equation is as follows:

Cx = Co*exp [(x/2*a)*[1-(1+(4*lam*a)/v)^0.5]]

Cx = Final Concentration
Co = Initial Concentration
x = distance to compliance point
a = dispersivity
lam = decay rate
v = velocity

For more information on this equation please call REGENESIS and ask for "Regression Techniques and Analytical Solutions to Demonstrate Intrinsic Bioremediation" by Timothy E Buscheck and Celia M. Alcantar.

Source Treatment
A method of ORC Application designed at remediating a contaminated zone beneath a designed area by calculating the total hydrocarbon mass in a specific volume.

ORC OXYGEN BARRIER APPLICATION

Replaceable Well Socks

The ORC Oxygen Barrier treatment has the objective of reducing liability by stopping the migration of a contaminated groundwater plume beyond the property boundary or achieving compliance at a downgradient point. The ORC is best applied in completed monitoring wells with screened intervals through the contaminated portion of the saturated zone. In this application, a mixture of ORC and inert silica sand is contained in filter socks. After 6 months, when the oxygen is depleted, the socks may be removed from the wells and replaced with new socks. Treatment factors to account for unknown oxygen demands are not as important in this application since the socks may be replaced, so an additional demand factor of 2 is used.

In this application, it is assumed that there is a continuous source of dissolved phase hydrocarbons moving through the ORC oxygenated zone. The oxygen in this zone is replenished by replacing the ORC filter socks. The objective is to completely contain the contaminant or to reduce it so that compliance may be achieved at a point downgradient. The software permits design and placement of the oxygen barrier wells in any configuration that is appropriate for the site. The dispersion of the oxygen from the ORC must be considered. A thorough discussion of this subject is found in Regenesis Technical Bulletins 4-1.0 through 4-1.3. In general, to get overlapping oxygen coverage the wells need not be placed closer than five feet on center. Twelve feet on center is about the maximum which can provide overlapping oxygen dispersion.

Once the basic site characteristics are entered, the software will ask for the well diameter, number of wells, well spacing, and the distance to the downgradient compliance point. From this data, a calculation of the ratio of oxygen available to oxygen required is generated. If this number is greater than 1.0, then there is theoretically enough oxygen in the system to remediate the hydrocarbon load passing through the barrier. It should be noted that actual treatment efficiencies may vary downgradient from the ORC Barrier due to discrete variability in the hydraulic conductivity, groundwater velocity, hydrocarbon mass present, and the spreading of dissolved oxygen from the source. If the ratio of oxygen available to oxygen required is less than 1.0 then the program calculates the hydrocarbon concentration at the downgradient compliance point using a variation of the Dominico-Schwartz attenuation model, published by Tim Buschek of Chevron. The user may then increase or decrease the ORC oxygen load provided to the aquifer to achieve a specific compliance level at the downgradient compliance point.

In order to achieve and maintain compliance, the ORC oxygen barrier must be recharged. As the barrier is recharged the number of socks needed should be reevaluated This reevaluation is primarily dependent upon the continuance of the contaminant source. If this load decreases, or increases, then the total number of socks per charge may be decreased, or increased, accordingly.

Slurry Injection Barrier

The ORC Slurry Injection Barrier model is appropriate when the cost of completed monitoring wells can be avoided. The user is prompted to input all the basic site characteristics, as with in the replaceable sock barrier, then the software outputs the theoretical required amount of ORC needed to remediated the contaminated plume. The ORC per hole and the minimum spacing are also calculated. These values are directly related to the number of holes, so by changing the number of holes a good spacing can be found for a specific soil type (closer spacing for tight soils and farther spacing for sandy soils). The user can vary the number of points in a barrier in order to design a custom barrier to fit their specific sites needs. The solute transport model is included in this model in order to allow the user to see what the hydrocarbon level will be at their compliance point. This is done by varying the ratio of oxygen provided to oxygen required. A ratio of 100% is considered to be full clean up, so anything below that will raise the hydrocarbon level at the compliance point.

Slurry Backfill Barrier

The ORC Slurry Backfill Barrier model is identical to the ORC Slurry Injection Barrier with a few exceptions. Once the total amount of ORC is calculated, the model asks you input the desired number of holes. From this input three main calculations are made, ORC per hole, hole spacing, and minimum hole diameter. It might seem odd to calculate the minimum hole diameter due to the fact that bore holes usually come in standard sizes. However the relationship between the number of holes and the hole diameter is directly related, so by varying the number of holes the hole diameter can be fit to a standard auger size. The solute transport model is also included in this model and is used in exactly the same way as in the slurry injection barrier.

ORC® FILTER SOCK
INSTALLATION INSTRUCTIONS

ORC® Filter Socks are used to enhance bioremediation of petroleum hydrocarbons in groundwater. The filter sock contains ORC and an inert carrier matrix. The socks come in one foot sections. They are laced together to span the vertical polluted saturated zone in monitoring type wells. Once the socks are laced together and lowered into the well, they become hydrated and begin releasing oxygen. The following instructions are vital to proper installation and subsequent removal of the socks.

SAFETY PRECAUTIONS

- ORC is completely non-toxic, but is composed of ultra-fine particles.
- Wear dust masks and goggles to prevent soft tissue irritation.
- Reference the Material Safety Data Sheet for specific technical and physical information.

CONDITION OF SOURCE WELLS

- Test for well deviation and smoothness before ORC installation.
    - For the test, use a 5 foot section of pipe with an outside diameter 1/2 inch smaller than the source well's inside diameter.

KEY REQUIREMENTS FOR INSTALLATION

A) **SOCKS MUST BE INSTALLED WITH BLACK GROMMETS ON TOP.**
B) Wrap socks as independent units (see page 3, figure 5).
C) A maximum of 20 2-inch socks per section.
D) A maximum of 8 4-inch socks per section.
E) A maximum of 6 6-inch socks per section.
F) Make sure each sock is properly shaped (cylindrical and without bends) to facilitate ease of installation and removal.

HELPFUL HINTS

- ORC matrix hardens into a cement once hydrated.
- Minimize slack between each sock, by periodically pulling up slack while lacing.
- Tie off ORC retrieval lines to the well cap. **REGENESIS** recommends the use of a 3/8" diameter x 6" long eyebolt.
- The ORC Socks should be wetted to prevent excessive dusting just prior to installation.
- Make sure your work area is clean to avoid oil and dirt deposits on the socks.

ORC REMOVAL

- ORC socks will be approximately 20% heavier after water saturation.
- Static friction from screened casing may cause difficulty in removal.
- A winch and stanchion (or comparable equipment) may be necessary to help remove the socks due to increased weight, friction etc.

(SEE DETAILED FIGURES INSIDE)

REGENESIS
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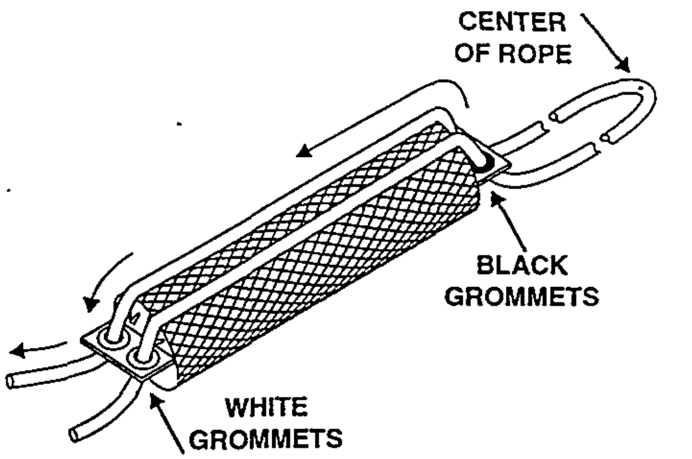
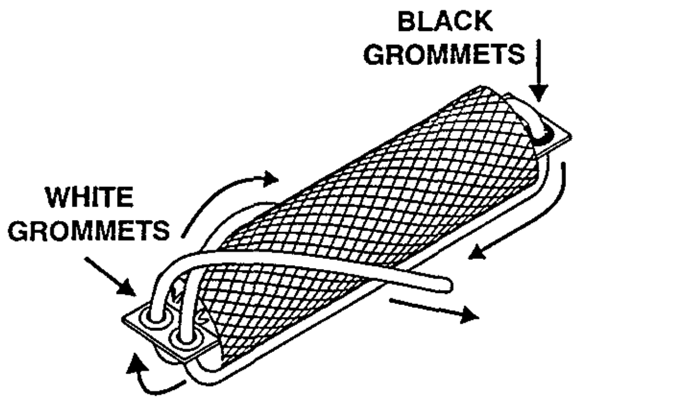
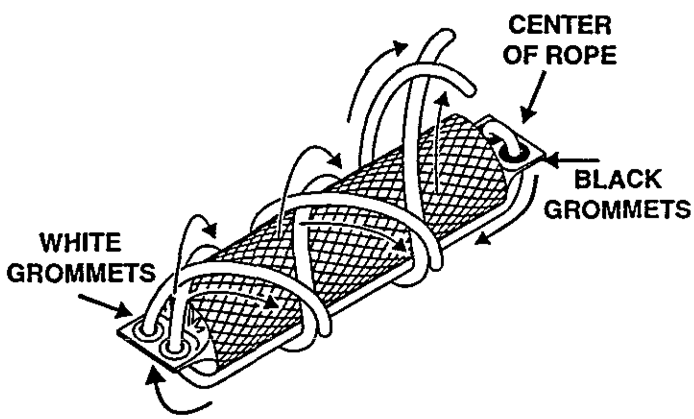
4 INCH AND 6 INCH LACING DIAGRAM



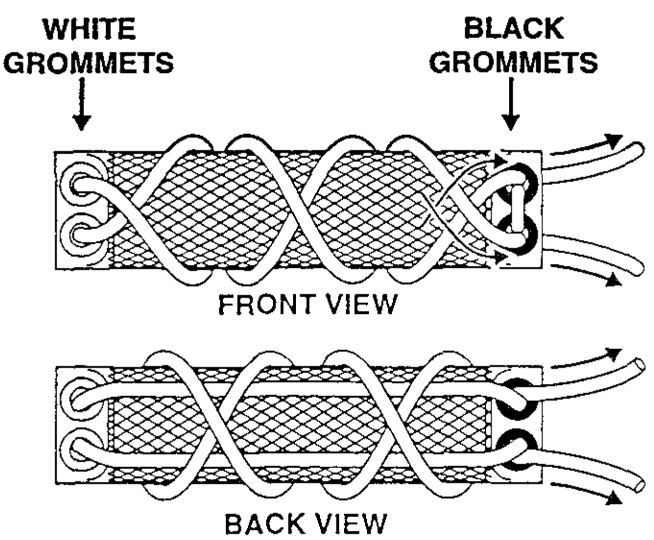
1) Find the center of the rope. Begin lacing the ORC Socks by threading the two ends of the installation rope through the black grommets and then through the white grommets at the bottom of the same side of the bottom sock.



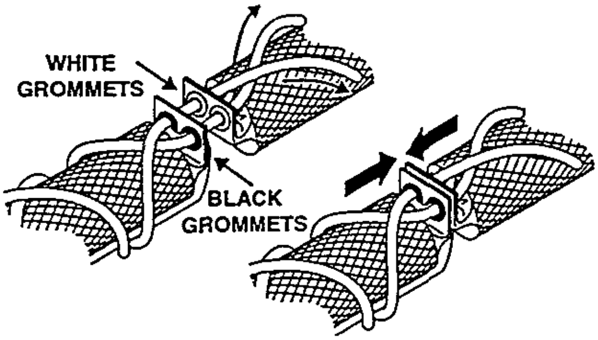
2) Pull the rope through the bottom sock, making sure the center of the rope is between the black grommets. Cross the ropes over each other.



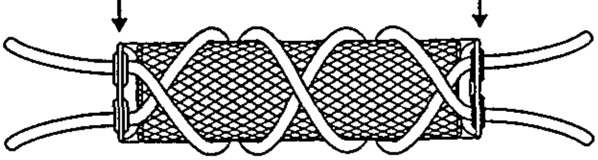
3) Loop the ends of the rope around the back of the sock and cross them. Repeat this step once again, so the rope is wrapped around the sock with two full turns.



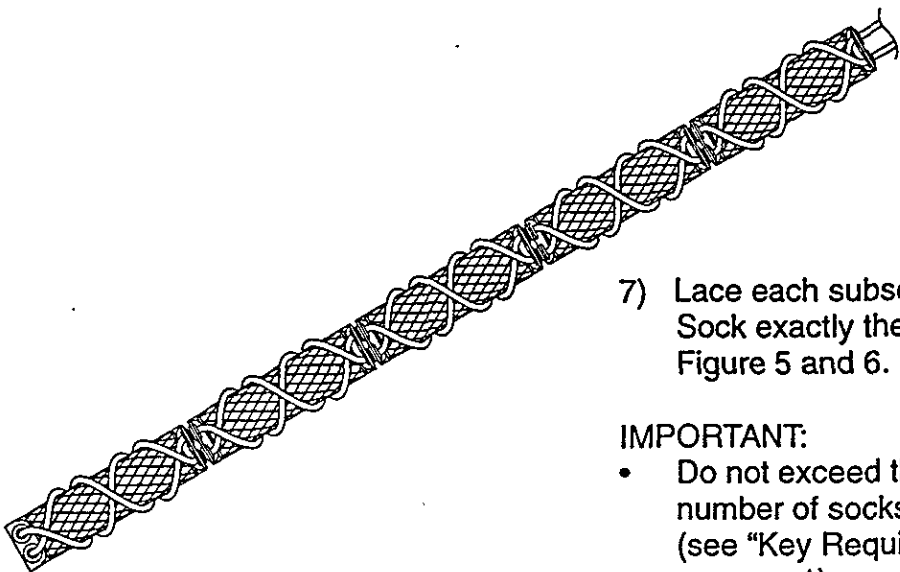
4) Bring the ends of the rope around from the back, cross them, and thread them into the black grommets. The rope ends should be inserted into the black grommets diagonally from the white ones they started from. Threading the black grommets will be tight only on the bottom sock due to the unique lacing pattern.



5) To avoid the ORC Socks slipping past each other, the socks must be laced with the grommet flaps of the bottom sock and second sock butting against each other (as shown).



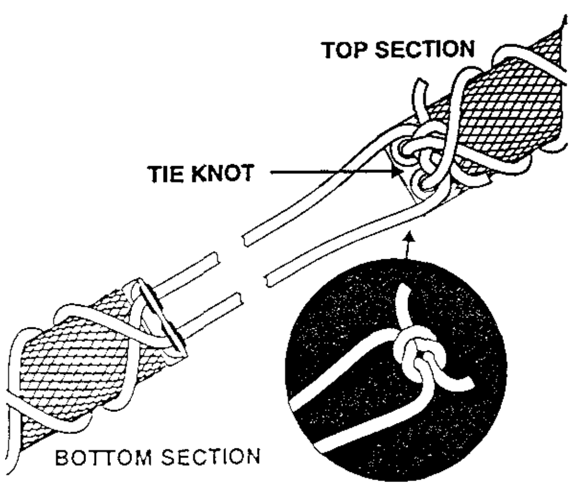
6) The remaining socks on the rope section are laced up according to Figure 6. Make sure that the rope is turned around the sock two full turns, with the grommets of each sock butting up against the next sock as shown in Figure 5.



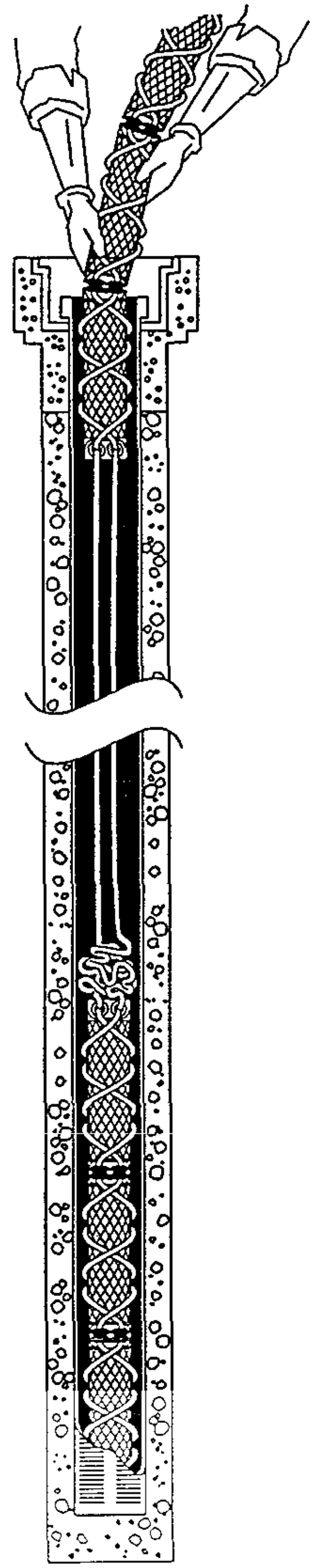
7) Lace each subsequent ORC Sock exactly the same as in Figure 5 and 6.

IMPORTANT:

- Do not exceed the maximum number of socks per section (see "Key Requirements D & E" on page 1).
- Minimize the slack between the socks.

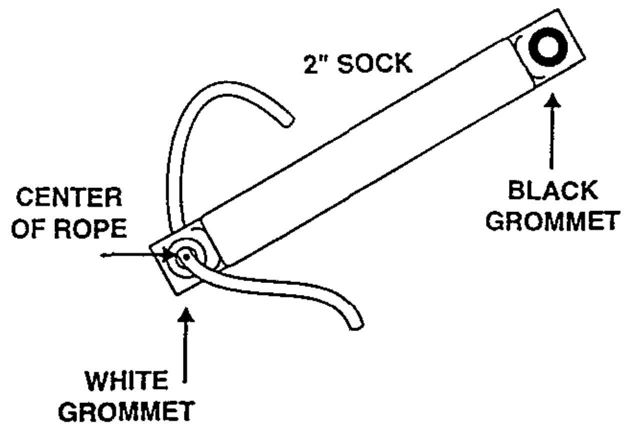


8) If you need to install more ORC Socks than the maximum allowed per well size (see "Key Requirements D & E" on page 1), then multiple sections must be installed. Each section is laced exactly the same, but they should be tied off to each other. Tie the end of the rope from the lower section to the bottom sock of the upper section; this allows each section to be installed and removed independently. (see well diagram)

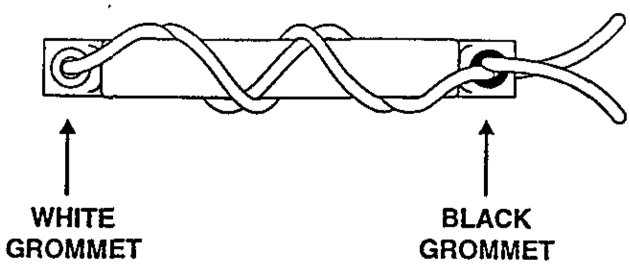


Well Diagram

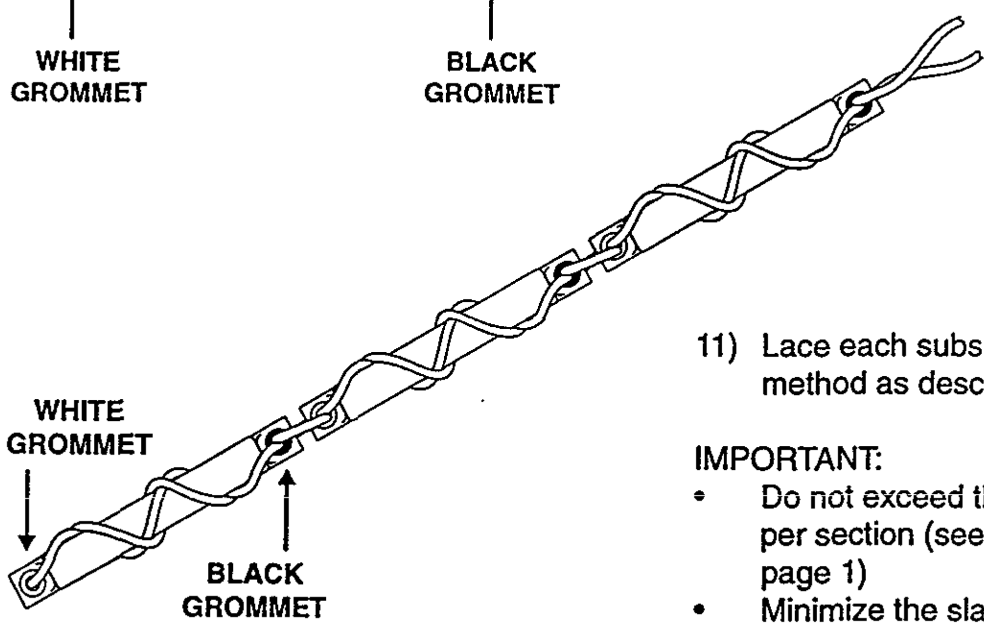
2 INCH LACING DIAGRAM



9) Find the center of the rope. Begin lacing the ORC Socks by threading one end of the installation rope through the white grommet, making sure that the center of the rope is pulled through to the center of the white grommet on the bottom sock.



10) Wrap each end of the installation rope around the sock twice and then cross them through the black grommet.



11) Lace each subsequent sock using the same method as described in Figure 2 above.

IMPORTANT:

- Do not exceed the maximum number of socks per section (see "Key Requirements B" on page 1)
- Minimize the slack between socks.

Please call our technical support personnel with any application questions at (714) 443-3136 between 8:00 a.m. and 5:00 p.m. Pacific Time.
Proper installation is critical to effective use of ORC and avoiding problems in the well.